NATIONAL CONFERENCE on

Electronics Communication, Intelligent Computing and Information System (ECICIS 2020)

5 SEPTEMBER 2020

Organized by:
DEPARTMENT OF ELECTRONICS AND COMMUNICATION
L. D. COLLEGE OF ENGINEERING, AHMEDABAD

In association with:
INSTITUTION OF ELECTRONICS AND TELECOMMUNICATION ENGINEERS
AHMEDABAD CENTER
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ABOUT CONFERENCE

L D College of engineering always believes in providing a platform for the development and nourishment of the research. The conference “Electronics Communication, Intelligent Computing and Information System - (ECICIS 2020)” is organized by Electronics & Communication Department, L.D.C.E. on 5th September, 2020. This conference is aimed to provide a platform to research scholars, academicians, and industrious to present and share their innovative ideas, work and views with experts.

Since March 2020, due to the corona pandemic, the world comes under the shadow of darkness. We thought instead of cursing the darkness, let us light the candle of creativity and research, so we planned and executed ECICIS 2020 online National Conference totally free without single rupee registration fee. We received total 29 papers out of 15 best papers are accepted and 14 are rejected.

The main motive of this conference is to encourage innovation and ideas in terms of countering the challenges faced in day-to-day lives, activities, and technologies. The conference covers different areas of research including VLSI design, 5G technology, GPS/NAVIC receiver, Wireless design, Neuromorphic, IoT and all the prominent areas on which the whole world is focusing.
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Research activities pave the way for the advancements. As an educational institution, encouragement and support to research can be provided by establishing a platform for the research community, to interact with each other and to share and exchange the knowledge and in turn creating a strong base of the new thought processes.

To promote R & D, the college has created central facilities of Design Lab, DST IT Incubator, Centre of Excellence Welding, Centre of Excellence Siemens, ISRO NAVIC Satellite Communication Receiver, Supercomputer Lab and SSIP Cell for students and teachers. Many departments have got the project grants from GUJCOST, AICTE, DST and SSIP. Recent Start-ups such as Exposit, Reolo, Trauma Patch received National/ International award. Approximately 111 Projects are under SSIP Cell. College has filled 43 Patents in different areas.

I extend my best wishes to all including participants, organizers and those who are witnessing the conference. This National Conference on “Electronics Communication, Intelligent Computing and Information System (ECICIS 2020) on 5th September, 2020.” will be beneficial to all participants in terms of learning experience and sharing experience. Key note addresses from eminent professors and research scientists, paper presentation in different domains will enhance the knowledge and networking among researchers and will also help the participants immensely in their research career. This proceeding of the conference has been documented with utmost care. Once again I extend my pleasure in welcoming all the participants and convey my best wishes for ECICIS 2020.
The organization of National Conference on “Electronics Communication, Intelligent Computing and Information System“ (ECICIS 2020) is a step in the direction to provide a platform where trio of industry, academics and research institute collaborate and implement ideas, which are beneficial to humankind as a whole. When during pandemic the whole nation is step up towards “Atmanirbhar Bharat” and to make our country self-sufficient in Electronics hardware production, this is a small contribution from the EC department of LDCE to ignite the minds of the community.

To promote R & D, the department is involved in central facilities of Design Lab, ISRO NAVIC Satellite Communication Receiver, and SSIP Cell for students. Department is doing various activities like seminars/workshops/expert talk under ISF and IEEE APS/MTTs chapters. Department has motivated the students and approximately 10 Projects are under SSIP Cell. Department has filed 06 Patents in different areas in one year.

The knowledge exchange during conference will bridge the gap for future technical world. The conference covers different areas of research including VLSI design, 5G technology, GPS/NAVIC receiver, Wireless design, Neuromorphic, IoT and all the prominent areas on which the whole world is focusing. This proceeding of the conference has been documented with utmost care. Once again, I wish the excellent will be explored and achieved too.

Finally, I would like to thank all the reviewers and keynote speakers for their involvement. My thanks and appreciations are due to the members of the Local Organizing Committee and Local Technical Committee who worked ceaselessly to make the conference a success. I am also thankful to all those colleagues and friends who gave their input to the conference. I wish all the best to the participants of National Conference ECICIS 2020.
It is matter of pride and happiness that L D College of Engineering, Ahmedabad in association with IETE Ahmedabad is organizing a conference on Electronics Communication, Intelligent Computing and Information System (ECICIS 2020) on 5th Sept 2020. The conference aims to bring researchers from all over nation on a common online platform and to promote research activities in this testing time of COVID-19. The scope of “ECICIS 2020” encompasses various areas of electronics & communication engineering, computer science and engineering, information technology, electrical engineering, instrument and control system.

The conference has varied participants from research institutes, academia, research scholars, Postgraduate and Undergraduate students from all over India. I congratulate all of you whose papers have been selected for presentation in the conference. I am sure that deliberations in the conference will be of immense use and fruitful to the participants.

I congratulate members of organizing committee to timely propose such an appropriate topic for the conference. I complement to all who have contributed directly or indirectly in making the conference a great event.

I wish conference a grand success.
Development of Embedded Linux-based enhanced voice assistance for visually challenged people on W-IoT

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Abstract—Internet of Things (IoT) is evolving in various domains such as smart cities, smart industry, automotive, smart health, wearable, etc. There is a gap in the technology that helps the visually disabled people to this advance level in real time. There is a very much need to have a single robust solution utilizing the information of surrounding with lower latency. A novel embedded system which comprises of camera, sensors and IoT platform for visually challenged people is proposed here in this paper. A novel algorithm to help visually impaired people in navigating the indoor and outdoor environment using voice assistance is introduced. To prove the validity of algorithms, experimental results using Embedded Linux prototypes are shown. Details of the proposed scalable system for optimal solution are presented.

Keywords—Embedded Linux, Embedded system, IoT, voice assistance, object recognition, navigation.

I. INTRODUCTION

The internet of things is the advancement or expansion of current internet. Imagine each of the things associated with each other in regular life. In such situation the individual person has the capacity to monitor his connected things from any place, at any time and from any system [1]. The IoT is expected to provide better quality of life for households and industry. For example, smart homes will provide automatically managed climate control system, air conditions, TVs and other appliances. The usage of IoT is increasing in many domains and wearable IoT is seen as one of the advanced paradigm in health care, fitness, smart watches, etc [2][3]. Human’s eye plays an important role in recognizing information of surroundings because visual signal provides more information than voice information [4]. Visually impaired people face lots of limitations in their day to day life. In today’s world, we can make use of IoT and Embedded Linux technology to solve this problem. There are several solutions developed to provide better life to visually challenged people such as smart cane [5], Brain port [6], Google glass, smart cane with face recognition [4], etc. However, cost effective and scalable solution is important because Andhra Pradesh Eye disease study reported that the odds of having blindness increased with decreasing monthly per capita income [7].

Object recognition and obstacles of surrounding using Open CV or machine learning techniques offers lower latency, but at the cost of higher overall system complexity and storage space. In recent years, wearable IoT platform such as Intel Edison, Raspberry Pi have been a capable small device that allows people to explore computing and programming to make human lives easier by numbers of applications and there are many artificial intelligence-based applications that have been obtained by such devices. To prove the feasibility of our proposed system, we developed an experimental setup using camera, sensors and Raspberry Pi platform. The rest of the paper is organized as follows: Section II provides background and the motivation of this work. Section III gives brief description of Embedded Linux. In Section IV we describe our proposed methodology, algorithms and details of our proposed Embedded Linux based enhanced voice assistance configuration for visually impaired people. Section V presents enhanced and improved results. Finally, Section VI concludes the paper.

II. BACKGROUND AND MOTIVATION

A. Background

Visually impaired people face enormous challenges in their day to day life while navigating on streets, finding door or things especially in the unfamiliar environment. There are existing solutions which have been tried to address this solution. Google glass is resemblance technology but it is not intended for the blind [3]. Brain port [6] refrains the user from speaking and it is not feasible to use in practical scenario. Furthermore, it is an uneconomical solution for blind who belongs to the working class.

The work in [4] further recognizes people, presented in [5] by using smartphone, Wi-Fi camera, bluetooth and microcontroller. To reduce the compute complexity, vibration patterns are generated according to each recognized person. Results presented in [4], [5] consider the use of camera and

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The grant for the development is sponsored by Student Start-up and Innovation Policy (SSIP), Gujarat. Initiative of Education Department, Government of Gujarat, India.
vibration techniques. Data extracted from the camera is limited to recognize the person. In practical scenarios, this is not a valid assumption and to address this issue, the solution has been proposed. In [3], a scalable platform solution for blind people is proposed, where Intel Edison platform is used to utilize its compute for real time solution. However, results presented in [3] observes delay of one second to process camera frame.

B. Motivation

According to the survey report by WHO, Total number of visually impaired people in the world approximately exceeds 285 million and 90% of the world’s visually impaired live in low-income settings [7][8]. It includes 39 million who are blind and 246 million have low vision. Figure 1 shows visually impaired people in different region of the world. Among that only 6.8% of them belongs to higher class. Hence, the surgeries and other assistance device are uneconomical for the rest.

III. EMBEDDED LINUX

Embedded Linux is a Linux Operating System (OS) specifically designed or configured to use for embedded devices such as Raspberry Pi, Intel Edison, BeagleBone, MinnowBoard, smart home devices, etc. The motivation to use embedded Linux on these types of devices is the tiny footprint. The Yocto project from OpenEmbedded is a build framework that provides flexible infrastructure, tools and methods to help you create custom linux for embedded system [9].

Some of the benefits for choosing Yocto framework for embedded Linux OS are:

- Designed for long term use
- Tiny footprint (7 to 15 MB)
- Reuse of software stack
- Ease of customization (saves time and money)
- Supports various architecture and board support packages (IA, ARM, MIPS, etc.)
- Good collection of application developer tools such as SDK, eclipse, power analysis, debug, etc.

Due to these properties and benefits, it is more flexible and suitable to develop software stack for IoT platform or embedded devices.

IV. EMBEDDED LINUX-BASED ENHANCED VOICE ASSISTANCE

To test the proposed solution in real environment a prototype is developed. Raspberry Pi is used as a compute and prototyped the system. System comprises of Camera, GPS, Sensors, mic and speaker. The object recognitions and person recognition are obtained with the help of camera sensor and machine learning technique. Figure 2 depicts the high-level block of proposed prototype system.

![Fig. 2. High-level block of proposed prototype system.](image)

The composite platform solution is designed to provide high degree of flexibility, scalability and cost effectiveness. The proposed solution is designed and optimized to be used on any embedded Linux based devices. In this paper, the work presented in [3] is considered and further the solution has been optimized to provide real time voice assistance using Raspberry Pi board.

The systemd service is utilized to initialize the initial prerequisites such as connecting to speaker, initializing camera, and sensors. Figure 4 and 5 shows an example of Bluetooth connection invoke by systemd service to connect paired...
Bluetooth speaker/headset and it routes the audio packet to speaker/headset to provide voice assistance to user. The tiny you only look once (YOLO) v3 [11] model has been retrained with the custom requirement of objects.

**Fig. 3.** Block diagram of proposed methodology.

**Fig. 4.** Systemd service to invoke蓝牙 connection with paired device.

**Fig. 5.** Service to connect Bluetooth device during start-up of the system and route the audio packets to Bluetooth speaker using Pulse Audio.

Figure 6 shows an experimental setup has been made using Raspberry Pi for feasibility and reliability. The algorithm flow of A-Eye [3] have been used and the work for outdoor navigation and latency optimization is further extended on low end processor i.e., Raspberry Pi. Figure 7 illustrates the flow of a-Eye.

**Fig. 6.** Prototype of Embedded Linux-based enhanced voice assistance system in cap like form factor.

**Fig. 7.** Flow of A-Eye [3] extended to implement outdoor navigation with the help of Google API and minor changes for our proposed system to work with low end processor. The proposed optimize solution can be utilised to work on various embedded devices.

V. RESULTS

A prototype has been implemented as proof of concept for result comparison with a-Eye [3]. The cap like form factor is made which is shown in Figure 6. Raspberry Pi development board have been used to implement face detection/recognition, object recognition and surrounding of the user. Sensors are positioned in different direction to cover 360 degree surrounding of the person. Figure 8 shows an experimental result in milliseconds of object recognition with various objects such as doorknob, banana, car, chair, dog and cat, having an average accuracy of 90-95%. The results of object recognition have been tested multiple times. Figure 9 shows an experimental result of person detection. Table 1 shows an average result from multiple runs using proposed methodology. The result shows that the proposed system reduces the latency as compared to A-eye solution.
This paper proposed a novel embedded Linux based enhanced voice assistance system. The solution which can be utilized on any low-end processor or IoT platform for recognition and detection of surrounding in real-time is presented. To validate the feasibility of proposed system solution, an experimental setup using Raspberry Pi, Camera and sensors is proposed which process the data and provides interactive voice assistance to help visually impaired people. Details of proposed system configuration and solution are discussed. Future work includes face recognition using embedded Linux.

ACKNOWLEDGMENT

We express our deep thanks to Mr. Ankit P. Navik who helped us guiding in the software development and further enhancement. We are deeply thankful to Mr. Devendra N. Tandel for support and guidance. This research is supported by Student Startup and Innovation Policy (SSIP), Gujarat India.

REFERENCES


Fig. 8. An experimental result of object recognition in milliseconds with average accuracy of 90-95% for various objects.

Fig. 9. An experimental result of person detection in milliseconds.

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<td>Object Recognition</td>
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<tr>
<td>Person Detection</td>
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Maximum Power Point Tracking for Photovoltaic Systems Using Ripple Correlation Control

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Abstract—In this work a simulation study of Maximum Power Point Tracking (MPPT) with Ripple Correlation Control (RCC) technique has been done. Photovoltaic (PV) array along with the DC/DC converter and its Maximum Power Point Tracking (MPPT) control strategy has been implemented with RCC for various solar radiations at 25° C, and simulations results are presented. RCC with low pass filter and tuned with Proportional Controller (PI) is implemented. Simulation results show RCC removes all ripples from voltage, current and power outputs.

Keywords—PV, MPPT, RCC, Ripples, DC/DC converter, PI controller.

I. INTRODUCTION

Sustainable energy resources are always in demand due of the fast and continuous depletion of conventional resources. Among all these sustainable energy resources, solar energy preferred widely and which has the potential to replace conventional energy sources. It is one of the most sustainable sources of renewable energy and is harvested using photovoltaic systems; these systems are environment-friendly. But, this green energy harvesting also suffers some drawbacks. During all day time the level of solar insolation is not same and also increase in temperature degrades the power transfer to load. Due to which the power generated by solar panels is not same all the time and hence each and every time the MPP varies [1]. Solar panel can deliver maximum power to load for a fix value of voltage and current. This point is known as Maximum Power Point (MPP).

![Single stage PV system block diagram.](image)

Presently per watt production cost of solar energy is not that much economical, so efforts have been made to improve its efficiency with the help of DC-DC converters and charge controllers. These converters have many advantages in solar PV system like it can provides isolation, effective in tracking maximum power point and hence in maximum power extraction. Also, their control can be made simple. Power electronic converter systems are used to deliver maximum power and the switching of these converters is controlled by the duty-cycle generated by the MPPT algorithm. Mainly there are two available types of charge controllers; (i) Pulse Width Modulation (PWM) and (ii) Maximum Power Point Tracking (MPPT). MPPT charge controller is preferred over PWM in Photovoltaic systems since a typical PWM charge controller can only be able to regulate the output voltage of a Photovoltaic (PV) array, but not the current, whereas, in MPPT controller voltage and current both can be regulated. The complete block diagram of a typical in these techniques has been proposed. The main shortcomings of conventional algorithms like HC, P&O & IC is they are incapable of tracking MPP under varying environmental conditions i.e. change in irradiance or temperature. The other major drawbacks are slow tracking speed, poor convergence, and high steady state oscillations. Therefore, to track MPP under varying environmental conditions, conventional methods need to be integrated along with other methods for better performance. Even though the above alterations have enhanced its performance but not sufficient enough under all operating conditions [6, 14, 23]. It gives a motivation to find some alternative ways to solve this problem.

Ripple Correlation Control (RCC) [26-30] provides a solution of this steady state ripple problem, which is caused by internal ripples present in the system, due to the power electronic circuitry. As P&O, IC and hill Climbing all these methods do not consider these ripples as internal perturbations, due to which the algorithm just takes these ripples as external perturbations and output oscillates around MPP, which in turn creates oscillations in output voltage and current, and hence in power. These oscillations are harmful for the load.

![P-V and I-V Curves of the PV panel.](image)
There are many alternative strategies that also evolved, like Soft Computing methods, optimization techniques; to solve multiple MPP point problems. RCC technique has been well received by the research community due to its ease of implementation, robustness and ripple removal characteristics. In this work simulation of RCC with boost converter has been done for ripple free high-power requirements.

II. Ripple Correlation Control (RCC)

Ripple correlation control is a nonlinear control approach for power electronics applications [26-27]. RCC use current, voltage, or power ripple and correlates it with the switching functions to affect control [27]. The RCC solves major problems through less complex implementation. The most important factors and advantages of the RCC are the simple circuit implementation, fast computation/simulation time, there is no need for external perturbation like in P&O and IC, to generate ripple contents, converges asymptotically to the object and its converging rate can be tuned by the controller gain. RCC removes all the ripples caused by power electronics circuitry, whereas conventional techniques contain ripples in their output.

RCC is a technique which is used for the calculation of the duty cycle which provides maximum power, which will be supplied to the gate of switching circuits to maintain MPP [28]. The main advantage of RCC is that it uses inherent ripples that occur due to the power electronic elements i.e., the DC-DC convertor used in the PV system. Through the correlation of the time-based derivative of voltage and power the RCC tries to identify whether this correlation is more than zero which on the left side of MPP, or less than zero which is on the right side of MPP, or exactly zero which equal to MPP [28].

\[
\frac{dP_{PV}}{dt} \frac{dV_{PV}}{dt} > 0 \text{ when } V_{PV} < V_M \\
\frac{dP_{PV}}{dt} \frac{dV_{PV}}{dt} < 0 \text{ when } V_{PV} > V_M \\
\frac{dP_{PV}}{dt} \frac{dV_{PV}}{dt} = 0 \text{ when } V_{PV} = V_M
\]

III. SIMULINK MODEL OF PV SYSTEM WITH RCC MPPT

Figure 3 represents the Simulink model schematic of the PV system used to obtain the desired results.

Figure 3 shows the photovoltaic system consisting of PV panel that is connected to a dc-dc boost converter with a RCC MPPT controller subsystem for 350 Volts output requirements, for a load of 2Ω resistance. In Figure 4 architecture of LPF based RCC [30] has been presented, which controls the switching of MOSFET. RCC implemented in this work is different from [26-27], as they have used high pass filters for removing ripples, whereas in [30] they have used low-pass filters. In this work PI controllers along with tuning of filters have been done for optimum ripple free outputs.

IV. SIMULATION RESULTS

In this work simulation results are obtained for RCC MPPT for various level of solar irradiance i.e. 800 W/m², 1000 W/m² and for step response as shown in figure 5. This is for representation of variable irradiance conditions i.e. cloudy weather conditions. Most of the MPPT techniques fail under, variable environmental conditions. RCC achieve good tracking in all sort of conditions. The difference between PV panel outputs and outputs with RCC MPPT are shown in all simulation results for voltage, current and power for different solar irradiances.

Fig. 5 Step response used in Simulation.

PV and Output Voltage using RCC MPPT

Fig. 6 Voltage output of RCC MPPT for 800 W/m² irradiance level at 25°C.
From the figure 7, it can be clearly seen that at start the PV output current i.e. without any MPPT has a sudden change and due to which a spike appears at output power curve (figure 8). This underdamped response of power is removed by using RCC MPPT (figure 8).

Similarly, from the figure 10 and 11, it can be clearly seen that at start the PV current output without any MPPT has an abrupt increase due to which a spike appears at output power curve (figure 11). This underdamped response of power is removed by using RCC MPPT (figure 11).
Figure 12, 13 and 14 shows the response for step input. From the figure 13 and 14, it can be clearly seen that whenever there is change or transition occurs the PV current exhibits underdamped characteristics, which is harmful for the load devices. RCC removes these spikes or we can say that it maintains the underdamped current characteristics to critically damped. The same can be seen in output power (figure 13).

V. CONCLUSION

In this work a simulation study of MPPT with RCC technique has been presented. Photovoltaic array along with the boost converter and its MPPT control using RCC for 350V output voltage have been implemented with RCC MPPT at different solar irradiations at 25°C temperature. The system has been designed for 350 Volts, 6.5 KW power output, which is attained through boost converter. Simulation results show RCC removes all ripples from voltage, current and power outputs, with good tracking performance.

REFERENCES

A Survey on Evolution of Wireless Cellular Communication from 1G to 6G

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Abstract— Wireless communication exchanging information where physical connection is not available. This reduces the distance between person to person across the globe. As per today's technological demand, continuous enhancement is necessary in wireless communication. This article deals with evaluation of wireless technologies with their comparative studies on 1st generation(1G), 2nd generation(2G), 3rd generation(3G), 4th generation(4G), 5th generation(5G) and 6th generation(6G). It shows how the performances of various generations are enhanced and addition of different features in different generation technologies.

Keywords—Wireless Communication, 1st generation(1G), 2nd generation(2G), 3rd generation(3G), 4th generation(4G), 5th generation(5G), 6th generation(6G)

I. INTRODUCTION

In today's era of the world, People demand for electronic gazettes which will make their life softer, easier and faster. This leads towards advanced wireless communication which adds more significant output in their life. The wireless contact history and development is as follows. Electromagnetic (EM) waves are key factors in wireless communication development. Huygens was working on the theory of light reflection and refraction in 1678[1]. Earlier in 1819, because of the wave existence of the light (or we can have electron) wired contact turns wireless. Through a wired medium, electrons follow particle nature and wave nature in a wireless medium (e.g. air). Hence, Electromagnetic waves appear into the depiction [2]. And during 1831 Faraday proves that J. Maxwell formulated electromagnetic induction and wave equations at 1864. Hertz H experimentally validates the transmission and response of Electro Magnetic waves over a few meters apart and at 1896 Marconi developed a 3-km communication [3]. With this, the following institutions became more common around the globe for wireless communication.

The wireless network has now developed much wider than anyone could have expected in the first introduction of the cellular model during the 1960s and 1970s. Mobile cellular subscribers are rising by 40% per year, with mobile cellular subscriptions four times higher than fixed telephone lines by the end of 2010. Worldwide, rapid growth of mobile phone subscribers has shown conclusively that wireless communication is a secure, viable medium for voice and data transmission. Including mobile voice telephone calls, cellular's widespread popularity has driven the creation of new wireless technology and network standards for many other modes of telecommunications traffic.

II. FIRST GENERATION(1G) COMMUNICATION TECHNOLOGY

The mobile wireless communication systems of the first generation are entirely dependent on analog signals. In Northern America, the analog communication system (AMPS) was originally implemented, while in Europe and the rest of the world, the Total Access Communication System (TACS) variation is known. Where such an analog mobile network is primarily depended on circuit-only. This technology was intended for voice communication only, not for data communication. The first prototype was introduced in the 1980's by the analog telecoms standards. A voice call with analog modulation can be made with higher frequency about 150 MHz and more through 1 G, as the radio towers are broadcast. 1 G Multiaccess Division (FDMA) communication technology uses. It has short channel capacity, unpredictable handoff, low voice links, and little security at all, as voice calls are played back into radio towers and make this call very vulnerable to illegal third party eavesdropping.

![Fig. 1. Example of a figure caption.](image)

III. SECOND GENERATION(2G) COMMUNICATION TECHNOLOGY

Started in end of 1980s and ended in the end 1990s, the second generation 2G network was designed primarily intended for voice communication through digital signal and frequency up to 64 kbps. This technology also introduce short messaging services(SMS) which was newer feature against 1G. The required bandwidth is around 20-200 KHz[4] for 2 G transmission. Digital modulation is used by a global mobile communication system and GSM to improve the quality of voice communication, but there is limited data service available on the networks. As rivalry led to the mobile adoption, the efficiency and reach of the transmission continued to be improved by the 2 G network. 2 G networks can be classified into Time Division Multiple Access (TDMA) and Code Division Multiple Access
(CDMA) standard based on the type of multiplexing used. 2 G uses CODEC to compress digital voice data and multiplex data[4].

Fig. 2. Second generation network architecture

IV. SECOND AND HALF GENERATION (2.5G) COMMUNICATION TECHNOLOGY

Mobile cellular wireless technology built among its predecessors 2 G and its 3 G counterparts is 2.5 G, which stands for "second and half generation." For define the General Packet Radio Services, the word "second and half generation" is used. GPRS supports 56Kbit / s for 115Kbit / s data rate. 2.5 G networks are supported by other services like WAP, SMS, MMS, Mobil Games, Search and Directory.

V. THIRD GENERATION (3G) COMMUNICATION TECHNOLOGY

The technology of the third generation (3G) was invented in 2000. This technology offers 144Kbps-2Mbps transmission speed. For multimedia cell phones, 3G technology is typically called smart phones. Three forms of mobile communication infrastructure are used in 3G.

CDMA (Multiple Access Code Division) 2000: CDMA 2000 channel width and speed is 1.25 MHz, 144 kbps, recommended by North American wireless telecommunication standards organizations.

WCDMA (Wide band code division multiple access): CDMA 2000 channel width and speed are 5MHz, 2Mbps, respectively. The first commercial W-CDMA system FOMA was introduced by NTT DoComo in Japan in 2001.

TD-SCDMA (Time Division synchronous code division multiple accesses): Multiple Access Time Division Synchronous Code Division (TD-SCDMA) refers to an air interface used in the People's Republic of China Universal Mobile Telecommunications System (UTMS) networks. The TD-SCDMA standard runs between 1785 MHz and 2220 MHz on frequency bands. TD-SCDMA sends voice data at 8 kbps with potential data rates of 12.2, 64, 144, 384 and 2048 kbps for turn circuit services including video.

Fig. 3. Third generation network architecture

Fast Internet access, mobile tv, video calls, video conferencing, multi-media (MMS), multi-gaming, 3D sports, etc. are also available through 3 G phones. HSDPA (High Speed Downlink Packet Access) is also called 3.5G. It provides 8.1Mbit / sec higher data transfer speed than 3 G cellular system.

VI. FOURTH GENERATION (4G) COMMUNICATION TECHNOLOGY

The fourth generation of mobile technology offers 100Mbps data rates. 4 G has similar features to 3 G but has been developed in conjunction with new technologies such as MMS, movies, High Definition Digital Television. LTE, a feature of 4 G technology. In March 2009, the International Telecommunications Union-Radio Communications Sector (ITU-R) established a set of 4 G standard specifications called the International Mobile Telecommunications Advanced (IMT-Advanced) specification, stating 100 megabits per second (Mbit / s) peak speed standards for 4 G service (= 12.5 megabytes per second) for high mobility communications[4]. Carriers utilize orthogonal frequency division multiplexing (OFDM) in place of time division multiple access (TDMA) or multi-access code division (CDMA) are gradually branding their networks as 4G, even though their data rate speeds are not as high as the International Telecommunications Union (ITU) mentioned. A 4G cellular network need a mobile device to transfer data rate at 100 Mbit / sec, according to the ITU. Although carriers still disagree on developing 4 G wireless communication networks using Long Term Evolution (LTE) or (Worldwide Microwave Communication Interoperability) WiMAX, all carriers seem to agree that OFDM is one of the key reasons that a service can genuinely be marketed as 4G. OFDM is a digital modulation that divides a signal into many narrowband channels at different
frequencies.

VII. FIFTH GENERATION (5G) COMMUNICATION TECHNOLOGY

5G applies to the fifth generation which began in the late 2010s. Connectivity and coverage rates are far greater than facilities that could be seen with 5G technology. 5G will focus primarily on the World Wireless Web (WWW). 5G LTE uses OFDM and LTE millimeter allowing 20 mbps bandwidth and 2-8 GHz frequency bands. This supports the personal virtual network. It’s cheap in prices, and multi-user can use it [5].

Fig. 4. Fourth generation network architecture

VIII. SIXTH GENERATION (6G) COMMUNICATION TECHNOLOGY

Just as the change from 4G to 5G reflects an extension of the spectrum used and the introduction of new frequencies, so will the progression of interaction between 5G and 6G. Although 5G leverages mm Wave in the microwave frequency range, 6G in the Terahertz (THz) band, usually referred to as 100 GHz to 3 THz, would benefit from even shorter wavelengths. To some extent, 6G networks will follow the 5G-driven evolutionary path which involves increasingly more autonomous networks, improved service quality and automation of knowledge, edge computing, and a service-based architecture approach. Nevertheless, there is also the potential for much greater improvements to the core network with 6G, which can align with the integration in technology. For example, in the past, Mind Commerce and others addressed the potential for a so-called "nano-core" to emerge as a popular computing core comprising high-performance computing (HPC) and artificial intelligence (AI) components [6].

Fig. 5. Fifth generation network architecture

IX. COMPARISON OF ALL GENERATION COMMUNICATION TECHNOLOGY [7]

<table>
<thead>
<tr>
<th>Features</th>
<th>1G</th>
<th>2G/2.5G</th>
<th>3G</th>
<th>4G</th>
<th>5G</th>
<th>6G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>2 Kbps</td>
<td>14-64 Kbps</td>
<td>2 Mbps</td>
<td>20 Mbps</td>
<td>&gt;1Gbps</td>
<td>10 to 11Gbps</td>
</tr>
<tr>
<td>Technology</td>
<td>Analog</td>
<td>Cellular</td>
<td>Digital</td>
<td>Unified IP &amp; Seamless combo of LAN/ WAN/ WLAN/ PAN</td>
<td>4G+WW &amp; Satellite</td>
<td>5G+Satellite</td>
</tr>
<tr>
<td>Multiplexing Techniques</td>
<td>FDMA</td>
<td>TDMA</td>
<td>CDMA</td>
<td>CDMA</td>
<td>CDMA</td>
<td>-</td>
</tr>
<tr>
<td>Switching Techniques</td>
<td>Circuit</td>
<td>Circuit / Circuit for Access NW and Air Interface</td>
<td>Packet except for an interface</td>
<td>All Packet</td>
<td>All Packet</td>
<td>-</td>
</tr>
<tr>
<td>Core Network Technology</td>
<td>PSTN</td>
<td>PSTN</td>
<td>Packet Network</td>
<td>Internet</td>
<td>Internet</td>
<td>Internet</td>
</tr>
<tr>
<td>Handoff Techniques</td>
<td>Horizontal</td>
<td>Horizontal</td>
<td>Horizontal</td>
<td>Horizontal &amp; Vertical</td>
<td>Horizontal &amp; Vertical</td>
<td>Horizontal &amp; Vertical</td>
</tr>
</tbody>
</table>

X. CONCLUSION

Today, cell phones are made up of everything from the least size, the largest phone space, speed dialing, variety of video player and audio player and camera etc. In recent times, data exchanging has turn into a child’s play with the advancement of web and Bluetooth technology. Sixth-generation cellular mobile communication networks (6G) integrate regional coverage satellites. This can be a mixture...
of nanocore and artificial intelligence, connecting all network operators to one center. Under 6 G, the cost of mobile calls will be fairly high, but in 7 G this problem will be modified and calling costs will be reduced and the consumer will benefit from the lower price.

REFERENCES
Optimization of Pin Count and Test Time for Fault Isolation

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Abstract—In Application Specific Integrated Circuit (ASIC) world, the design is more complex day by day and adding the extra logic for testing purpose it will make more complex design. Due to this issue need to optimize some parameters like area, time, cost, pin count, etc. Design for Testability (DFT) refers two factors controllability & observability. If control & observe each and every node of the circuits is called good testability. Pin count is directly affect the area. Test time is directly affect the cost of circuits. Three stages are required to make design testable & optimize d: first is scan insertion in this step insert the scan design in to the testable design, second one is Automatic Test Pattern Generation (ATPG), for generating the test vectors to test the design from primary inputs/outputs & third stage is pattern simulation, to validate the generated patterns.

Keywords—Design For Testability, Pin Count, Test Time, Scan Compression, One Pass Scan Synthesis

I. INTRODUCTION

DFT provides the testability of manufactured design; testability can improve by controllability & observability of the design. Controllability is to control each and every node of the design from primary inputs. Observability is to observe each and every node of the design from primary outputs.

To make design scannable need to add some extra logic, by scan insertion. All the storage elements should be converted in to scan cells, it gives the chance to select the two different modes like test mode and data mode. These all scan cells stitching together and create the scan chains. Now for testing of the design need to generate test vectors by automatic test pattern generation & that test vectors passes the simulation or not that will check in the pattern simulation. To design a circuit in such a manner that test time will reduce with low pin counts. For optimization of pin counts various scan compression techniques are available like Serializer-deserializer based scan compression, Logic BIST based scan compression, On Product Multiple Input Signature Register (OPMISR) based scan compression [1]. For DFT different fault models & scan insertion has been done using muxed D scan cell [2]. To optimize the pin counts test data compression is also used [3]. To reduce the test time, skip scan methodology introduce which is more reduced by divides the patterns in multiple groups [4]. After manufacturing of the chip should be tested on Automatic Test Equipment (ATE). In ATE more number of pins are not available for testing test vectors so, that engineer can reduce the pin count using scan compression [5].

The paper is organized in seven sections. Section I provide the introduction of research work. Problem definition represented in the section II. Scan insertion describes in the section III. In section IV generate the test pattern, by using automatic test pattern generation. Section V describes the pattern simulation. The experimental results presented in the section VI. And in the section VII concludes the research work.

II. PROBLEM DEFINITION

In this research work two parameters should be optimized, which are pin count and test time. Pin count affects the area of the chips. Test time affects the cost of the chips for testing: Engineering economics is the study of how engineers choose to optimize their design construction methods to produce objects and systems that will optimize their efficiency. The cost will depend on the test time.

Example: $10 = 10$ chips/1 sec = 10 chips 
$10 = 10$ chips/0.5 sec = 20 chips

A. Specification of Block

This block contains many sub blocks & it is a part of networking chip. In this block total numbers of sequential cells are 7819. Here the figure 1 shows the numbers of
function pins, which is the diagram of block and figure 2 shows the sequential element and function logic, which is the schematic diagram of a block.

![Fig. 1 Block diagram of design](image1)

![Fig. 2 Schematic diagram of design](image2)

**B. Research Flow**

- **Scan Insertion**
  - Replace all storage element with scan cell.
  - Stitch all scan cell and create scan chain.
  - Scan compression.
  - Tool: DFT compiler.

- **Automatic Test Pattern Generation**
  - Produce effective test vectors.
  - Achieve high fault coverage.
  - Tool: Tetramax.

- **Pattern Simulation**
  - Generating a test bench to simulate the patterns.
  - Shows mismatch of patterns.
  - Tool: VCS

Here is the research work flow should be written above as figure 3. First step is scan insertion, that includes two techniques scan compression & one pass scan synthesis in DFT Compiler. Next step is ATPG, for that tetramax tool is used to detect stuck at faults. Last step is pattern simulation done in VCS simulator to validate patterns.

**III. SCAN INSERTION**

Scan insertion is the process of converting all storage element to scan cells. Three types of scan cells mostly used in scan insertion first one is muxed D scan cell, second is clock scan cell and third one is Level Sensitive Scan Design (LSSD) cell. Muxed D scan cell is generally used for scan insertion because it has only a single clock.

All the scan cells connecting together & create a chain it is called scan chain. It needs three pins, Scan Data In (SI) which is the scan input for scannable design, Scan Enable (SE) which enables scan mode, Scan Data Out (SO) which is the scan output for scannable design. It will create a scan ready design after scan insertion.

![Fig. 4 Flow of scan insertion](image3)

In figure 4 listed the flow of scan insertion process in DFT compiler. The first step is to read the target libraries & after reading the link libraries, which are given by the vendors. Now read the gate level netlist. The next step is set the current design & link the libraries with the design. Then set the scan...
configuration like scan enable, muxed D scan cells. Next is create & define the scan ports, clocks & resets. In this design seven clocks are present in the design, `pp_egress_clk_rst_if_clk`, `pp_egress_apb_if_clk`, `chain_upstream_if_clk`, `arp_pp_egress_if_clk`, `vl_sms_WRCK-timing`, `sms_proc10_ppe_sms_1_clk_sms`, `sw_pp_egress_if_clk`.

Eleven resets are present in the design, `arp_pp_egress_if_rst_n`, `pp_egress_clk_rst_if_rst_n`, `pp_egress_apb_if_rst_n`, `sw_pp_egress_if_rst_n`, `chain_upstream_if_rst_n`, `pp_egress_mac_if_rst_n`, `sms_proc10_ppe_sms_1_dm0`, `sms_proc10_ppe_sms_1_dm1`, `sms_proc10_ppe_sms_1_dm2`, `sms_proc10_ppe_sms_1_rst_sms`, `vl_sms_WRSTN`.

Next step is to create test protocol to generate the test environment for the design. Then check test design rules in the RTL source file, using RTL test DRC. Next step is preview_dft & insert_dft, is build the scan chain and produces a range of reports on the proposed scan architecture, another is implements the proposed scan architecture respectively. After performing scan insertion, need to perform design rule checking again to ensure that no violations have been introduced into design by the scan insertion process. Then last step is writing out the scan inserted netlist in verilog format & test protocol file.

### A. Scan Compression

Scan compression technology divides standard scan chains into a larger number of shorter chains, called compressed scan chains, which reduces tester time.

Figure 5 shows the decompressor controls the flow of scan data into the scan chains. The compressor reduces the captured data from the larger number of compressed scan chains so that it can be observed through the scan-out ports. The combination of the decompressor and compressor wrapped around the scan chains is called the codec, which is short form of compressor-decompressor.

### B. One Pass Scan Synthesis

One pass synthesis technique is done after fixing all violations, which performs test ready compilation. For one pass synthesis compile scan command is available. Scan options perform a test ready compilation, which maps directly to scan cells. In this technique, after pre DRC again synthesis will come for extra optimization of the design.

Four steps of one pass scan synthesis listed below:

1) Scan configuration:

It gives the chance to change the configuration of design like number of scan cells, number of scan chains, number of scan cells placed in single scan chain.

2) Scan replacement:

In this step all the non scan elements converted into scan element, which is called scan replacement.

3) Scan reordering:

Scan cells placed in such a manner that required interconnection should be minimum so based on that scan cell should be reordered, which is called scan reordering.

4) Scan stitching:

If all scan cell placed perfectly, stitch them all in to one scan chain, which is called scan stitching.

### IV. AUTOMATIC TEST PATTERN GENERATION

Automatic Test Pattern Generation is used to generate the test vectors which provide distinguish between the fault free output and the faulty output. These test vectors are for test the circuit after manufacturing. The effectiveness of ATPG is measured by the number of modeled defects or fault models, detectable and by the number of generated patterns. ATPG efficiency is depend on the fault models and different types of circuit under test and give good test quality and test time.

In Figure 6 listed the flow of automatic test pattern generation process in tetramax. The first step is to read the scan inserted netlist & read the verilog libraries. Now build the top module of the design. The next step is to check the DRC by using standard procedure file. Then set the fault models & add all faults in the design. Next step is run the automatic test pattern generation. Then check the test coverage & fault coverage reports. The last step is writing out the patterns & testbench.
Pattern simulation is showing the mismatch of pattern which can be generated by the ATPG tool. Three steps of pattern simulation are listed below:

Step 1. Insert testbench file, which was created by using ATPG tool.
Step 2. Insert pattern file, which patterns you want to simulate and that was generated by ATPG tool.
Step 3. Include netlist while doing simulation.

In Figure 7, the flow of pattern simulation process in VCS is listed. The first step is to read the scan inserted netlist & read the verilog libraries. Now read the generated patterns & generate the object file. Then compile & simulate the design. The last step is showing the patterns are passes or not.

<table>
<thead>
<tr>
<th>Pin Count</th>
<th>Patterns</th>
<th>Test Coverage</th>
<th>Fault Coverage</th>
<th>Length of Max Scan Chain</th>
<th>Test Application Time</th>
<th>CPU Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>385</td>
<td>84.13%</td>
<td>76.51%</td>
<td>967</td>
<td>394536 Cycles</td>
<td>12.01 Secs</td>
</tr>
<tr>
<td>8.96</td>
<td>702</td>
<td>86.99%</td>
<td>85.73%</td>
<td>84</td>
<td>58968 Cycles</td>
<td>14.30 Secs</td>
</tr>
<tr>
<td>8</td>
<td>384</td>
<td>90.20%</td>
<td>79.37%</td>
<td>967</td>
<td>371328 Cycles</td>
<td>10.24 Secs</td>
</tr>
<tr>
<td>8.96</td>
<td>823</td>
<td>92.01%</td>
<td>89.72%</td>
<td>84</td>
<td>69132 Cycles</td>
<td>13.22 Secs</td>
</tr>
</tbody>
</table>
Table I show the results for eight pin count, which is compressed with 96 internal scan chains. Patterns are lowest in simple scan & highest in combined technique. Test coverage is also lowest in scan & highest in combined technique. Test application time is lowest in compression & highest in simple scan design. CPU time is more in compression & less in one pass scan synthesis.

TABLE II. RESULT OF FIVE PIN COUNT OF DESIGN

<table>
<thead>
<tr>
<th>Methods &amp; parameters</th>
<th>Scan</th>
<th>Compression</th>
<th>One Pass Scan Synthesis</th>
<th>Compression &amp; One Pass Scan Synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin Count</td>
<td>5</td>
<td>5.60</td>
<td>5</td>
<td>5.60</td>
</tr>
<tr>
<td>Patterns</td>
<td>417</td>
<td>717</td>
<td>389</td>
<td>707</td>
</tr>
<tr>
<td>Test Coverage</td>
<td>84.13%</td>
<td>85.87%</td>
<td>90.11%</td>
<td>91.85%</td>
</tr>
<tr>
<td>Fault Coverage</td>
<td>76.85%</td>
<td>85.51%</td>
<td>79.39%</td>
<td>89.55%</td>
</tr>
<tr>
<td>Length of Max Scan Chain</td>
<td>1547</td>
<td>129</td>
<td>1547</td>
<td>129</td>
</tr>
<tr>
<td>Test Application Time</td>
<td>64748</td>
<td>94777</td>
<td>604111 Cycles</td>
<td>93457 Cycles</td>
</tr>
<tr>
<td>CPU Time</td>
<td>13.01 Secs</td>
<td>14.78 Secs</td>
<td>9.59 Secs</td>
<td>11.94 Secs</td>
</tr>
</tbody>
</table>

Table II shows the results for five pin count, which is compressed with 60 internal scan chains. Patterns are lowest in one pass scan synthesis & highest in compression technique. Test coverage is lowest in scan & highest in combined technique. Test application time is lowest in combined technique & highest in simple scan design. CPU time is more in compression & less in one pass scan synthesis. Table III shows the results for single pin count, which is compressed with 12 internal scan chains. Patterns are lowest in simple scan & highest in combined technique. Test coverage is lowest in scan & highest in combined technique. Test application time is lowest in compression technique & highest in one pass scan synthesis. CPU time is more in compression & less in one pass scan synthesis.

VII. CONCLUSIONS

In this research work scan insertion has been done by scan compression technique and compressed by number of scan chains*10*1.2. Another method is one pass scan synthesis. Four combinations conclude in the experimental result for different methods like simple scan, compression, one pass scan synthesis & combination of both. When scan design is ready, generate the test vectors for stuck at faults to test the design. Pattern simulation is done for verifying the test vectors, which gives the result of passed or failed vectors. By observing all the results for three different pin count which are eight, five & single. Out of all these the best result getting in one pass scan synthesis technique, test time is 9.59 secs & pin count is five.

REFERENCES


Table III. RESULT OF SINGLE PIN COUNT OF DESIGN

<table>
<thead>
<tr>
<th>Methods &amp; parameters</th>
<th>Scan</th>
<th>Compression</th>
<th>One Pass Scan Synthesis</th>
<th>Compression &amp; One Pass Scan Synthesis</th>
</tr>
</thead>
<tbody>
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<td>Pin Count</td>
<td>1</td>
<td>1.12</td>
<td>1</td>
<td>1.12</td>
</tr>
<tr>
<td>Patterns</td>
<td>384</td>
<td>718</td>
<td>398</td>
<td>820</td>
</tr>
<tr>
<td>Test Coverage</td>
<td>84.13%</td>
<td>86.09%</td>
<td>90.11%</td>
<td>91.99%</td>
</tr>
<tr>
<td>Fault Coverage</td>
<td>76.51%</td>
<td>85.73%</td>
<td>79.39%</td>
<td>89.68%</td>
</tr>
<tr>
<td>Length of Max Scan Chain</td>
<td>7734</td>
<td>645</td>
<td>7734</td>
<td>645</td>
</tr>
<tr>
<td>Test Application Time</td>
<td>304719 6 Cycles</td>
<td>4631110 Cycles</td>
<td>307813 2 Cycles</td>
<td>528900 Cycles</td>
</tr>
<tr>
<td>CPU Time</td>
<td>12.37 Secs</td>
<td>13.90 Secs</td>
<td>11.23 Secs</td>
<td>11.82 Secs</td>
</tr>
</tbody>
</table>


Implementation of Embedded Linux Device Drivers with Waitqueue on BeagleBone Black

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Abstract— In this emerging technological era, the Embedded Linux technology is in the great demand for various efficient high-end applications like Internet of Things, Industrial Robotics, Smart Devices and Supercomputers. There is use of kernel device drivers in lowest level of Android and iOS which is emerging for more development in terms of the efficiency, fast scheduling and robustness. Linux kernel has the functionality of scheduling which correlates to the process management and dividing the resources of computer efficiently. The proper sleeping and waking of up the task used currently takes a lot of effort in kernel side. This sleeping and waking up of threads are required for efficient use of resources and proper interrupt execution based on priority of function needed to be done by the kernel. Wait-queue come into the play which is the robust mechanism used for sleeping the particular task or thread and waking it after certain conditions are matched. The proposed paper showcases the implementation of the wait queue on Embedded Linux device drivers on the Advanced Risc Machine (ARM) platform BeagleBone Black (BBB). The Debian OS (Linux kernel) is running on BeagleBone Black. The device drivers are the Linux Kernel loadable modules used for interfacing between the hardware and software.

Keywords— Embedded Linux, Device Driver, BeagleBone Black Board, Cross-Compilation, Wait-queue

I. INTRODUCTION

Device Driver is a piece of software whose aim is to control and manage the particular hardware and often written in C language. These are dynamically loaded which reduces the memory consumption in kernel space and hence increases the efficiency of the system. From the operating systems point of view, drivers can be in either kernel space (running in privileged mode) or user space (with lower privileges). Also, the prime purpose of the driver is to instruct the computer on how to communicate with the input or output device by translating the operating system’s Input Output instructions into a language that a device can easily understand. There are three major types of device drivers namely Character, Block and Network. Character device driver deals with the byte wise data transfer and keyboard, mouse, camera are some examples of character devices. Block device driver deals with the transfer in form of collection of bytes in which back and forth communication is possible and pen-drives, hard-disks are some examples of block device drivers. Network devices communicate with the use of packets on the system request and deals with processes like synchronization, routing, session management, packet handling for Wi-Fi and Ethernet [1].

Linux is used in embedded device which is termed as Embedded Linux. It can reduce the cost of hardware by taking the advantage of multitasking operation of Linux. It has limited memory space and disc space and also it is platform independent. Moreover, Linux is utilized in these applications due to its other major advantages like open-source development and support to plethora of architectures like x86, ARM, MIPS, PowerPC and Alf-Egil Bogen Veggard Wollan RISC (AVR). Embedded Linux is used in the plenty of quirky applications like Robotics, Smart Devices, IoT and ML, etc.

The use of proper Scheduling mechanism is required for the high-end applications which are inculcated using the Embedded Linux. Hardware functionality needs to have priority based scheduling. Processes are waiting often for external triggers and events like key presses or browser waiting for the interactions or servers waiting for the connections or robots triggering for the start. The proper efficiency is there only in waiting for the tasks which leads to very less CPU time. The blocking system calls are used for waiting a process and it wakes only after the interruption is encountered by the system caller. The sleep() system call and also unnecessary loops are used for waiting but these does not schedule the task efficiently as the wait-queue. The polling mechanism is used in certain cases but it uses more kernel memory and wastes the kernel jiffies. The proper synchronization is not inculcated by other system calls so, for the efficient use of hardware functionality the robust mechanism must be there.

Wait-queue is a data structure in the Linux Kernel used for managing threads and tasks for the robust application which are waiting for the certain conditions to become true for the further process. These data structures are storing the list of processes waiting for an event. Wait-queues are used for the elaborate kernel subsystems from many years. Wait-queue is the efficient mechanism for performing the scheduling of the different threads based on the conditions of the process [2]. Wait-queue uses less core scheduler involvement which helps the kernel to easily perform the tasks. It frees the processor for the other uses during its waiting time which elevates the efficiency.
Embedded Linux development boards are used for the high-end applications. Some of the boards are BeagleBone Black, Raspberry Pi, Asus Tinker Board. BeagleBone Black (BBB) is robust and efficient open-source low-power single-board computer platform for Embedded Linux development produced by TI (Texas Instruments). It has Cloud 9 which can be used for remotely configuring the board for applications. It boots Linux very quickly and has great community support where developers around the globe collaboratively develop the kernel development of the board. It has very high expandability supporting plethora of Capes (Additional Hardware modules for high-end specific applications like Crypto Cape for OS level Security). These boards are showing the prospering growth in the field of Internet of Things (IoT), Drones, Robotics, Smart Appliances, Smart Cities, High end Industrial Applications [3].

![Fig 1. BeagleBone Black](image)

The BeagleBone Black has TI Sitara AM3358BZC100 Processor with 1 GHz and 2000 MIPS speed, 512 DDR3L 800 MHz SRAM Memory and 4 GB with 8 bit eMMC onboard flash is present in this Single Board Computer. It works on 1 GHz ARM Cortex A8 and has GPU of PowerVR SGX530. It has total external 92 pins in two headers (P8 and P9 with 46 each). It has Ethernet (10/100 RJ45), SD, MMC, USB, micro HDMI Connectors on the board. It exhibits great versatility providing connectivity to large number of devices using various protocols and standards like 4 x UART (Universal Asynchronous Receiver Transmitter), LCD (Liquid Crystal Display), MMC1 (MultiMedial Card), 2 x SPI (Serial Peripheral Interface), 2x I2C (Inter-Integrated Circuit), ADC (Analog to Digital Converter), 4 Timers, 8 PWMs (Pulse Width Modulation) and 2x CAN (Controller Area Network). Three on-board buttons are there namely reset, power and boot. The Software Compatible with BBB is Linux, Android, and Cloud9 IDE (Integrated Development Environment) with BoneScript.

II. RELATED WORK

Many researchers and authors around the globe have carried out research and analysis on device drivers and below mentioned are its references.

Aleix R. et. al implemented the linux kernel scheduler for multi core systems for extending the functionality of the kernel for high-end applications. The User-Monitored Threads (UMT) concept is used for the proper performance of the threading in each core [4]. Pooja T. et. al analyzed the response time for the intensive computing tasks using the Linux Completely Fair Scheduler. The analysis is done on the embedded systems for efficiently reducing the energy usage and minimizes the CPU usage in terms of frequency [5].

Michael K. et. al analyzed the Linux scheduling with certain mechanisms for efficient implementation of threading. The proper switching of CPU processes is shown with the help of Vampir displays [6]. Simon W. et. al implemented the multiple page support in the Linux kernel. The increased performance was depicted with achieving the scalable performance on the faster processors for mapping the address space efficiently [7]. Domenico C. et. al analyzed the software aging of the Linux Operating System for execution of the processes. The several kernel parameters are collected for the analyzing of the subsystems for its efficiency [8].

Luca A. et. al implemented the container-based real-time scheduling in the Linux kernel using the kernel waiting and scheduling functions. The mechanism was deployed for controlling the real-time applications using Docker [9]. Raimarius D. et. al designed the Open Embedded Real-time controllers for industrial control systems for hard real-time constraints. The efficient performance in terms of scheduling and periodicity is practically implemented [10].

Razali T. et. al implemented the Robot Operating System in BeagleBone Black based Mobile Robot for Obstacle Avoidance Application using Ubuntu 14.04. The proper debugging is carried out on the communication between each node [11]. Jaydevsinh J. et. al ported the Linux kernel to the BeagleBone Black which is ARM based platform. The steps like building the kernel, u-boot and x-loader are described with the cross-compilation are mentioned. The OS is customized, then compiled and finally it is burnt into the core [12]. Immanuel A. et. al showcased the duty-cycling performance of Linux-based IoT devices and improved it by proper profiling the linux kernel. Raspberry Pi 3 and Raspberry Pi Zero are used as the Embedded Linux platforms for identifying the time consumed for the different units [13].

![Fig 2. Character Device Driver Model](image)

III. DEVICE DRIVER MODEL

Character Device Driver is interfacing with the user space using virtual file system for performing the functions of controlling the specific hardware using byte-oriented method. The wait-queue is implemented in the device driver for proper scheduling in the kernel.
IV. IMPLEMENTATION

The waitqueue based device driver insertion is done using `insmod()` of .ko file of the driver which is cross-compiled from x86 to ARM platform using the cross-compiler and removal is done using `rmmod()`.

The Wait-queue is the robust mechanism in the Linux kernel used to implement the waiting and waking the processes. It achieves the conditional wait on an event. The sleeping of the process is needed when either the user space or kernel space program is waiting for the data.

Three important steps for implementing this wait queue are as follows, first is initializing the wait queue, and then queuing the task to sleep and on condition waking up the task for further operations. The use of two data structures namely `wait_queue_head_t` and `wait_queue_t` which are defined in `include/linux/wait.h` is there. The initialization of wait-queue in device driver is done by static and dynamic methods.

Fig 3. Static Initialization of Waitqueue

```c
#define __WAIT_QUEUE_HEAD_INITIALIZER(name) { 
   .lock = __SPIN_LOCK_UNLOCKED(name,lock), 
   .task_list = { &(name).task_list, &(name).task_list } 
}
#define DECLARE_WAIT_QUEUE_HEAD(name) 
  wait_queue_head_t name = __WAIT_QUEUE_HEAD_INITIALIZER(name)
```

Fig 4. Dynamic Initialization of Waitqueue

```c
#define init_waitqueue_head(q) 
{ 
   Static struct lock_class_key _key; 
   init_waitqueue_head(q, &q, _key); 
} init(0)

void __init_waitqueue_head(wait_queue_head_t *q, const char *name, struct lock_class_key *key) 
{ 
   spin_lock_init(&q->lock); 
   lockclass_get_class_and_name(&q->lock, key, name); 
   INIT_LIST_HEAD(&q->task_list); 
}
```

The different `wait_event` APIs are used for queuing the tasks with the option of conditions to be completed for waking. For waking, the various `wake_up` APIs are implemented.

Two processes are used in this implementation of waitqueue device driver. For the two processes, two devices are created. Some of the major APIs used for these initialization of the device driver purpose are `kthread()`, `alloc_chrdev_region()`, `cdev_init()`, `device_create()` and `class_create()`. The file operations structure is also used for storing and reading the data of the file which includes the `open()`, `read()`, `write()` and `release()` functions. For removing the driver, `device_destroy()` APIs are inculcated.

Here, the reading of the data of two files is kept in the waiting and these are completed whenever the data is written in `/proc/write` file. The two different conditions are used for waking up these two processes but the same waitqueue is utilized for efficient CPU utilization. The two read functions of the different device files are kept on different wake-up condition and the `/proc/wait` function is having the wait function for implementing this waitqueue. This can be used in hardware projects by implementing like waiting for the Ultrasonic and IR sensors to initiate its process until the push button is pressed.

As shown in Fig 5, the different conditions are undertaken for the two sensors (value of variable flag is 1 for first sensor and flag is 2 for second sensor) but on the same waitqueue named `wq`. In write function, the read processes are woken up using `wake_up_interruptible()` API and then changing the values of flag variable.

V. RESULTS

The implementation of the waitqueue is shown below in the three different terminals with two depicting the reading from the sensor and one with writing the value to `/proc/write` variable for waking up the two sensors.

![Fig 5. Read and Write functions implemented for Waitqueue](image)

![Fig 6. Implementation of Waiting of Sensor reading](image)
So, after entering the `echo 1 > /proc/wait`, the write process is completed and the two sensors are now woken up for sensing the data as shown below.

![Fig 7. Final Implementation](image1)

The implementation of the waitqueue for the process execution is presented in the proposed paper which includes the usage of Linux Device driver. The proper scheduling mechanism is needed for less CPU utilization when one process is waiting and other process can perform the tasks easily. This can be easily done using this robust data structure namely waitqueue. This is done on BeagleBone Black which is the robust platform for the better efficiency, more secure on the kernel side. This board is designed for high-end computing applications and this can be easily undertaken in the Embedded Linux platform. In the further note, the proper scheduling can be increased by using the locking mechanism for the tasks like semaphore and mutex in the future. Also, there are certain spinlock mechanisms which continuously checks for the state of the process when it is available or not. The major application of this is in the calibration of the sensors for its operations after the certain time and condition matching with the switches.

**REFERENCES**

Development of IP Address Management System for Better End-point Security

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Abstract - In today’s competitive world, data is one of the most valuable asset an organisation has and to lose that data, or unauthorized access could put the entire organisation at risk of loss of customer confidence, organisation liability and the loss of current and future business. So, endpoints or entry points of end user devices such as laptop, desktops, workstations connected over network needs to be secured through their identification, monitoring and protection with standard practices. The main intent of this paper is to discuss the features, design & development details of IP Address Management System (IPMS), a web based solution to make online the existing manual procedure of IP allocation and management so as to enable a better end-point security management system that can be adopted by similar organisations. We also present the future scope of extension of this software system.

Keywords- End-point Security, IP Address, Information System, Network Security, Web Technologies.

I. INTRODUCTION

SAC has adopted distributed architecture of IT implementation in projects and entities. ‘Central Control and Distributed Management’ model for Information, Network and Cyber Security implementation is best suited to our working environment and culture. IP Address management plays a critical role in end point security and network security. Industry standard practice has been established for IP allocation and management at SAC-ISRO.

End-point security practices of safeguarding the data and workflows associated with the individual end-point devices connected over network. To make online the existing manual workflow of static IP address management for new network devices (e.g. computer systems, printers, switches, instruments, storage devices (Networked Attached Storage, Storage Area Network, or any other network devices) and monitoring the status at various levels, we have designed & developed “IPMS”, a web based workflow automation software system, which facilitates online workflow of IP Address request, assignment and activation.

This enables better end-point security by reducing the turn-around-time besides capturing the inventory of IP, and Antivirus (AV) and Network Admission Control (NAC) Software installations. In this paper we discuss the features of IPMS and the process involved in design & development. We also present the future scope of inclusion of other centre level workflow processes within this software system.

The paper is organised as follows. Analysis & design of IPMS system, key software features and performance testing results are briefly discussed in Section 2. Section 3 covers the conclusions and future scope of software extension.

II. ANALYSIS & DESIGN OF IPMS SYSTEM

The sections below give: the existing system limitations, proposed IPMS system analysis, design, implementation, software security measures and testing details.

A. Existing System

Current system has many limitations, that made us to develop this new system that overcome the shortcomings of existing system as listed below, which is de-centrally managed by various stakeholders:

a. Turn around time is more, as many stakeholders are involved, which in turn take more time in processing the specific IP allocation request and its status intimation to the subsequent teams.

b. There is a lack of central inventory for IP Address and AV & NAC software installation listing. IP Address availability status resides mainly with the respective entity coordinator and AV & NAC status resides mainly with the Network Administrator.

c. Unutilised IPs are not released for re-assignment after de-allocation.

d. Multiple copies of data leads to inconsistency in IP allocation, as it is manually maintained at standalone systems.

B. Development of IPMS System- Objectives

The major benefits, this centralised software system overcomes all the shortcomings mentioned above and offers more efficient and robust solution as follows:

i. Online IP Address Management

ii. Centralised Inventory of IP Addresses, AV & NAC as allocated building-wise

iii. Consistent data with all stakeholders

iv. Request Status & Monitoring

v. Email Notifications at relevant events

vi. Report Generation

vii. Improve productivity of all its users.

C. Software Stakeholders

We have identified different users to be realised for this software system.


b. Entity Coordinator: Assign IP, New IP Requests on behalf of entity user, Edit requests, IP reallocate requests and entity report generation roles.


d. Anti Virus (AV) & Network Admission Control (NAC) Member: AV & NAC status updation and report generation roles.
D. Common Software Features
The following key features have been implemented and categorised as common features and user specific features, as listed below and depicted in Fig. 1.

1) **SSO Login**: Based on the SAC Single Sign On application interface, an authentication mechanism for different users / actors by checking with Active Directory (AD) for valid credentials and returns a service token. If valid, authentication is allowed, otherwise, login is invalidated.

2) **Email Notification**: The complete workflow of the software system is enabled with an automatic email notification mechanism that will aid in notifications related to IP request status intimation, forwarding Assigned IP request to AV & NAC Teams, IP allocation to requester and overall status reporting to Network Administrator.

E. End-User Features

1) **New IP Request Submission**: A request for NEW IP allocation shall be placed using this feature. The key metadata data fields as follows:
   a. Building Number (Selectable List)
   b. Device Type (Selectable List)
   c. MAC Address (Textual Field)
   d. Lab or Sitting Place (Selectable List)
   e. Room No. (Textual Field)
   f. Multiple Network Interface Card (NIC) (Yes/No)
   g. Employee Profile (fetched from SAC-COWAA Centralised Database)

2) **Save-as-Draft and Edit Provisions**: Save and Edit features are available and may be utilised before final submission made to SAC Entity Coordinator.

3) **Status Visualisation & Search**: End user shall be able to view his/her own requested and search details at any point-in-time.
   a. Pending Requests: User shall be able to view the status of pending and re-allocated request(s).
   b. Draft Requests: User shall be able to view the status of draft request(s).
   c. Activated List: User shall be able to view the status of activated IP request(s).
   d. View Event Details: User shall be able to view the time-tagged event details of respective IP request.

4) **Re-allocate IP Request**: End user shall be able to generate a re-allocation request for already active IP address registered with IP management software. End user shall be able to make following changes for IP reallocation request:
   a. Building No.
   b. Lab/Sitting Place
   c. Room No.
   d. MAC Address
   e. Multiple NIC (Yes/No)

5) **Report Generation**: End user shall be able to generate a activated IP report in HTML as well as spreadsheet formats.

F. Entity Coordinator Features

1) **Assign IP Address**: Respective SAC Entity-wise Coordinator (s) shall be able to allocate/ assign an IP address to the respective networked device and based on OS flag status it is forwarded either to AV & NAC Team or NW Admin. If OS flag=True, then it means, AV and NAC installation required, else, installation is not required.

2) **IP Address Generation Logic**: The core logic for IP generation based on the consideration of the building number and room number, for example, mentioned as NN.MM.building_no.room_no, where first two octets of the address (NN, MM) are expressed individually in decimal numbers.
   IP is assigned as room number, if it is a sitting place, otherwise, other available IP list shall be displayed for selection. Below building-wise details of IP address range as an example are listed in Table-1.
### TABLE I: IP Range – Building Number Wise

<table>
<thead>
<tr>
<th>Building number</th>
<th>IP Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-19</td>
<td>NN.MM.1-19.1-254</td>
<td>This IP range is reserved in case of IP get exhausted in any building.</td>
</tr>
<tr>
<td>20-54</td>
<td>NN.MM.20-54.1-254 NN.MM.120-154.1-254 NN.MM.220-254.1-254 (e.g. E.g. 20.X , 20+100=120.X and 20+200=220.X)</td>
<td></td>
</tr>
<tr>
<td>55-119</td>
<td>NN.MM.55-119.1-254 NN.MM.155-219.1-254 (e.g. E.g. 99.X and 99+100=199.X, 119.X and 119+100=219.X))</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Number &gt; 119</th>
<th>IP Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19 taken in sequence shall be selected for assignment; 254 IPs in each building.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Special Case #: If it is a Sitting Place (e.g. 24), then assign the respective IP based on location (As per above logic, if 24 available then 20.24 else 120.24, 220.24), else, assign from generic list mentioned above.

3) **Auto IP Address List Computation:** Based on the core logic based on building applicability, available IP address list shall be populated as selectable field to be assigned for the networked device.

4) **Edit Requests:** SAC Entity Coordinator shall be able to modify the MAC Address and Multiple NIC Availability (optional fields) as entered by the respective entity user.

5) **Generate IP Requests:** On behalf of SAC Entity User, coordinator shall be able to place a request for New IP request by fetching the respective entity user profile from Employee database similar to request submission feature.

6) **Report Generation:** SAC Entity Coordinator shall be able to generate a Activated IP and Forwarded IP report in HTML as well as spreadsheet formats.

7) **Status Visualisation & Search:** User shall be able to view his/her own requested, verified, activated and forwarded requests with search details at any point-in-time.

### H. AV & NAC Team Features

1) **Verify IP Request:** AV & NAC team verifies IP request and then proceed for further action of installation of antivrus and Network Admission Control software. Initially status shall be changed to ‘In-Progress’ and Finally, AV & NAC Install Status shall be updated for ‘AV & NAC Installed’ or ‘Not Applicable’ in case install not required.

2) **Report Generation:** The following key reports shall be generated (both HTML and PDF formats):
   - a. Verified IP List
   - b. Activated IP List
   - c. Device-wise detailed report

### I. Methods, Tools and Techniques Used

The software system has been designed based on MVC Model-2 architecture and developed using J2EE, Web 2.0 technologies and MySQL as the database management system. ISRO Software Process Standard (ISPD) [1] which is in-line with IEEE 12207 standard [2] were adopted for software development. Windows platform is used for development as well as deployment and the web browser is used as web client to access the application over network. IPMS application has been interfaced with the centre email server for email notification at various events.

### J. Security Measures

The software application has an in-built safety features to validate all manual inputs and query choices for their validity, such as valid inputs and valid sequences to overcome SQL injections and cross site scripting. Various layers of security are enforced at application level, database server and web server, through login credentials. Only registered and authorised users are able to login into the application. Session management features are incorporated for logouts, intermediate URL access and application exits. Server and application access logs are also captured as part of audit trail.

### K. Software Testing Results

The developed software infrastructure is tested for its functional, performance and security testing; and the test results obtained are within acceptable limits. Software is tested on Xeon@3.30 GHz, Quad Core, 8 GB RAM, 64 bit windows environment server for its performance (namely, load, throughput and response time) for a simulated load [3] for 20 Users accessing the application at once and at delay of 10 seconds. Results obtained are throughout: 30 requests/sec; response time: within 500 milliseconds and Error %: Zero as all responses are received.

### L. IPMS Graphical User Interface

Fig. 2, final activated IP event detail of specific request is depicted.
III. CONCLUSIONS & FUTURE WORK

The current software system caters to IPMS workflow for SAC networked system. The major benefits that systematic use of this software can deliver are as follows:

i. Centralised workflow of:
   a. IP Address Allocation Requests
   b. Antivirus and NAC Installation
   c. Status visualisation (by all concerned).

ii. Online Report Generation (PDF/HTML) for:
    a. Activated IP with AV and NAC Status.
    b. Centre wide systems inventory with IP list.

iii. Improved user productivity and end-point security.

IP management for end-point, enable better security w.r.t. network device identification and status monitoring for antivirus and network admission control over network. The future enhancement of this software system is to interface this software with software asset inventory system w.r.t. applicable networked systems in the centre.

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REFERENCES

Abstract—Electricity has been a great source of human being. Electricity requires another source to be converted for the usefulness. The only source—the sun which is available 24 x 7 if it is believed that World is one. The plain on the earth gets the solar rays in a span of a fixed time. The peak demand of electricity has also fixed span of time. The one International grid which delivers the electricity to whole world but only through solar generation—it’s a vision from India. The plan, the advantages and the problems related to the implementation of it has been presented in this paper. The International Grid—an Indian Dream (IG-ID) has expected with different phases and it will help Indian economy to grow.

I. INTRODUCTION

The Ministry of New & Renewable Energy (MNRE) has started the process to engage a consulting firm for developing a long-term vision, implementation plan, road map and institutional framework for implementing the ambitious 'One Sun One World One Grid' plan, which is termed as IG-ID by its real feelings of International Grid—an Indian Dream. Under the One Sun One World One Grid (IG-ID) program, India has given birth of a dream—to have an interconnected one international power grid across nations for the supply of green energy. The mutual power exchange policy at its initial stage has been implemented by IEX in India. Here, the vision behind the IG-ID is 'The Solar energy is constant source which never exhausts from the mother earth' and is a constant at some geographical location, globally, at any given point of time. With India at the fulcrum, the solar spectrum can easily be divided into two broad zones viz. far East which would include countries like Myanmar, Vietnam, Thailand, Lao, Cambodia etc. and far West which would cover the Middle East and the Africa Region. [1] MNRE has a critical role to play in synergizing over 100 countries, all the continents, to build consensus, power exchange policy which is need of the future and set an example by constituting a framework for such a global power exchange policy. Through the IG-ID initiative, India dreams to have the whole world with feelings of “vasudev kutumbakam” towards building a global ecosystem of mutual power exchange of not only renewable resources but solely solar energy that are seamlessly shared for human advantage and global sustainability. The IG-ID would have three phases.

II. PLAN OF IMPLEMENTATION

The various phases of the work has been plant as below:
A. Phase I

The first phase of the plan lays down the interconnection of Middle-East, South-Asia and South-East Asia (MESASEA Grid). The motive behind the IG-ID is to provide cost efficient and green energy supply to countries in need; especially the highly electricity depended countries in the Middle-East. This will be an important phase for the facilitation of cross-border energy trade. Under this phase I, under-sea link has also proposed in IG-ID which is also termed as OSOWOG. This phase is yet to be processed in international market.

B. Phase II

The second phase of the plan will involve connecting the MESASEA Grid (interconnected in Phase I), with African Nations. A large number of African countries are in need of power supply – they have large scarcity of the electricity but not the solar energy. Under phase II, the phase I is extended by the electrical connection of the load as well as the solar source from the African Nations.

C. Phase III.

The final phase, which is PHASE III will involve interconnection on a global level. Global Interconnection to the grid is the final objective to be achieved for sustainability.

An interconnected grid would help all the participating entities in attracting investments in renewable energy sources as well as utilizing skills, technology and finances. Resulting economic benefits would positively impact not only the energy need for the human but also curtail the poverty by providing power need, eventually it will mitigate water scarcity, improve sanitation, increase agriculture businesses and other socioeconomic challenges. Further, the Indian Dream would lead to curtail project costs, improved efficiencies and increased asset utilization for all the participating countries. The presumption that one GRID is superior to a constellation or a “federation of GRIDs” of say, 0.5 MW to 5+ MW capacity, appears flawed. Given trends, GRIDs economics will surpass grid economics, even with the cost of batteries included. Public policy attention was devoted to developing battery technologies at scale for local applications. Policymakers have also prioritized designing urban and rural GRIDs, with sophisticated controls and demand side management baked in, and studying the issues surrounding their ownership, technical feasibility, and deployment. They would achieve the access, resilience, and reliability the world needs. IG-ID is impacting by both satisfactory efficient energy grid and socioeconomic development in the world.

Solar based other sources like wind energy and other renewable sources – tidal, ocean thermal, etc can contribute to the IG-ID; the individual capacity and distribution of energy sources in the transformed manner makes concentration and national dominance through transactive energy(TE) to the world. [7,8]

IG-ID seems to be a brilliant idea in pursuit of sustainable development. However, it faces certain challenges in its implementation:
III. ADVANTAGES TO INDIA

- Equality in International Electricity Market: IG-ID places India in the equal status with the other developed countries which compete China’s Global Energy Interconnection project, Europe’s gold-standard power pools.
  
  o Also, IG-ID provides an opportunity for India to put a step ahead with the global climate crisis and prove an accelerating growth to curtail the carbon emission with collaboration with other countries.

- Climate Mitigation: IG-ID assumes more importance in backdrop of the USA’s withdrawal from the Paris climate deal.
  
  o Also, IG-ID will help to mitigate ill effects on climate by providing clean and renewable energy sources.

  o Further, enabling member countries to fulfill their Nationally Determined Contributions (NDCs) towards reducing global warming.

- Balancing Neighbor countries: IG-ID will provide a strategic rebalance in favour of India and will control the increasing Chinese dominance in Asian subcontinent, providing a better alternative to developing countries. The Government of India has set a target of 175 GW for renewable energy generation by 2022, and is expected to touch 330-441 GW by the year 2040. On the other side, in China thermal and hydro generation grew from a high base, electricity generation from wind and solar are larger on a percentage basis. With an increase of almost 20 per cent generation from nuclear also grew appreciably in global energy market in 2019.

- Reduction in the fuel dependency: India is currently importing around Indian Rupees 490 billion of petroleum commodities (including coal) [which is going to be curtailed by IG-ID].
  
  o IG-ID can help India achieve its needs and subsequently promote sustainable renewable energy exports and may improve the current account deficit and curtail imported inflation pressures.

IV. PROBLEMS WITH IG-ID:

- Growth of Battery Industries: With development in electricity storage technologies, making of batteries is appreciably increasing and yet to grow which curtails the viability of the need to follow the sun along any latitude only.
Easy Installation of GRIDs: Large capital expenditures are no longer necessary; there is freedom of solar installation along with bidirectional Grid – IG-ID.

Resiliency of Grids: As the area of the grid connection, equipment interaction will increase, it is going to be challenging task in context to cyber-attacks, protection and security along with terrorist attack through IG-ID.

Transmission Losses: Solar generation is at less than 20% efficiency, could reach up to 35% at maximum in addition there will be major transmission losses on such scale with available cable and conductors.

Dependency on other countries: India is dependent on imports for solar commodities which may be shifted to the African countries and Japanese market, but not self dependent in immediate effect.

Transmission connection issues: IG-ID is extensive use to all the countries in different phases and hence their policies, electrical parameters need to be framed in international standards which should be trusted by all the grid participants.

- The major hurdle of integration is nothing but to make the other socioeconomic growth on halt which is against the solar commodities and in favor of the petroleum commodities.

V. MILESTONES

- International Standardized Organization (ISO): The IG-ID requires an international standard – organization which makes a major role in the policy making for other countries by motivating to participate in IG-ID.
  - In this context, ISO can act as an independent organization for the electricity market which can take decisions about how the grid work efficiently and dispute free.

- Motivating IG-ID to neighbors: Along with prioritizing designing GRIDs, neighbor countries attention is needed for developing battery technologies at scale for local benefits and profit making for them too.

- Establishing chain to other countries: Starting from the neighbor countries like China, IG-ID will have to find ways of working with other countries and their ambitions in a constructive manner rather than only one country objective.
  - Also, there is a pressing need to build its domestic capacity in solar equipment under the AatmaNirbhar Bharat program. Indian Industries should be able to export the
commodities to the participants of IG-ID. If the milestones are followed with the parallel cooperation of the participating developed countries and motivating the underdeveloped countries to take a lead in the advantageous manner phase wise, the IG-ID would overcome the problems said here.

VI. POWER DEMAND

The Indian Energy Exchange program has already been started from trading of the energy. From this exchange program one can participate in the bidding and can become buyer and seller of the energy. A glimpse of it has been represented here. The various solar and Non-Solar power demands have been observed in the year 2019 from January, 2019 to December 2019. It is shown in the following figure 1.

Here, REC is Renewable Energy Certificate. In context to the power generation, following figure shows the International capacity of the power generation using solar energy:

So the demand and the generation capacity in the case of solar energy is completely different, but looking at the time span in the usage of the electricity at International Market, it is of a different scenario.

The only transmission losses are to be incurred by the users but the cheaper solar energy can be of the capacity of the every nation being one world.
This paper is merely to introduce to the world about the Indian vision for the One Grid – an International Grid using Solar. The World Bank has already granted some Indian Rupees and the bidding for the interested companies have been invited by Government of India. This paper is to make the Institutional representative to know about this future for making the students capable for the skill required for this vision. This vision will help the Indian Economy by providing recruitment to them and free energy will be available to the developing countries.

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PLANT DISEASE DETECTION ROBOT

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Abstract—Agriculture plays a cardinal role in the economy. Farming requires proper nourishment of crops, especially during the initial period, as they are prone to many diseases. If precautions are not taken at the proper time, these diseases can seriously affect the productivity of the crop. The objective of the paper is to present a robotic system that will assist the farmers in the detection and treatment of crops. In this paper, we have considered the example of a group of diseases called blights which are widely observed in cotton plants. Suitable treatment is provided by the identification of disease at an earlier stage using image processing algorithms and spraying suitable fungicide. The image processing algorithm also employs unsupervised machine learning algorithms to detect the disease. The system is simulated using Matlab GUI. The robot can be controlled through Wi-Fi.

Keywords—Robot, Unsupervised machine learning, Digital image processing, V380 Camera module.

I INTRODUCTION

Food is the basic need of any living organism and farming is the major source of food for human life. Farming contributes to the economy of almost every country. However, farming highly depends on the climatic conditions. This can sometimes have a negative impact on the quality and quantity of crops. Apart from climatic conditions, several other factors can hamper the productivity of crops like bacterial diseases. Therefore, growing crops demand continuous observation.

In today’s world, where technology plays a cardinal role in almost all sectors like industries and healthcare, a lot of research is promoted for various applications of technology in the farming sector. Different types of technologies are implemented to perform different functions on the farm, for example, to regulate the supply of water, for weed cutting, plowing, etc.

The conventional method of detecting the diseases in plants include only naked-eye observation. Such practice requires a lot of effort and time of farmer when we consider observing all the plants on the farm. This project serves the purpose of detecting abnormalities in the leaves of the cotton plant through a robot. Image processing algorithms are applied that easily detect the abnormalities in these plants.[1]-[2] Most of the plant diseases in crops like cotton can be treated by spraying suitable fungicides or pesticides [3]. This can be done by an agricultural robot.

II LITERATURE REVIEW

The use of advanced technology in agriculture is growing day by day. A wide range of robots can be used in agriculture for performing dull repetitive tasks as well as advanced tasks such as image processing and disease detection and treatment. Currently, robots are most commonly engaged in tasks like weed control, harvesting and picking, mowing, pruning, seeding, spraying and thinning, sorting, and packing. Common diseases in cotton plants that can be detected by the leaves of the plant using this robot include different types of blight including Ascochyta Blight and Bacterial blight. Blights can be prevented by selecting a fungicide spray. [3] This spray is based on copper oxychloride. Identical sprays can be used to treat any blight infected plants.

Literature Survey-

[1] “Intelligent autonomous Farming for plant disease detection using Image processing”
In this paper, an Agricultural robot is designed for capturing the images of the plant leaves and attempts the detection of diseases in plants. A camera is placed on the robot. Images are captured and transferred wirelessly using an RF module.

In this paper, the model employs image processing implemented in open. The SVM classifier was used for image classification and recognition.

This paper discusses the major diseases and treatments for these diseases. Image processing is employed for the detection and identification of different diseases. The image is converted to YCbCrColor Model for the detection of diseases.
III  COMPONENTS

1. **Arduino UNO**

![Arduino Uno board](image1)

Fig. 1. Arduino Uno board

The Arduino Uno is an open-source microcontroller board. It is based on the Microchip ATmega328P. The board consists of 14 digital I/O pins and 6 analogs I/O pins. It is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can also be powered using an external 9-volt battery. In our project, Arduino is programmed through Matlab. For this, the Arduino support package is installed so that Arduino can communicate to Matlab through Bluetooth, Wi-Fi, or directly by USB cable.

2. **Robotic chassis**

![Robotic chassis](image2)

Fig. 2. Robotic chassis

It is specifically designed for robots. It helps in providing support to the Arduino board, accessories, and various parts that are connected to it. The wifi module, battery, and sprayer are placed on this robotic chassis. The camera is mounted on a composite fiber CCTV stand which is placed on the robotic chassis. The stand elevates the camera by 1 foot from the chassis which makes it easier to capture the images of plants. Two motors are attached to the chassis to provide mobility.

3. **Camera**

![Camera](image3)

Fig. 3. V380 Camera module and camera stand

**Specifications:**
- WiFi connectivity
- 360-degree view
- Night vision
- 360-degree angular movement controlled by using a mobile app
- Motion sensor
- Operating voltage - 5v and 2 amp current
- Low operating voltage (can also operate on power bank)

This camera is mounted on a camera stand which is placed on the robotic chassis. The camera is elevated by 1 foot using this stand. The movement of the camera is controlled by a mobile application.
4. **Wi-Fi module**

![ESP8266 Wi-Fi module](image)

The ESP8266 Wifi module is System On Chip with an integrated IP protocol stack. It provides a Wi-Fi network to Arduino. In this project, the WiFi module is used as a means of communication between Matlab and the Arduino.

5. **Motors and motor driver module.**

![Motor driver](image)

The motor driver is compatible with the Arduino board. The motors are operated through the motor driver. The program for driving motors is written in Arduino IDE.

6. **Fungicide spray**

![Fungicide Spray](image)

The spray gun is mounted on the camera stand. It is connected to a tank of water, placed on the chassis using a small pipe. The servo motor is used to control the spray mechanism. The output from PWM pins is given as input to the servo motor.

When abnormalities are detected in a particular plant, the amount of fungicide is sprayed over the plant before moving to the next plant.

![Plot of duty cycle vs angle of servo motor](image)

**Table I. variation in the angle of servo motor with respect to change in the duty cycle of PWM.**

<table>
<thead>
<tr>
<th></th>
<th>duty cycle in%</th>
<th>angle in deg</th>
</tr>
</thead>
<tbody>
<tr>
<td>spray1</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>spray2</td>
<td>75</td>
<td>67.5</td>
</tr>
<tr>
<td>spray3</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td>spray4</td>
<td>25</td>
<td>22.5</td>
</tr>
<tr>
<td>spray5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>spray6</td>
<td>25</td>
<td>22.5</td>
</tr>
<tr>
<td>spray7</td>
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<td>45</td>
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<tr>
<td>spray8</td>
<td>75</td>
<td>67.5</td>
</tr>
<tr>
<td>spray9</td>
<td>100</td>
<td>90</td>
</tr>
</tbody>
</table>

IV **METHODOLOGY**

**Robot control:-**

The robot is controlled by the user with the help of a GUI control panel in Matlab. By using the GUI control panel, we can control the movements of robots like “forward”, “backward”, “left”, and “right”.

![Control Window](image)
This panel is created in GUI to control the motors connected to the robotic chassis. The robot can be moved forward, backward with, and turned right and left using the four-movement control keys. When these keys are pressed, the robot continues the respective movement until the key is released.

The slider assists the keys while taking turns. When the key kept at "F" and the left or right key is pressed the robot will take forward left or forward right turn respectively. On the other hand, when the slider is moved to "R" and when the left or right key is pressed, the robot will take a reverse left or reverse right turn respectively.

Another key, ‘Capture’ is provided to get snapshots. On pressing this key, the ‘get snapshot’ function is executed and the image will be captured from the live view axes.

Capturing the image:

The camera module shares the live view to the GUI through a wifi network. When the user presses the “CAPTURE” button, the image of a particular plant leaf is captured and this image is displayed on the screen and used for image processing.

The movements of the camera are controlled by the help of a mobile application called “v380”.

This camera has a 360-degree view. With the help of the mobile application, the camera can be rotated in clockwise as well as an anti-clockwise direction. This device also has internet connectivity and communicates with the mobile app over the internet.

Fig. 9. V380 Mobile App

Connectivity with Matlab:

robocam=ipcam('http://172.28.17.193/video.mjpeg', 'admin', 'password').

Here, the robot camera is an object and “http://172.28.17.193/video.mjpeg” is the IP address of the camera module. "admin" is a character vector representing the username of the IP camera. This should be the second argument while "password" is a character vector. It should be the third argument.

The live view of the camera is also available in the control panel in Matlab GUI.

Fig. 10. Live view from the camera module

Image Processing:

- Image Acquisition
- Image Preprocessing
- Image Segmentation
- Clustering
- Feature Extraction

Fig. 11. Image Processing

Image Acquisition: The first step involved in image processing is collecting the data. This step takes the input in Matlab for further processing.

Image Pre-processing: After the images are taken from the camera view, they can not be directly processed. As the word ‘preprocessing’ suggests, the noises should be removed from images before processing as they can be misleading. Functions like image erosion serve this purpose by deleting unwanted data in the images like the background of the image. Many methods can be employed for enhancing the image. In this project, we have using histogram equalization. It is one of the best methods for enhancing as it adjusts the global contrast without loss of any information. It is also one of the simplest methods compared to other methods like using morphological filters.

Fig. 12. Histogram of an acquired image
**Image segmentation:** This step is significant in disease detection as it involves partitioning the digital image into multiple segments. In segmenting, the Otsu classifier and k-mean clustering algorithm are used.

**k-means clustering** is a vector-quantization method. It is an unsupervised machine learning algorithm that clusters the image into different clusters based on the coherence of the colors present on the leaves. It partitions the data into k mutually exclusive clusters and returns the index of the cluster to which it assigns each observation. In this project, it is observed that the abnormalities on the leaves of the plants occur in the cluster with index 2.

**Otsu Classifier** - Automatic thresholding can be implemented using Otsu’s classifier. It is an algorithm that bifurcates all pixels into 2 classes labeled as background and foreground. This algorithm is implemented on the cluster 2 where abnormalities can be detected if present.

**Feature extraction:** This is the last step in image processing, the feature extraction of the targeted cluster is implemented. The shape oriented feature extraction is calculated. This step extracts the features and decides whether cluster 2 indicates the presence of abnormalities.

**Output block:** This is a text box that displays the final result in the GUI i.e plant is affected or not. The image processing algorithm detects if the plant is affected. Accordingly, the signal is given to Arduino. If the plant is affected, then fungicide is sprayed on the affected area using a sprayer.

**Connection of Arduino with Matlab:**

---

![Image of enhanced image](image13.png)

**Fig. 13.** Histogram of enhanced image

![Image of images](image14.png)

**Fig. 14.** Output window

![Image of steps](image15.png)

**Fig. 15.** Image processing steps

![Image of connection](image16.png)

**Fig. 16.** Connection of Arduino and Wi-Fi module

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![Image of image segmentation](image17.png)

---

42
Interfacing the Wi-Fi module with Arduino UNO.

![Connection established between Matlab and Arduino](image)

Fig. 17. Connection established between Matlab and Arduino

Arduino hardware communicates with the host computer through Wi-Fi and chooses the connection type as “Wi-Fi” for interfacing use static IP address box. The program of the wifi module begins uploading the server of the Arduino board. Now, the Arduino board and Matlab are connected, and Arduino can perform the tasks given by the user through the Matlab GUI.

![Hardware connection & block diagram](image)

Fig. 18. Hardware connection & block diagram

V RESULTS

After the image robot arrives near the plant and the image is captured properly, the image processing takes place. Based on the outcome of image processing, if the plant is affected, the fungicide is sprayed on the plant. The robot then moves towards the next plant.

![Image captured](image)

Fig. 19. Image captured

![The result displayed in GUI for Unaffected plant](image)

Fig. 20. The result displayed in GUI for Unaffected plant

Out of 20 plants tested, 17 results were accurate. Hence we get accuracy at 85%.

VI CONCLUSION

This robot is intended to detect the diseases in plants. This will be done by using image processing algorithms thus providing a more efficient way of protecting plants than just by human observance. The v380 camera module is placed on a Wi-Fi controlled robot that will capture images of leaves of the plant. It will then examine the images to detect whether the plant is affected by the disease so that the required action can be taken. In this way, the robot will significantly contribute in protecting the plants from disease.
The current robot is controlled by a MATLAB GUI. Deep learning and neural networks can be implemented for the autonomous control of the robot. Currently, the camera only provides the live view and image capturing feature. Computer vision can be employed for the autonomous movement of the robot. Also, the camera has a two-way communication function through which the actions of robots like spraying fungicide can be controlled by voice messages.

ACKNOWLEDGEMENT

This project and study would not have been possible without the valuable guidance and support of our project guide, Mrs. Gayatri Vidhate, and Atul Nigavekar, Head Of the Department, Electronics Engineering, Kolhapur Institute of Technology, Kolhapur.

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A Short Review on Neuromorphic Engineering

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Abstract— Neuromorphic engineering is an emerging research field. It takes inspiration from the biological neural network. This review paper explains the need for a neuromorphic designing approach and provides some information about different hardware components used to implement neuromorphic designs. This paper also contains a small comparison of different neuromorphic chips.

Keywords— neuromorphic, neuron, synapse, memristor, CMOL

I. INTRODUCTION

The word Neuromorphic has two words combined. Neuro means 'related to nerves' & morphic means 'having a particular shape/form.' By combining these two, we can easily understand the meaning, which is 'having the shape of nerves.' So basically, the meaning of neuromorphic engineering/computing is 'engineering/computing having the shape of nerves,' which means 'Brain-inspired engineering/computing.' The term “neuromorphic” was given by Mead [9] in 1990. It takes neurons as building blocks. The computer technologies we are using today has Von-Neumann architecture. It has some underlying problems like serial processing & bottleneck (To move from main memory into the CPU, data and instruction have to go through the data bus, which certainly is a problem because the data bus is much slower compared to the processing power of CPU & fetching rate for data and instruction is not same still they both have to pass through a common data bus) [15]. The bottleneck issue is solved using cache memory (stores some data & instructions at CPU side) or using Harvard architecture (data and instructions are stored in different memory having different buses for connection with CPU). Computers that we are using today still use von-Neumann architecture due to complexity and cost associated with Harvard architecture [16]. It is only used by some specialized GPU(Graphics Processing Unit) and embedded microprocessors like Atmel AVR. These CMOS based digital systems are power-hungry and inefficient in terms of scalability [8]. It is nearly impossible to precisely calculate the performance of the human brain. Still, it is postulated that it operates at 1 exaFLOPS, which is equal to a billion billion calculations per second. If the metabolism of the brain is converted to electrical power, it would require only 20 watts of power. Comparing that with the latest Japanese supercomputer FUGAKU, which uses 158,976 A64FX CPUs & consumes 28.3 Megawatts of power to operate at 0.54 exaFLOPS. That's why Neuromorphic technology seems to be a solution for future technologies with high performance & low power requirements. This short review paper provides a brief idea about Neuromorphic engineering, starting from the initial research phase until now, using some of the diverse but interlinked research work.

Fig. 1 A biological neural network having two neurons [4]

II. NEURON

The work of 19th century Spanish anatomist Santiago Ramón y Cajal showed us the importance of neurons as a central functional unit of the nervous system [7]. There are about 100 billion neurons in the brain. Each and every neuron forms synapses with many other neurons [2]. The gap between the axon of one neuron and the dendrite of another neuron is called a synapse. When combined incoming signals reach a threshold level, the neuron sends an action potential through the axon, which causes the release of neurotransmitter to the next neuron using Sodium & potassium channels created by synapse [10]. Neurotransmitters are produced by Soma(cell body of a neuron). An action potential is sudden and short(1ms) increase in voltage, after which there is a waiting period of 10ms [10]. In reality, the nervous system is a lot more complex, but for the sake of this review paper, the information given here is sufficient. A biological neural network having two neurons is shown in Fig. 1.

III. ANALOG OVER DIGITAL

Digital provides double precision & almost noise-free outputs that are easily reproducible and easily reprogrammable [3], but not scalable in terms of power & space and not good in parallel processing. Neural computing itself is inherently analog and noisy/variable [3] at a large scale. But inter-neuron communication is in a digital manner using all-or-none spiking. Biological neural network provides a large number of high-speed computations using parallel processing with less precision compared to digital computers while using minute power and extremely tiny space [3]. That's why the research field is pivoted towards the analog approach.

IV. NEUROMORPHIC DESIGNS WITH CONVENTIONAL DEVICE HARDWARE
A. Field Programmable Neural Array

By taking hardware reconfigurability as a goal, FPNA was designed. It is a specialized version of FPAA (Field-programmable analog arrays). It uses sodium and potassium active channels, electronic synapses and dendrite matrix as building blocks as shown in Fig. 2 and Fig. 3. Every node consists of these three, except the output of soma (for triangular wave generation), which nearly satisfies neuromorphic design’s main objective. These blocks can be reconfigured. The design uses conventional device hardware like MOSFET and pFET in the subthreshold region (Analog approach). The integrate and fire approach is not used here, but it can be implemented [1].

B. A Single Synapse

A subthreshold analog approach was used to create a single synapse using 400 CMOS transistors. It can be used in visual processing & possibly in neural prosthetic devices like artificial retina in the future [2].

C. Silicon Neuron

SiN uses CMOS transistors operating in the subthreshold region. Using this analog approach, circuits became efficient in terms of power, space, and weight. They became independent of network size except for the propagation delay (more scalable) [3].

V. NEUROMORPHIC DESIGN USING SPIN DEVICES

The subthreshold analog approach reduces power requirement, but the use of a spin device can offer solutions that need extremely low power [4]. Spin devices use the spin property of electron combined with magnetic property of ferromagnetic materials to store, retrieve, or change data/bits. It solves the issue of charge leakage faced by extreme high-density electronic designs [11]. Ultra-low voltage operation devices like LSV(lateral spin valve), DWM(domain wall magnets), and MTJ(magnetic tunnel junctions) can be used to realize energy-efficient neurons [4]. Fig. 6 shows the Spin-based neuron model with three DWM synapses. The free layer of the neuron MTJ is in contact with the channel, and its polarity is determined by the spin polarity of the combined input current of synapses [4].

Fig. 2 Schematic of the Field Programmable Neural Array (FPNA) [1]
Fig. 3 A single cell including dendrite connection [1]
Fig. 4 Circuit diagram of Axon-Hillock neuron [13]
Fig. 5 Circuit diagram of current mirror integrator synapse [14]
Fig. 6 Spin-based neuron [4]
VI. NEUROMORPHIC DESIGN USING MEMRISTOR

The memristor is defined as a two-terminal, passive device considered to be the fourth fundamental electrical element. It behaves like a variable resistor with a nonvolatile memory that retains its last value even after being powered OFF [12]. CMOL (CMOS/nanowire/MOLecular/ nanodevice) has combined the existing CMOS technology with the ultrahigh-area density to create two-terminal neuromorphic devices [12]. Here, a memristor was used as a synapse to create a neuron using CMOL [12].

VII. CONCLUSION

Neuromorphic engineering is an interdisciplinary research field that uses electronics, computer science, biology, physics, and mathematics to design neural networks. It can be implemented in numerous technologies like image processing, prosthetic devices, artificial intelligence, etc. It is a new and exciting research field having many unexplored frontiers ahead.

REFERENCES

The Role of Outcome Based Education in Making Self Dependent Engineers for a Sustainable Development of Communication Technology

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Abstract— Engineers evolved through a proper system of Outcome Based Education (OBE) can correctly work as a self-dependent engineer. They can disseminate acquired engineering knowledge in their domain effectively and appropriately in various practical scenarios, even beyond their domains. How the core competencies to become a self-dependent engineer is influential in achieving the sustainable development goals in unconventional areas, and disaster situations are explored in this paper. The study focusses on identifying the significance of OBE in making self-dependent engineers, identifying the areas of communication technology where the outcomes can be applied, identifying the elements of sustainable development goals related to communication technology, and in analyzing the impact of the pandemic situation on the specific sustainable development goal ‘quality education’. Typical cases of agriculture, flooding, and pandemic management are used for analysis. An elaborate and detailed analysis of the impact of the COVID 19 pandemic situation on quality education, the fourth sustainable development goal specified by the United Nations is attempted, revealing a digital divide which in turn will cause the widening of the gap between the rich and the poor. In such cases it is feared to have a dearth of self-dependent engineers, moulded through lesser practical experiences, contradicting the basic outsets of OBE.

Keywords— Outcome Based Education; Self Dependent Engineer; Sustainable Development Goal; Quality Education; Communication Technology; Digital divide.

I. INTRODUCTION

A self-dependent engineer can be successful and existing if and only if the acquired engineering knowledge can be applied convincingly, effectively, and appropriately in various practical scenarios. The moulding of the engineers through the system of Outcome Based Education (OBE) only can produce such type of competitive engineers [1]. The preliminary part of this paper analyses the core competencies to become a self-dependent engineer. Rather than the conventional areas, how these competencies are related to the OBE in unconventional areas and disaster situations is explored in the second part with specific reference to electronics engineers. How these elements can be linked to the terms of sustainability goals is explored in the third part.

This paper aims to understand the role of OBE in making them self dependent engineer and to find out their role in sustainable development

Objectives are:
1. To identify the significance of OBE in making self-dependent engineers
2. To identify the areas of communication technology where the outcomes can be applied
3. To identify the elements of sustainable development goals related to communication technology.

II. BASICS OF OBE

At present, the engineering education practised in various universities and institutes is teacher-centric. The courses in electronics and communication engineering also is not an exception. Here, completion of the courses by the teachers on time and achievement of grades by students is significant rather than the dissemination of the proper knowledge. Now, globally the changes are happening from teacher-centric learning to student-centric learning, known as Outcome Based Education.

In Outcome Based Education, rather than the quantum of knowledge, the quality of the knowledge is assured. How much the student can acquire in the proper sense is significant here. In Outcome Based Education, three competencies are to be assured. The first one is the reflection of knowledge, "to learn and adapt through self-reflection to apply the knowledge responsibly and appropriately". Second is the understanding of the fundamentals, "why you are doing and what you are doing". The third competency is the practicality of knowing "how to do things and the ability to make appropriate
decisions” [2]. A self-dependent engineer means, all these outcomes are hand in hand when dealing with the problems. Alternatively, indirectly the decisions are not sudden and spontaneous. It is through a rigorous process of analyzing the knowledge (so far acquired through systematic learning) within the framework of the problem (how to do it) adaptively and acceptably.

Here, when we discuss the outcomes, we are not considering the achievement of the outcomes at the module level or course level. It is considered as a program outcome, after completion of the courses or completion of the program. Alternatively, it can be considered as a graduate attribute after completing the program of study.

III. BASICS OF SUSTAINABILITY

Generally, the term sustainability indicates programs, initiatives, and actions aimed at the preservation of resources in four distinct areas: human, social, economic, and environmental - known as the four pillars of sustainability. United Nations has declared 17 sustainable development Goals (SDGs) to transform our world [3] by the year 2030.

The Goals are:
1: No Poverty
2: Zero Hunger
3: Good Health and Well-being
4: Quality Education
5: Gender Equality
6: Clean Water and Sanitation
7: Affordable and Clean Energy
8: Decent Work and Economic Growth
9: Industry, Innovation, and Infrastructure
10: Reduced Inequality
11: Sustainable Cities and Communities
12: Responsible Consumption and Production
13: Climate Action
14: Life Below Water
15: Life on Land
16: Peace and Justice Strong Institutions
17: Partnerships to Achieve the Goal

This report is to find out the scope for the development of sustainable development goals in the area of communication engineering by self-dependent engineers. When we discuss the communication engineering, it may contain the elements, infrastructure, and systems required to establish a proper communication system; it may have the technology to transfer the information from one discipline of engineering to another discipline of engineering.

As an example, consider the case of increasing water levels in a reservoir. It is a civil engineering problem. Conventionally the water level gauges called stages are installed in all reservoirs. Just by observing the point where water is touching on the scale, we can understand the water level. However, in the condition of the drastic rising of water levels due to flooding, it is highly risky to go near the stage to get the reading. Sometimes the locations of the stage may be inaccessible. Here either by engaging independent floats or floats linked to the scale (stage) or by moisture sensors installed on the stage, can convey water levels to a remote place. Here partial mechanization plus triggered electronic sensors indicate the presence of water at various altitudes and this physical data is converted as an electronic data which in turn can be appropriately communicated to various parts of the equipment itself or a control system [4]. So a civil engineering problem is aided by the technologies of electronics, by a competent engineer. Here, in the curriculum, the electronics engineer did not learn the civil engineering problem, but what he learned in electronics, he applied to a context sensibly. This is the core of OBE.

IV. ELECTRONICS IN AGRICULTURE

In agriculture, electronics changed many things like farming made it easier for farmers. It focusses on improving the rural conditions by enhancing the communication process.

With the use of technology, the struggle of the farmer has reduced very much. The conditions of the soil can be analyzed before sowing the seeds. The amount of water in the soil can be measured, controlled, and regulated with the help of sensors. Soil fertility, the presence or absence of various chemicals, also can be modified by monitoring the pH and nutrient levels of soil by electronic devices. Sensors and transducers can be used for this purpose.

Optimum moisture content in the soil [5], as well as the humidity of the air, can be assured after monitoring the present levels and adjusting the flow of water (or moisture). Through the flow measuring devices, the discharge of water can be quantized and optimized in the irrigable lands. The excess water in the field may lead to waterlogging, whereas the absence of water may lead to drought and distress to the plants. Both can be monitored and controlled by electronic devices. Broadly, an arable land can be converted into fertile land by proper irrigation and fertilization, which has to be done after proper monitoring, measurement, and controlled distribution of water and nutrients. In this agriculture scenario, how the electronic engineering solution is linked to OBE and Sustainability goals is shown in Table I.

V. ELECTRONICS IN FLOOD CONTROL

Warnings about the depression storms and cyclones can enhance the precautionary rehabilitation of people. The network of satellites, geostationary or not, and the images taken from the satellites periodically acts as a critical element in the climate analysis and weather prediction. Nowadays, the analysis of cyclones results in pinpointing the location of landfall of the cyclones and their predicted trajectories. The
affected area can be evacuated well before the landfall so that the life of human beings and animals can be rescued. Even the intensity of the rainfall can be predicted by monitoring the pressure and temperature of the convective clouds. The speed of the wind and direction of movement of the cyclonic storm also can be predicted. The information can be disseminated to the affected people through a well-connected network of communication channels including, newspaper, radio, television, text, and calls through mobile phones, and short text or video messages through various social media platforms. Rising levels of water bodies due to the cyclonic storm can be estimated based on the rainfall in the catchment areas. The approximate time to reach the flood flow in various downstream terrains also can be forecasted.

In the COVID 19 pandemic condition [7], various tools of electronics can be effectively used in controlling the spread of the pandemic, and or to reduce the effect of the pandemic. For example, consider a person tested positive with COVID 19, and his immediate contacts are not known. Then the previous travel movement of the person can be traced to the mobile phone he/she was using. Various cell locations, tower locations, and the path of movement can be made available. After that, based on the activities of the person, the activities and time spent can be correlated; then the time spent at various places of importance can be determined after a lively interrogation. Then warnings can be issued to the public. Those who have been in those places during the time of the affected person’s visit will have to go for self-quarantine as part of a precautionary measure. If any of these secondary contacts are also having positive symptoms, then tracking can be extended further. These are all possible through the effective monitoring of the communication channels. Then if the clusters can be identified with a lot of positive cases, the closing or shut down of the cluster can be thought off after proper data analysis. The movements within the cluster [8] and the transport to the cluster can be controlled. Electronic devices can monitor the movement of the people from the cluster or to the cluster. Further, the supply of essential materials, food, and medicines to the people belonging to the affected areas also can be monitored through an electronic system. Even by using drones, the movement of people can be checked.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Learning</th>
<th>Sustainability Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical (how to do and make a decision)</td>
<td>Either by meters or by samples.</td>
<td>Collect, use and interpret data on rain, wind, flood flow, terrain conditions</td>
</tr>
<tr>
<td>Reflective (apply knowledge appropriately and responsibly)</td>
<td>. The variation of moisture level can be monitored using sensors and transducers. Learning might have happened in Level 1 or 2 of a 4 level study Program.</td>
<td>Continuous monitoring and observing the trends and changes by data analysis and conveying it to the proper agencies without delay</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Learning</th>
<th>Sustainability Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental (understanding what you are doing and why)</td>
<td>Collect, use and interpret data on rain, wind, flood flow, terrain conditions</td>
<td>Goal 3: Good Health and Well-being  Goal 9: Industry, Innovation, and Infrastructure  Goal 11: Sustainable Cities and Communities  Goal 13: Climate Action  Goal 15: Life on Land  Goal 17: Partnerships to achieve the Goal</td>
</tr>
<tr>
<td>Practical (how to do and make a decision)</td>
<td>Using sensors, gauges, and transducers, a variation of temperature, pressure, velocity, etc. can be monitored. Learning might have happened in Level 2 or 3 of a 4 level study Program.</td>
<td></td>
</tr>
<tr>
<td>Reflective (apply knowledge appropriately and responsibly)</td>
<td></td>
<td></td>
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TABLE I. AGRICULTURAL SCENARIO- RELATION OF OBE AND SUSTAINABILITY GOALS

TABLE II. FLOOD AND FORECAST SCENARIO- RELATION OF OBE AND SUSTAINABILITY ELEMENTS

In the cases of rescue during a flood, the positioning of stranded people can be made precisely with the electronic devices through the tower locations or based on longitudes available through various GPS systems. To and fro responses can be coordinated by a central control room, so that most comfortable access also can be decided, from an outside location of the distress. The distribution of the relief materials and food also can be coordinated from remote places through effective management of communication.

In this flood control [6] and forecast scenario, how the electronic engineering solution is linked to OBE and Sustainability goals is shown in Table II.

VI. INFLUENCE OF ELECTRONICS IN MANAGEMENT OF PANDEMIC LIKE COVID 19

In the COVID 19 pandemic condition [7], various tools of electronics can be effectively used in controlling the spread of the pandemic, and or to reduce the effect of the pandemic.
Remote controlled small vehicle units can ensure even the supply of medicines or food to the affected persons. Robots developed for food distribution and medicine distribution within the wards of the hospitals will ensure the basic protocol of social distancing without spreading the contaminants. Readymade robots available were too costly, and most of the robots were not available in the markets. By blending the traditional mechanical technology with electronic controls, local level technology was developed for the development of these robots. Most of the engineering college labs acted like a start-up unit in developing the prototype of robots for the distribution of food to the COVID affected patients [9].

Due to the lockdown and boundary closure of various villages, the most suffered people are the farmers. The agricultural produce cannot be taken to the markets, which were functioning previously, but now not accessible due to the control of crowds. The majority of the perishable goods cannot be retained for a more extended period without processing. So local self-help groups began to evolve for the local distribution by maintaining the social distancing protocol [10]. Buyers and sellers are linked through a common local electronic social platform (a WhatsApp group or a Telegram group or Facebook group) so that at the time of availability of the product as well as the distribution can be coordinated [11]. If the harvesting is planned in connection with the distribution, altered, differed, or staggered marketing also possible. If production is high, this will help the farmers to get an assured income.

Fishing, poultry, butchery, meat distribution, etc. also can be worked in similar lines locally, with communication technology. So total paralysis of the economy will not happen to the low-income group of the society. A co-existence according to the situation without wasting the resources is treated as one of the elements of sustainability.

In the control of COVID 19, it was generally advised for social distancing and proper sanitation of the body. People were asked to use masks while they are in public places. They were advised to wash their hands with a soap solution for at least 20 seconds continuously if they had a touch with any suspicious locations. Otherwise, the application of sanitizers on the hands was advised. In all these cases, a sensor-based soap dispensing unit, or a sanitizer dispensing unit is required. Most of the places were developed locally by engineers with available resources [12]. The mechanical dispensers based on a sensor detects whether the person is within the proximity of dispensation and dispenses the required quantity of soap or sanitizer. Otherwise, the dispenser working with a pedal can be made active by operating through the foot. Same way for hand washing, water can be made available through a touchless sensor unit to control the flow to make it available on an optimum basis.

In the logistics, the routes and protocols are decided by the communication networks. The optimized distribution network is decided based on the algorithms of logistics decided by integrating available routes, current traffic data, requirement mapping, and mapping of available time, fuel, and type of vehicle. This optimization is positively contributing to conserving valuable resources.

In this scenario also, various elements can be mapped with OBE and sustainability goals, as given in Table III.

VII. ELECTRONICS IN EDUCATION

When the open learning process is suddenly transformed into e-learning, there was no other option other than the technologies of communication. Neither the institutions, universities, boards, states nor the country was practising a hundred per cent online platform for education. The requirement of transformation was on an emergency basis, and the resources available were nominal minimum. The challenges [13] were in developing learning materials, disseminating the materials, remote teaching, assuring the participation, enhancing the learning skills and the assessment. Ultimately the connectivity between the end-user (the student) and the disseminator (teacher) is through electronic media. Electronic gadgets are required for all the stakeholders [14] to become a part of the new system, which is costly.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Learning</th>
<th>Sustainability Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical (how to do and make a decision)</td>
<td>Continuous monitoring and observing the trends and changes by data analysis and conveying it to the proper agencies without delay. Enabling tools to detect various biological conditions. Developing tools to detect the presence or absence of microbial organisms.</td>
<td></td>
</tr>
<tr>
<td>Reflective (apply knowledge appropriately and responsibly)</td>
<td>Tracking of vehicles and human beings by various communication technologies. Signal processing Error elimination Learning might have happened in Level 3 or 4 of a 4 level study Program.</td>
<td></td>
</tr>
</tbody>
</table>

The student requires either a smartphone, a tablet, a personal computer with a mic and a camera (or a laptop) is required with high-speed internet connectivity. At the same time, the teacher should be equipped with all the similar things, gadgets to help in recording or to edit the deliverables is required. A video conferencing tool is also required. A
Learning Management Software (like Google Classroom, BlackBoard, Moodle, etc.) also is required To manage the users, contents, and assessments. Moreover, in a country like India, an uninterrupted power supply is required at both ends to assure proper delivery. Various power and data service providers came with subsidized tariff plans and local/cloud-based technology to overcome the hurdles [15]. However, ultimately it is a costly exercise and 'less effective' system on a massive scale. The term 'less effective' is debatable generally, but here it is used intentionally because of the lack of proper training either in usage or delivery and also because of the sudden transformation. The traditional face to face teacher-student interaction is not possible in the e-learning on a massive scale. Especially for the primary children, the touch, feel, and bond of the teacher has more influence on the little prodigies than the chapters taught through television or on a similar screen.

The cost implications of transformation are indicated in Table IV. The details are based on the requirement for an average engineering student in a remote village. When considering the communication part, the extent of the expenditure is given in Table V.

### Table IV. Cost of Transformation to Online Learning

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost in Rupees</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop or Personal computer</td>
<td>25000-45000</td>
<td>One time</td>
</tr>
<tr>
<td>Essential gadgets like headphones, scanner, camera, lapel mic, stylus pen, etc.</td>
<td>5000-8000</td>
<td>One time</td>
</tr>
<tr>
<td>Uninterrupted Power Supply</td>
<td>3000-5000</td>
<td>One time</td>
</tr>
<tr>
<td>Smartphone/tablet (optional)</td>
<td>12000-20000</td>
<td>One time</td>
</tr>
<tr>
<td>A proper and conducive study location with proper furniture</td>
<td>3000-7500</td>
<td>One time</td>
</tr>
<tr>
<td>Internet connection (ADSL, Wireless or broadband)</td>
<td>750-1000</td>
<td>Per month</td>
</tr>
</tbody>
</table>

### Table V. Recurring Items of Communication for Online Learning

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Space required to store the contents</td>
<td>300 MB to 600 MB for a one-hour video lecture with standard resolution.</td>
<td>Around 2 GB per day for four classes online.</td>
</tr>
<tr>
<td>Data for streaming/downloading</td>
<td>300 MB to 600 MB per hour</td>
<td>Around 2 GB per day</td>
</tr>
<tr>
<td>Data Cost</td>
<td>Around 2 GB per day</td>
<td>Around 100 Rupees per day (Rs. 40-50 per GB)</td>
</tr>
<tr>
<td>Electricity</td>
<td>Two Units per day</td>
<td>Rupees 4 to 10 per day (Rs. 2 to 5 per unit depending on the slab and service provider).</td>
</tr>
</tbody>
</table>

The first challenge for the engineer here is to reduce the one time cost per user and to extend the service to all stakeholders irrespective of their economic conditions. By introducing alternative materials or low-cost alternatives or by re-using some of the e-wastes, this can be thought of. The second challenge is to reduce the recurring cost of electricity, which is practicable by making available alternative fuels at affordable costs by appropriate technology. The third challenge is to reduce data costs. By enhancing the data streaming technologies, the quality of the data transfer with minimum file sizes can be thought off. Other than that, if online resources are available and accessible multiple times without much data consumption, the local personal storage requirements can be avoided. The network loading also can be reduced to a greater extent. Ultimately, enhancing the quality of the service at affordable costs within the scope of sustainability is a challenge for the engineers.

In the outlook of OBE, online learning cannot assure the achievement of required outcomes. Especially the skills of application achieved through practical training will be compromised as a demonstration only. Hands-on training will be lacking, and this deficiency may reflect negatively in the quality of the self-dependent engineer.

In the outlook of sustainability, the right and access to education are denied through the digital divide. Those who can afford the recurring cost and the one-time costs, they only may be able to get access to quality education, which in turn will be widening the gap between the poor and the rich; the privileged and the underprivileged; the “haves” and “have not”. The terrain specific and geographic features also may hinder the connectivity of many students, the more will be on the opposing side.

### VIII. Conclusion

Outcome Based education only will make a communication engineer, self-dependent. The elements of OBE and its influential role in making the engineer self-dependent are analyzed through various scenarios explicitly relating to the sustainability goals. The sustainability goals which are relevant while applying the communication technology to the agricultural scenario are analyzed first. All the available technology that can be applied to the agricultural field is not mentioned here. Only typical cases for the clarity of approach are mentioned. An in-depth analysis of any electronics course was also not done while considering the elements of OBE. A generic mention only is attempted. Otherwise, if a module wise outcome or a course-wise outcome from any university program is selected, that itself will be big enough beyond the scope of this analysis. The same approach is adopted while considering the influence of communication technology in flood control.

How communication technology can be used in the management of the pandemic situation is illustrated in the third part. Detailed analysis, including the cost parameters, is mentioned in the fourth part where the discussions are on, how the education sector is affected by COVID 19 pandemic scenario. Ample indications are there to believe that the digital divide may be responsible for widening the gap [16] between the poor and the rich in the education sector. Also,
technical education may be inaccessible for many, because of the lack of money. If online education is extended, the critical parameters of OBE will be compromised, and every chance of getting less quality self-dependent engineers. Serious discussions are required among the technical community to make the education available at an affordable cost in a closer and conducive environment with lessor technical jargon.

REFERENCES


Development of Crop Vegetation Index Measurement System

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Abstract— The continuous crop condition monitoring is necessary for the farmer to keep track of the growth of the Crop. The Drought and less moisture level create a huge problem for the Agricultural industry. To overcome this problem, the solution is to build an Embedded system containing a Processor Board with Near-infrared (NIR) band-pass filter and RED band-pass filter camera. The NIR Filter is reflecting more light compared to visible filters which helps isolate Good and drought leaves. The system calculates the basic principle of the NDVI (The Normalized Difference Vegetation Index) using Near Infrared (NIR) and RED film and the processed image provides Crop Yield in pictorial form. The main feature of this system is that it captures the RED and NIR filter photos on an embedded board and provides a processed image with highlighted Drought and good area of the farm which helps the farmer to focus on the Drought area of the farm. The main benefit of this system is independent of the satellite NDVI pictures.

Keywords— NDVI, GIS system, NIR filter, RGB filter, AI-ML

1. INTRODUCTION:-

Traditionally in India, monitoring of the Crop Yield on a regular basis, Crops are damaged or dry / not grow as required, which create huge loss of the productivity of the farmer and nation. Below are the major parameters which can affect due to not monitoring the Crop Yield on regular basis are: Decrease the lot of Crops, West of Water, nutrients and Pesticide, Affect the earning of the farmer, Loss of time and money, Higher demand of not able to fulfill. To measure vegetation index, it is dependent on Satellite images as satellite camera are able to measure NDVI.

System will help farmers to keep monitoring of Yield and get more and more productive growth of the crop. This is the system will help farmers to focus on specific areas by monitoring the Crop Yield on a regular basis. The proposed system is targeted to measure the vegetation index for crop yield in real-time.

The concept behind measuring vegetation index is based on NDVI Image capturing.

\[ NDVI = \frac{(NIR - RED)}{(NIR + RED)} \]  

(1)

With reference to the above equation, we need two separate camera filters one is called as NIR (Near Infrared) and second one is RED filter. The RGB image on top of this can help to prepare a much more accurate GIS system. By capturing both different filter images and applying the NDVI equation, we will get the NDVI value between -1 to 1. Here -1 is indicating the Crop yield in not in good condition and 1 is indicating very good growth of the Crop.

Tunisia occupies around 15 to 20% of the total cropping land. About 1/3rd of the land is under cultivation.[1]. Like most cases around the world Tunisia is also suffering from low income from agriculture products and efforts. And due to this, the food supply is suffering heavily. Comparing the global numbers, it has less production efficiency of the farming products. Majority of the farmers pass through small areas of farms and are highly fragmented. Mostly 30% of the farms are bigger than 25 acres, remaining are much less than that, out of that, 50% are smaller than 15 acres. The major factor affecting is irregular and unpredictable rainfall across the country. Marva HACHICHA and team has done extensive work on the estimation of farm productivity for better planning of farming activity. Mapping of farming land and vegetation land is of utmost importance for the success of sustainable farming and to improve the quality of the life of farmers. Fortunately for the agro driven economy, large Remote sensing satellites are increasing day by day. The resolutions of image sensors and imaging radars and other remote sensing stuff has helped a lot to study the land mapping, crop health, quality of vegetation, rain patterns, and land cover dynamics. The number of remote sensing agencies, platforms, and GISs are increasing rapidly during the past few decades [2]. The extensive work done by Jeevalakshmi and team [2] very rightly says, Sensors designed optimally for the purpose, can supply accurate and real-time land, farms, crops, resources along with location. While the satellite images...
will provide easy to visualize image classifications. The continuing advancement in sensing technology on time and space dimensions has brought the massive revolution in usability and acceptance of the technology for governance and decision making.

China and many surrounding countries have very poor/unpredictable rain (including India). The frequent drought is one of frequent factors to upset sustainable agriculture growth and sustainability. Even in the era of technology, it is difficult to quantitatively monitor and predict rainfall.[3]. Remote sensing is capable of supplying nearly real-time data, which is cyber powered by ML and AI technology, which is bringing the trust to the farming community and the people connected with farming and rural parts of the countries. One of the most popular technologies used for this is (NDVI). Using multiple bands, NDVI senses through different depths of vegetation canopies. The NIR channel can see roughly many leaf layers, while the red channel sees only one leaf layer or less.

Ali Mermer and team has done extensive work at Turkey [4] on NDVI using satellite imagery and produced a large amount of knowledge base for the farming community of Turkey and the world. The Central Anatolia Region occupies more than 33 percent measuring around 40 million acres is covered with rangeland region in Turkey [4]. In the previous half a century. The research showed light on declining cropping and crop yield which resulted in poverty and productivity in the rest of rangelands [4]. The management of available resources and plan for the optimum utilization of these resources, implementation of technology, techniques; and extensive usage of IT, ML and AI power is the only remedy to come-out with these growing crisis. Turkey has undertaken a mission of education supply-chain and stakeholders of farming and commodity communities.

The figure below shows the marked regions mapped on GIS by extensive data processing by the group [4]. NVDI and NVDI based specific techniques are used to monitor cyclic patterns of vegetation and yield of the regions.

Governments in these countries are taking majors to reduce the dependencies on rainfall and increase the productivity of modernizing, efficient usage of available rain water, and by introducing the technology and techniques for sustainable farming. Please refer to Fig.2 below for geometric distribution.
resolution sensors for imaging, soil analysis as well as environmental monitoring at farm level is playing a big role. The portability of data across cloud and collaborative application is going to make a big impact in the farming community, farm experts and governance related to farming, irrigation and trading.

ACKNOWLEDGMENT

We acknowledge the sincere thanks to the entire testing team at Teksun, who has taken huge efforts in data collection and analysis. We also express our gratitude towards Shri Brijesh Kamani, CEO and Founding director of Teksun to help in conceptualizing the experiments and to extend the resources for entire research activities including financial support, facility and human resources.

REFERENCES


II. FUTURE WORK

Huge efforts are needed to plan and achieve high productivity by accurate forecasts and planning supported by NDVI technology and mapping the information on GIS for easy and accurate understanding by farmers and farm consultants. The major efforts need to be put into accurate framework design to support extremely large data-sets, execution of big numbers of algorithms and programs. The need to use satellite images, aerial photography, laboratory data of soil, environmental data of the past as well as predictions.

III. CONCLUSION

This paper deals with a good amount of work done by the people across the globe, and our own research on soil as well as crop monitoring technology. NDVI is one of the promising techniques to solve the complicated puzzles of modern smart farming supported by ML, AI and much more cyber technology power. The high

Fig. 6 Yield Image

Fig. 7 NDVI Image


Reversible Logic for Advancement of High-Performance Sequential Circuits

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Abstract: Reversible logic is amongst the newer areas of research that can be used for designing circuits with lower power consumption. The Boolean digital circuits are designed using irreversible logic that dissipates power. The digital circuits can be designed by using the reversible logic. The cost metrics of the reversible circuits are different from that of conventional Boolean circuits. The cost metric parameters such as Constant Input, Garbage output, Delay, and Quantum cost are suitable for the reversible logic circuits. A reversible D – Latch implemented in Verilog language has been proposed in the paper. Two Fredkin gates are used in the proposed circuit. By using reversible gates, the cost metrics of the circuit were improved and the garbage output, as well as the power consumption, were reduced compared to the reference circuit.

Keywords: Reversible logic, Quantum cost, Sequential circuits

I. INTRODUCTION

The dissipation of energy is one of the most pertaining issues in the present era. An IBM Scientist R. Landauer proposed a principle in 1960. According to it, energy dissipated in one information bit is equal to the dissipation of K*T*ln2 joules energy, where K shows the Boltzmann’s constant and the temperature T is in Kelvin. Moore’s law claims that after every 18 months, the count of transistors will double in a circuit. Reversible circuits do not dissipate energy because of no loss of information bit. Because, in these circuits, an equal relation exists between inputs and outputs. An m*n input circuit will have equal k*k output corresponding to it. The reversible circuit works on the charge recovery logic that is, the energy dissipated when an information bit is lost is reutilised further in the circuit. In this way, the logical reversibility in a circuit can be achieved. In other words, the physical entropy of the circuit should not increase. Debajyoti Banik [16] proposed a D latch designed using reversible gates. The circuit is quite efficient with respect to the conventional Boolean circuit. P. Picton [18] proposed reversible circuits using Fredkin gates. Reversible logic is used in Quantum computing. It is also used in CMOS design with Low Power consumption, nanotechnology, etc. The challenges in designing a circuit using reversible logic are to optimize the cost metrics of the reversible circuit.

1.1 Reversible Logic:

In reversible circuits, there is an identical relation between inputs and outputs so that the number of inputs can be retrieved from the outputs. It can run the systems in both directions. To implement this, one has to control the dynamics of the mechanisms for computational operations very precisely.

1.2 Constant input:

It points to the number of input vectors that are kept constant at logic ‘0’ or logic ‘1’ for the realization of the circuit. These are the inputs given to a circuit to keep it in reversible state [3].

1.3 Garbage outputs:

It points to the number of output vectors attached to make a circuit reversible. It is utilize to find the current inputs attached to an (m:k) task to assemble it reversible.

1.4 Quantum cost:

The essence of the circuit is pointed by this cost parameter in terms of the value of the prominent gate. The quantity of prominent reversible gates required are used find quantum cost for realization of the circuit [3].

II. REVERSIBLE GATES TYPES

2.1 Feynman gate:

This gate is a 2 by 2 reversible gate which have one quantum cost. It is also named as a controlled - NOT (CNOT) gate. It is the commonly used reversible gate [5]. To generate the reversal of second input one of the two input could be utilized.

2.2 Toffoli gate:

This is a 3 by 3 reversible gate which have quantum cost of 5. The input vectors are (A, B, C), and the output vectors are (P, Q, R) [6]. It can be used to fabricate any reversible logic circuit.

2.3 Peres gate:

This is a 3 by 3 reversible gate which have quantum cost of four [7]. The individual output signal could be generated from each input signal with this gate.

2.4 Fredkin gate:
It is a 3 by 3 reversible gate having quantum cost five. It is the most widely used reversible gate. [7].

![Figure 1](Web)

**III.**

**IV. COMPARISON OF SEQUENTIAL CIRCUITS**

<table>
<thead>
<tr>
<th>Reversible Gates</th>
<th>Size</th>
<th>Quantum Cost</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOT Gate [9]</td>
<td>1*1</td>
<td>1</td>
<td>P=A’</td>
</tr>
<tr>
<td>CNOT(Feynman) Gate [5]</td>
<td>2*2</td>
<td>1</td>
<td>P=A, Q=A’B+AB’</td>
</tr>
<tr>
<td>Fredkin Gate [9]</td>
<td>3*3</td>
<td>5</td>
<td>P=A, Q=A’B+AC, R=AB+A’C</td>
</tr>
<tr>
<td>Toffoli Gate [6]</td>
<td>3*3</td>
<td>5</td>
<td>P=A, Q=B, R=AB XOR C</td>
</tr>
<tr>
<td>Peres Gate [9]</td>
<td>3*3</td>
<td>4</td>
<td>P=A, Q=A XOR B, R=AB XOR C</td>
</tr>
<tr>
<td>NG [9]</td>
<td>3*3</td>
<td>11</td>
<td>P=A, Q=AB XOR C, R=A’C’ XOR B’</td>
</tr>
</tbody>
</table>

3.1. D LATCH

The conventional D - Latch is made up of Boolean gates. These are irreversible gates, and thus dissipates energy when an information bit is lost. The D - Latch 'latches' the logic level present on the Data input line whenever the clock signal is at a high level. When the data changes its state while the clock input is at a high level, then the output Q of the circuit mimics the input value, D. When the clock is at a low level, the previous value of the D input is captured in the latch.

![Figure 2](Conventional D - Latch [8])

As shown in the circuit of reference [8], it is evaluated by using the number of Quantum Cost and Garbage output. The Table 2 indicates the cost metrics of the proposed D - Latch.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Existing [16]</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantum Cost</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Garbage outputs</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Constant inputs</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Delay</td>
<td>7ns</td>
<td>9ns</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>-</td>
<td>26mW</td>
</tr>
</tbody>
</table>

**V. RESULTS AND SIMULATION**

In Fig. 4, the RTL design schematic of the proposed D - Latch circuit is mentioned. Two back to back Fredkin gates are used. The circuit is designed using Xilinx ISE 14.7 software using Verilog language. Spartan 3 family of FPGA is used.

![Figure 4](D-latch using Fredkin Gate)
When the input is at a high level and enable is also at a high level, the output can be shown as follows:

![Figure 5. D Latch for high input](image)

When an input is low and enable is high, the output is shown as follows:

![Figure 6. D Latch for low input](image)

**VI. CONCLUSION**

In this paper, a proposed reversible D latch circuit using Fredkin gates has been successfully implanted and tested. The evaluation of the circuit has shown less garbage output, reduced power consumption and less delay compare to the reference circuit.

Using reversible logic many digital circuits such as counters, multipliers, etc can be designed. It will greatly enhance the capability of the digital reversible circuits in comparison to Boolean digital circuits. This logic can be useful in nanotechnology, Biomolecular computation, communication, and FPGAs.

**VII. REFERENCES**


Controlling of Electrical / Electronic Appliances Using Internet of Things & Cloud Technology

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Abstract—“THERE IS NO PLACE LIKE HOME!!”, The Home is the word, which after listening we feel relax but do we really manage the home without any of the relaxation like without moving your muscles can we switch on or off any of the appliances or we can monitor from anywhere around the world or to monitor the temperature or humidity or any motion in the room from anywhere. We have been busy now a days. So, to operate our Home from anywhere in this world we need to add Smartness to our home. And it is done using IoT. IoT has been the main center or the main frame of today’s Era. Everything can be controlled, processed and automatized using Internet of Things. Here there is the same thing a Home to be monitored and also can be safeguarded using the sensor and actuators. And Platforms based on cloud computing help to connect to the thing’s surroundings everyone, control from anywhere and anytime in a user-friendly manner using custom defined portals around the World. The automation system will have ability to be controlled from a central host PC, the internet, and also remotely accessed via a packet PC with a windows mobile based application.

Keywords— Home, IoT, Smartness.

I. INTRODUCTION

The evolution of the shelter place has been from the caves to the concrete houses. This all places are known as Home, a place where we can relax are feel free to do anything, we all loves our Mother. We have seen mother working 24X7 without getting tired but before IoT there was no help that can fell her relaxed for a second also. Now-a-days the humans need more and more automation around them. Because there are many of the problems faced while being away from home, so there we need someone who can monitor the home like check the temperature or any gas leak or can on/off the appliances for us while being away. So, for that we need a man/guard. We need to give him the salary and even we can’t trust him.

For such an issue we can add the ‘SMARTNESS’ to the home. The Home Automation is the home after the smartness added to it. The Smart is the word from the IoT. So, we can link the Home to the IoT for Home automation.

Here in proposed system, the concept used for the Home automation is using IOT. In this Project we have used the sensors like temperature and humidity, Gas, Sound, PIR sensor. The data of this sensors are transmitted to the ESP32 and then through the WIFI to the Blynk Cloud and from that cloud to the Website Dashboard created on the Blynk MQTT protocol. Also, we can turn On and Off the appliances using the relays by sending the signal High and Low respectively to the cloud by the Blynk website dashboard on mobile using IFTTT application which tells the ESP to send HIGH or LOW signal to respected Relay. This is how the project follows the Flow.

The objective of this home automation system is to take the readings from the sensor and to show them on the mobile application and also to turn ON/OFF the appliances from the mobile phone or from the Laptop from anywhere in the world using cloud.

Figure 1 Smart Home
II. RELATED WORK

As there is not only one way to solve any of the problems there are many ways. In many different ways the Idea of home automation can be achieved and implemented. So, here are certain different and unique techniques published by the many other authors as a summary.

Bluetooth based Wireless home automation system using FPGA: Mr. Murali Krishna says that today the world has changed a lot. We have been living our life in a smart way. Now everything is wireless which gives the opportunities for the short range. Using the Bluetooth module (HC-05) and FPGA board we can make the home automation possible with wireless connection and by the serial communication the data exchange will take place.[1]

Hand Gesture based home automation for the visually challenged: Smitha P. and Sutha P. has described the home automation using the gesture by Rehabilitation Engineering. They have used Microelectromechanical system (MEMS) accelerometer for the detection of gestures and this gesture are detected in the 3-perpendicular direction. Which is then verified by the particular pre-installed gestures measurement in microcontroller and the act accordingly which is a great help for the visually challenged person.[2]

Email Interactive Home automation system: Dr. Sirishilla Manohar has introduce the innovative idea about the home automation. In this article there is an system which is made on the GVT app in which we need to enter the different cases for home automation like turn on led1. And it will generate an Email. By just reading the subject of the Mail the system will turn on led1.[3]

Home automation using Android application and predictive behavioral implementation: In this article the author Mrs. Latha A.P. and her team has made a system which is the cheap and affordable by the common person. They have introduced the home automation by android application which allows the user to control and monitor the home using Application or the website available.[4]

Home automation based on FPGA and GSM: Mr. Mayur V Sapate has introduce an idea based on the GSM module. By this we can use the Home automation facility where there is connectivity issue as GSM communicate with the server using AT Commands. And it is durable and coverage and connectivity is high and the control is done by using the SMS codes.[5]

Voice recognition-based Home automation for the paralyzed people: Mr. Mukesh Kumar and Shimi S.L. has done this system design for the minimum problem to the Paralyzed patient and has done this bed angle automation using the voice recognition. It has 3 modes and 3 modes have different voice data installed. The accuracy is also maintained properly I this proposed system.[6]

A study on smart home control system through speech: Parmeshachari B D has introduced about a system comprises of DSP processor for the voice recognition function, a microcontroller and relays for the appliances control function like switching lights ON and OFF. Zigbee wireless module is used which eliminates the need of additional wiring required for signal transmission.[7]

Java based Home automation system: A.R. Al Ali and M. Al Rousan introduced and simple home automation system using embedded board and Java using World Wide Web. It is very simple the sensors are connected from the embedded board and that is integrated to the Java based PC server which can be access from anywhere in the world using the website with interne t access.[8]

A smart home automation technique using Raspberry Pi using IoT: Vamsi Krishna Patchava, Hari Babu Kandala, P Ravi Babu has designed an system which is using the Raspberry Pi board and the web based controller. As home automation can be done using many of the development boards and modules no matter which but main is the server and application protocol.[9]

GSM based Home automation using App inventor for mobile phone: Mr. Mahesh Jivani has introduced to system which can run on using the SMS and network between module and the device is done using the GSM and we can also make our own app using the MIT App inventor.[10]

III. PROPOSED WORK

The system requires the main heart which is ESP32 or Node MCU. The flow diagram starts with the connection between the WIFI module and the local host i.e. The Hotspot or WIFI available for connection. After the successful connection established with each other the ESP is ready to receive or to deliver the user’s remote command to the Cloud. On the other hand, as the command is received or transmitted the cloud data gets update every minute. And according to that information is extracted through the programmed algorithms by the ESP and Displayed or again it is published back to the cloud after the processing that Data.
The complete system is comprised of sets of I, O, F, Fc, Sc. 

\[ \text{S} = \{ I, O, F, Fc, Sc \} \]

Where:
- **I**: Set of inputs.
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- **F**: Set of functions.
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- **Sc**: Set of success cases.

**Input:**
- Digital and analog data from sensors like DHT sensor, Gas sensor, Motion sensor, Light sensor, LDR sensor.
- Digital ON and OFF of the relay from the Blynk application.

**Output:**
- Display the sensors readings in particular Gauges on the Blynk application.
- Turn ON and OFF the appliances connected to the relay.
- If motion is ‘1’, Email the user.

**Functions:**
- Detection of sensors value from the sensors.
- Transmitting the data to the Blynk cloud.
- Fetch the data from the cloud and display in the application.
- Input from application to the cloud and to the ESP then relay is turned ON or OFF accordingly.

**Set of failure cases:**
- Fail to connect to internet and cloud.
- Fails to fetch and deliver the data due to poor signal strength of internet.
- Relay does not work properly.
- Sensors wearing and tearing, So not perfect reading.

**Set of success cases:**
- The internet connected successfully.
- Connection to Blynk cloud successful.
- Sensors readings are accurate and correct.
- The data is transmitted and received to cloud successfully.
- Display the sensors data to application.
- Response to relay from application works.
V. EXPERIMENTAL SETUP

The basic use of ESP32 is to interact with the sensors and the relays. Now the ESP works same as Arduino. It’s way too easy to communicate with ESP32. Simply need to write the code and we can have a communication between the sensors/relay and the cloud using this ESP32. So, we can tell that it is a connecting bridge between the cloud and sensors/relays. Figure 5 shows the ESP module and its pin diagram. The sensors shown in the Figure 6 are connected to the ESP and communicate through this ESP only. ESP is shown in Figure 5.

Now the sensors shown in figure 6 are just to take and measure the real time values and send it to the ESP and this sensor are DHT sensor used to measure the temperature and humidity. Gas sensor detects the gas like NH3, NOx, alcohol, benzene, smoke and CO2. Motion sensor and PIR sensors detect the motion but in different range. LDR sensor to detect the intensity of the light. These sensors are analog so the output of sensors is converted into digital.

A. Application Control:

The circuit and the connection are simple. As it is shown in the circuit, we have to first of all connect the ESP32 with the regulator IC 7805 because the input voltage we are giving is 9V which is way more then according to the specification of the ESP32 which is that the Vin must be not more than 5V, so the power to ESP is given Via regulator.

Now, the code is uploaded to the ESP32 through the Arduino IDE. According to code written if the ESP32 is connected to Wi-Fi credentials as inserted during the coding the buzzer will be HIGH for 2 seconds. If not, then the buzzer will buzz for 1 second interval for 5 seconds.
As shown in fig. 11 there are two buttons named as Hall light and TV. Now this both appliances are connected to the relays and grounded on the other end. So, when the Both buttons from the Blynk application is pressed i.e. it is high, the High signal is sent to the cloud first then to the ESP board Via internet i.e. Wi-Fi.

Then the ESP32 board will pass the High signal to the relay. The transistor and diode are used for amplification and for filtering purpose. So, when the ESP32 send the High to the particular pin the relay switch to the connection and the appliances start to work/ they get the Power supply.

In figure 8 it is shown that how the sensors are interfaced with the ESP8266. In similar manner in ESP32 we can interface the more than 1 sensor directly to it. There is no need of having Analog multiplexer. As there are 17 ADC pins in the ESP32. So, the PIR, DHT, motion and Light sensors are having manly 3 Pins (5V, GND, Signal).

Now the signal from the outside world is always analog. So, all this sensor signal pin is connected to an ADC pin of ESP32 which convert the Analog signal from the sensor to Digital signal and transmit to the ESP32 controller. Now this ESP32 will transmit the data of the sensors to the blynk application Via the Wi-Fi and Blynk cloud.

The data Extraction is based on the method of the Coder. It can vary from code to code. But it is essential to know that what type of data is got from the sensor and what kind of output we need to have according to that data.

Arduino software has been used as the interface between software and hardware of this project. Microcontroller needs a program to operate and execute the process associated with proposed design. It is easy to verify and compile after writing the code.

The complete flowchart which indicates the whole operation of the system and controlled by a mobile app. The focus of this project is to bring automation in home or industries.
Firstly, the Wi-Fi shield (Wi-Fi hotspot) connect to the existing network infrastructure & it initializing blynk server which is of open source server. The Wi-Fi module send single to app that provide for the client (operator) indicating system is in online or offline then it check the input-output pins.

If the client (operator) switches any of the switch the data will be received by blynk server. Lastly, this process is in continues operation the system will loop to the initial condition.

Firstly the ESP32 is powered from the battery so the code which is perloaded will start to execute.

VI. EXPERIMENT RESULTS

The proposed design is based on the IoT and Cloud Technology. The test results are bifurcated into three different categories in which as shown in Fig. 10, the Blynk server first successfully established in the system. In parallel the Electronic Appliances also prototyped in the Blynk mobile application. As shown in Fig. 11, appliances can also controlled from the mobile applications. The third part of experimental results is considered in form of the notification of alertness. As shown in Fig. 12, alertness of any appliances activity also presented in form of Email.

![Figure 10: Internet and Blynk cloud Connected successfully](image1)

![Figure 11: Statues of sensors and values and relay](image2)

![Figure 12: Alert!! Email and notification](image3)
CONCLUSION

Today the World has been so busy and it is hard to
manage things. In this paper we have learned many a thing
like how the IoT is the Future of us for the tomorrow’s
generation. This article is about the home automation on
bases of wireless communication and cloud computing. It
helped to come across how the ESP work and the
programming in Arduino. The cloud computing has made
the things easy to store any of the data. Which can be access from
anywhere in this world. Which is the basic necessity for IoT.
There is no doubt that IoT will take over everything that
existed in this world and lead us to the Machine age.

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Smart Irrigation System Enhanced with Internet of Things

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Abstract— There is a saying "Food is Life". For that, farming is essential. Now it takes lot of time to do farming on large area an especially for providing water to crops because person has to wait for the nature (Rainfall) or they can provide water through manually. So, let’s make the irrigation system SMART. How about this system become intelligent and works automatically? The proposed system is Smart Agricultural System based on IoT. In this proposed system, the water will be sprinkled in the whole farm just with the help of internet i.e. by sending text or voice message to the device attached to the farm. Also, device will send the statistics(graphically) of the soil moisture of farm to the user’s device/mobile and the data will be updated spontaneously after specific time. And mistakenly if the user forgets to send message, the device will sprinkle water automatically just by the checking the soil moisture. The best part of this is that one can control or run this system at any time and from anywhere in the world.

Keywords— Smart, IoT, Statistics, Mobile

I. INTRODUCTION

Necessity for living is food and oxygen. So, in order to obtain food we need irrigation. For food and crops farming is must and for oxygen we need trees and to do this water is essential. Many years ago, the irrigation process was manually done or depends on the climate conditions which requires more effort and time consumed much. Due to this the price of the crops increased because it took more time to grow as the water was not provided to the plants on time. Also sometimes crops or vegetables were not available due to climate conditions. So, there was difficulty and consumed more time in the irrigation system. And the most hard thing was that if the person is doing other business including farming than it was difficult to manage both the tasks. Now just imagine if person has to manage more than one farm which are at different places, it could be very burdensome to provide water in every farm. Now, to overcome this problem we need to make the irrigation system SMART, i.e. fully automated and real time system which can be developed using amazing concept called IOT (Internet Of Things). In this we require high speed of Internet and electronic components to run this project smoothly and from anywhere in the world.

We have built this system with different sensors that will sense moisture level of plants and the brightness of day at the area of irrigation. Information of all sensor is given to the Wifi available in Node MCU and it transmits the data to Adafruit IO Cloud via MQTT(message queue telemetry transport) protocol where a user can monitor and control those parameters in their Smartphone’s. The database will get updated on cloud spontaneously. And by this many more farms can be managed and irrigation process can be performed. Now as this system is capable enough to preserve this farm on its own, human can do the other tasks without wasting time on maintaining farm.

To help users for obtaining and getting knowledge of climatic conditions, the content of soil moisture and to make necessary changes according to it, we developed Smart Irrigation System using IoT. And this system is very effortless to operate for any user. And the consequences of this system is very effective and much efficient.

This system can be modify further by adding other components like buzzer and PIR sensor so that if birds who eat the crops that problem can also be solved. If birds comes in the range of the farm the sensor will detect the motion and buzzer will buzz so birds will afraid and will fly away. Also by using the DTH11 sensor to sense the temperature and humidity of environment and accordingly the water will be given to the plants and due to this water can be saved for future use.

II. RELATED WORK

Smart irrigation system can be implemented by many techniques. There is not a particular or specified form for it. It can be designed in many ways. So, talking of which here are some of the paper works related to this system.

Smart Irrigation System using IoT:SIS: Aman Kumar et. al. prepared smart irrigation system using arduino, bolt(iot device), sensors and http protocol. Here they have described four situations under which the system works. And as the moisture levels goes beyond the threshold value then it will displayed graphically on the website and can be operated remotely[1].
IoT Based Irrigation Remote Real-Time Monitoring And Controlling Systems: Tigist Hilemariam Senbetu et. al. presented iot based application on smart irrigation system based on ESP-32 using things speak and http protocol. Here ph value analyzer, Temperature identifier, Soil moisture measurement, Water controller(pump) are used as measurements. The system displays values based on the four sensors conditions. The status of the system can able to check at a remote real time monitoring and controlling. The information get from sensors are kept in cloud and can be observed by agriculturalist through his mobile.pc[2].

"Smart Irrigation System using IOT": Shiv Shankar Singh presented smart irrigation system using atmega328P along with bolt iot module and rain, soil sensors. Here, the BOLT is a cloud platform which will save data and which can be accessed from anywhere by the user who has internet connectivity. This project will check the soil moisture and based on the reading the motor gets on and off. The rain sensor will check the rain, if its raining it will send the message and the motor will be off. The control unit sends data and using bolt can be displayed on html web page[13].

"Smart Irrigation System using Iot Approach" : Dr.S.Jothi Muneeswari et. al. presented discussed a system which is autonomous containing of microcontroller, moisture sensor and temperature sensor. The readings obtained will be sent to system over wireless network using wifi. Along with it, if the moisture level is low and temperature is high there is no need of irrigation, else it is needed. [4].

"Self-Automated Agriculture System using IoT": K. Swarna Krishnan et al. introduces a system which is self autonomous where it monitors whole process and takes necessary actions. This system has an GPS based robot which does the controlling of harvesting by both ways manually as well as automatically. To measure moisture, temperature, humidity, growth control and many more different sensors are used. And these all operations will be controlled by sensors followed with Wifi or Zigbee further connected to microcontroller and raspberry pi[5].

"Development of IOT Based Smart Irrigation for Agriculture": R.Vijayabhanu described this application of smart irrigation for agriculture using ESP32 and the Wifi. The data is analysed by the soil moisture and temperature sensor and is displayed on LCD. Hence regular monitoring and irrigating can be done using this iot application[14].

"Internet Of Things (IOT) Based Smart Irrigation": Mrs.R.Hemalatha et al. described smart irrigation using iot board, arduino board, sensors and LCD. There are two sensor nodes which are used for transmitting and receiving the information. The Zigbee communication is further used to pass the data to the cloud and on iot board module UART webpage control makes it online wireless communication application. And thus the output is displayed on the sample webpage in form of curves and also the readings along with the LCD display[8].

"Smart Multi-Crop Irrigation System Using IOT" : Anbarasi M et al. presented smart irrigation system with raspberry pi and arduino Uno along with the Zigbee communication. Here, they used an LED which will glows when the soil moisture level goes below particular level and becomes off when goes above particular level[9].

"Smart Irrigation System And Plant Disease Detection": Lav Gupta et al. discussed smart irrigation system using arduino and raspberry pi which performs two tasks. From which first task was to monitor the soil level moisture and whether it was below the threshold value the water pump will start or else will remain off. And the second task was about the image the image processing. Here, it will examine the plant and take the necessary advance precautions to protect the crop[10].

The system requires the main heart which is ESP32 or Node MCU. The flow diagram starts with the connection between the WIFI module and the local host i.e. The Hotspot or WIFI available for connection. After the successful connection established with each other the ESP is ready to receive or to deliver the user's remote command to the Cloud. On the other hand, as the command is received or transmitted the cloud data gets update every minute. And according to that information is extracted through the programmed
algorithms by the ESP and Displayed or again it is published back to the cloud after the processing that Data.

The complete system is comprised of sets of I, O, F, Fc, Sc. \( S = \{I, O, F, Fc, Sc\} \).

Where:
- **I**: Set of inputs.
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- **Sc**: Set of success cases.

**Input**:  
- Digital and analog data from sensor like DHT sensor, Gas sensor, Motion sensor, Light sensor, LDR sensor.
- Digital ON and OFF of the relay from the Blynk application.

**Output**:  
- Display the sensors readings in particular Gauges on the Blynk application.
- Turn ON and OFF the appliances connected to relay.
- If motion is ‘1’, Email the user.

**Functions**:  
- Detection of sensors value from the sensors.
- Transmitting the data to the Blynk cloud.
- Fetch the data from the cloud and display in the application.
- Input from application to the cloud and to the ESP then relay is turned ON or OFF accordingly.

**Set of failure cases**:  
- Fail to connect to internet and cloud.
- Fails to fetch and deliver the data due to poor signal strength of internet.
- Relay does not work properly.
- Sensors wearing and tearing, So not perfect reading.

**Set of success cases**:  
- The internet connected successfully.
- Connection to Blynk cloud successful.
- Sensors readings are accurate and correct.
- The data is transmitted and received to cloud successfully.
- Display the sensors data to application.
- Response to relay from application works.
V. EXPERIMENTAL SETUP

Node MCU is an type of development kit that helps you to prototype or build IoT products.

- Ambient of Light

Which includes firmware that runs on the Wi-Fi SoC. Node MCU can take analog inputs with help of sensors and produces output in form of activating the actuators like Leds and Motors. The data from sensors is given to Node MCU and further to the cloud.

The soil moisture sensor is used to measure the moisture of soil, which contains a moisture sensor, capacitor, resistance, potentiometer, power and status of led. It has both analog and digital as output and gives moisture level as output.

It senses the level of moisture content present in irrigation field and compares with the reference value and further it will send it to the relay which will control motor accordingly. The data of soil moisture will also be sent to the cloud through Wi-Fi.

A. Working:

Basically, Node MCU, LDR, and moisture sensor will play the important role. Iot based smart irrigation system the water will be automatically sprinkled to the plants or crops when the value of the moisture sensor will go below specified value. So, the moisture value will be maintained automatically and the data will be send to the cloud(Adafruit IO) so that we can able to check it from anywhere in the world. Also, we can control the water flow according to our requirements as server has the buttons to turn ON and OFF the motor.

Monitoring the Sensors:

As shown in fig, setup all the components. Moisture sensor, LDR, and Relay module is connected to the A0, D1, and D0 pins of NodeMCU. Motor is connected to the relay module, so whenever NodeMCU generates trigger the water will be sprinkle And NodeMCU will get triggered when the moisture value will go below the marked value that is set in the firmware. After triggering the relay will turn ON the motor.
and the water will sprinkle. Also, the LDR will indicate the brightness of the environment so if the sun goes down and its fully dark then LED will glow to indicate the system is present and it is working.

VI. EXPERIMENT RESULTS

Test Results of the system which we proposed is presented here. Fig.7 shows the output of soil moisture(in percentage) and brightness of day(0 or 1) on serial monitor of Arduino IDE software. Fig.9 shows the dashboard on cloud server and the System data at particular date and time, Fig.8 shows Graphical output of soil moisture.

Figure 7: Output on serial monitor of Arduino IDE

Figure 8: Graphical Data of Soil Moisture

Figure 9: Dashboard on cloud (Adafruit IO) and Graphical output

CONCLUSION

Smart Irrigation System is presented here which is based completely on IoT and real time application. Water is provided to the crops/plants automatically by checking the moisture of soil when value goes below the reference value the motor will turn ON and when limit is reached it will be OFF automatically or user can also control it. The data is then forwarded to the server with help of protocols so user can know. User can manage this system relentlessly from anywhere in the world. The database on cloud will get refresh after some time. This system is comprising of high speed of internet, sensors, actuators, NodeMCU, smart phone's. The programming is done in Arduino IDE and Arduino C language is used. This system is a type of embedded system which makes this IoT concept remarkable.
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GPS Receiver Based Pollution Parameters Monitoring System

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Abstract—Air pollution monitoring is a major research area nowadays. A prototype for a mobile real-time air pollution monitoring system has been developed. This system is being developed to monitor pollution in real-time. This system uses low-cost air quality monitoring sensors with GPS and GSM/GPRS modules. The concentration of various gases will be measured using the semiconductor sensors and the location of that concentration using a GPS module. This concentration will be measured at various locations at a real time scale. Sensors after gathering data will send data to a database using the GPRS module along with the location obtained. The fundamental aspect of the above work is to provide a real-time dynamic pollution measurement system.

Index Terms—Pollution Monitoring, Microcontroller, Gas Sensors, GSM module, GPS module

I. INTRODUCTION

As we witness the growth of technology, we can sense both sides of it, giving us different tastes at the same time. With the advent of the Industrial Age, the onset of the massive production, and the over-exploitation of our precious resources, pollution is today one of the most highly debated issues. As such, reports often showcase that with the ever-rising need of man, carbon footprints now increase at a rate faster than ever before. Densely populated regions, immense traffic, and highly poisonous industrial emissions have led to pollution and global warming which is constantly adding weight to the consequences of man’s activities on nature. As we witness the growth of technology, we can sense both sides of it, giving us different tastes at the same time.

A report by the Centre for Science and Environment (CSE) in 2019 stated that air pollution is responsible for more than 30% premature deaths in our country; while every third child in Delhi has impaired lungs. More than 1.73 million new cancer cases are likely to be reported each year by 2020 due to the issues such as Air pollution, tobacco, alcohol, and diet change being the primary triggers. Moving out on an entirely new frontier of interdisciplinary study, we thought of addressing the most common problem of air pollution measurement and the systems that enable us to measure it. Through the effective measurement of air pollution parameters, we will be able to furnish some solid evidence on the rising needs of human steps against global warming and air pollution. If we can imply on solid grounds the necessity behind strict governmental actions to tighten the carbon footprints that we leave on the face of the earth, we will be in a better position to live a little longer. So, this project is in itself a heavy work in throwing light on the importance of taking steps against air pollution and its alleviation.

The current measurement systems employ an exhaustive usage of static sensors placed at several pre-defined points on a given geographical area which considers the employed measurement system to be ideal. This ideal measurement system is but only an estimation of the air pollution levels across a given area while it most certainly ignores the location-specific real-time data. In addition to these facts, the existing models employ the use of near-real-time data which in turn generates a pattern based on the database that has been captured across time. This project, as opposed to the current existing trends has a novelty in its air pollution measurement techniques. It uses a completely new method: air pollution measurement through non-static sensor networks. This method allows us to associate the data acquired through real-time location-specific data acquisition with the data acquired from the already established static sensor networks to aid in the process of air pollution measurement. This renders us a more accurate and reliable measurement system which in turn can lead to genuine and convincing insights into the pollution trends. As the pollution level remain always dynamic it is not possible to give an exact prediction based on one-time monitoring or monitoring it at some predefined selected locations. As technology is growing rapidly it is the foremost requirement of today’s modern world that the pollution measurement should
be real-time and location-specific.

II. METHODOLOGY

The system block diagram captures the basic modules that form the fundamental skeleton of the project implementation. The figure 1 shows the block diagram of the system.

![Block Diagram](image)

**Fig. 1. Block Diagram**

1) Mobile Sensors: The Mobile Sensors form the quintessential part of the project. It involves the remote non-static sensor networks formed by the collective contribution of the gas sensors, the GPS-GSM Module, the microcontroller, and the hardware associated with it in rendering its services.

We used some semiconductor gas sensors that will provide us analog information. These gas sensors are connected to a microcontroller and a GPRS module is also connected to this microcontroller which will help us to send the values to a database of our website. Simple hardware connections can be as shown as in figure 2.

![Circuit connections](image)

**Fig. 2. Circuit connections**

- Arduino board: It is the microcontroller board that we used to interface the hardware with software.

- LCD: Liquid Crystal Display, it is the output device that shows the output.

- SIM 900GSM: This GSM/GPRS module is used to send data obtained by the module to the mobile phone or web server.

- GPS module: This module is to provide the location of the device in terms of latitude and longitude.

- MQ135: It is one of the MQ series gas sensors that is used to measure the pollutant level.

This collective piece of hardware and software integration takes us to the next stage where the data whatsoever collected at these remote sensing units is transmitted to the base station through the Communication Channel.

2) The Communication Channel: The Communication Channel forms the underlying link between the transmitting and receiving end. The transmitting end is connected to the receiving end through one or more routes which includes Satellite links and Grounded Cable Networks RF Transmission links.

3) The Base Station: The Base Station can be anything from just a virtual cloud platform to a physical network point corresponding to a particular geographical location. It is a place where the core processes after collecting user data are carried out. The Base Station contains the operating tasks like Data Acquisition Data Processing Data Manipulation and Base Station – Website/Android App Link Maintenance

![Working](image)

**Fig. 3. Working**

4) The Data Processing Centre: The Data Processing Centre is the next crucial part of the project block diagram after the data is received and acquired in a presentable format that is understandable by a human. The Data Processing Centre then carries out certain pre-decided explainable mathematical functions using the data that is available and in turn, provides meaningful data from the raw data input using the mathematical models designed through the research development taking place in AQI and AQHI measurement techniques. Finally, the processed end data is fed to the user presentable platforms which could be anything feasible like an Android App or a Website.
5) Real-time Website/App: This is just an extension of the previous point where the data is processed. Here the data that is processed is continuously tested and is synchronous with the remote non-static and static sensing units. As both the non-static and static sensing units will contribute to the effective calculation of air pollution measurement and its index (AQI/AQHI) and in our case the HAQHI, the system requires rapid real-time functioning to avoid delays and/or glitches.

Every project has a degree of novelty while it leaves some threads open for extended research and development. Aligned with this concept, there is indeed plenty of scope of future work on the ideas rendered through this project. The extended work on this project may not be limited to but involve the following areas where it can be of extreme help: Search and Navigation Systems Safety in Transportation and Medical Research, Govt. Intelligence Societies.

III. RESULTS

The home page of the website is as shown in figure 4. As it evident the section like Home, Map, Route, history are available.

The figure 5 shows the current pollution data of the user detected by the GPS, so that it is easy for the user to get real-time data. Figure 6 shows the routing feature available in the website, which can be used to get one of the many possible routes to a destination.

The History feature provides information about the trends of pollution on daily and monthly basis. Figure 7 and Figure 8 depict the trends of pollution on a particular day and for a particular month respectively.

IV. CONCLUSION

We are developing a real-time and location-specific mobile sensor network that can monitor the specific gaseous pollutants. This as opposed to the stationary real-time monitoring, offers multiple data access with customer satisfaction and effective measurement of the pollution through pre-defined constraints. The real-time data availability also opens a room of space for further implementation on the individual transport units for purposes like spy and government operations.

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