Detection and Monitoring of Fire Accidents using IOT

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Abstract:- When building or residing in a home, construction workers, engineers, and homeowners must all expect the danger of fire. People have depended on single sensors to alert them to fires for a long time, but these devices can't determine the seriousness of the fire, so they may not immediately alert emergency services. By creating a smart fire detection system that simultaneously protects people's lives and property by sending out alerts to landowners, emergency services, and nearby police stations, our study seeks to put an end to this issue.

In this paper, provide a model that, in the event of an emergency, utilizes a number of integrated detectors. The system uses the GSM technology to transmit the relevant notifications as soon as a detector delivers a signal, after which it analyses the signal through a program to evaluate if there could be a fire. To give the fire department the details it supports without holding people in danger, an Internet of Things (IoT) network has been established.

Last but not least, the proposed system stands out especially for its capability to minimize false alarms, which in turn improves the system's dependability. Our testing outcomes showed that our technique is superior in these areas as well as in terms of price and performance using the Ubidots platform, which allows for quick and reliable data exchange.

Keywords:- *Internet of Things (IOT), Arduino IDE, Sensors, NodeMCU.*

I. INTRODUCTION

Fires must be treated seriously [1, 2] in order to prevent loss of life and property [3, 4]. An emergency situation arises if the observed temperature exceeds 50 degrees Celsius. Rescue teams often reach large structures like hospitals, schools, and banks within 15 minutes after receiving a call [5]. In the United States, fires in buildings result in a 2,950 civilian death toll, 16,600 civilian injuries, and $14.8 billion in direct property losses each year [6]. According to the National Fire Protection Association (NFPA), buildings without working smoke alarms, alarms that are not properly maintained, or alarms that are misplaced, account for two-thirds of house fires in the United States [7]. Effective fire alarm implementation might save lives and minimize property damage [8]. To choose the fire alarm that is appropriate for your home or place of business, it is helpful to get familiar with the many types of fire alarms that are on the market, such as heat detectors and smoke detectors. Heat detectors are a tried-and-true means of alerting people when the temperature increases above a certain degree.

As a result, it is better suited for applications where fast response is not required or where smoke detectors cannot be installed, such as in highly cold areas [9, 10]. Heat detectors have a lower risk of false alarms than smoke detectors, but their reaction time is slowed down by the constant rise in temperature. Despite these drawbacks, smoke detectors are still preferred over heat detectors. Smoke detectors can assist in detecting fires before they spread rapidly. Smoke is produced when an item loses heat in the form of carbon dioxide (CO_2). Smoke detectors are divided into three types: ionization, photoelectric, and combination. To know more about any of these types of equipment, simply check a book on measurement equipment and procedures. This paper will provide a basic overview of ionization. To put it simply, ionization is a radioactive material that absorbs heat radiation. A small, continuous current is allowed to pass between the electrodes as it enters the ionization chamber, which is filled with air. This kind is especially efficient against unexpected fires caused by explosions or accidents.

Nowadays, the concept of the internet of things (IoT) is employed in a broad range of contexts, from "smart" industries and "smart" agriculture to "smart" healthcare and "smart home" applications. Home automation is one of the many uses of IoT. Autonomous inter-appliance communication, in which devices are mutually aware of the information flow, reduces engineering expenditures in managing all devices involved and may be utilized for remote operation and maintenance, for example, in remote plant sites. Consumers nowadays often try to save money by not installing reliable fire alarm systems, which can cause deadly fires if they are not warned soon. Cost, efficacy, and responsiveness are just a few of the challenges that endure. Several studies have been conducted to solve these challenges, such as the integration of building automation with a network-based real-time fire detection and alarm (FDA) system [11]. With these challenges in mind, our study focuses on building a cutting-edge fire alarm system that employs both heat and smoke detectors.

As a result, the importance of this research lies in developing a cost-effective, efficient, and responsive fire alarm system. Despite the fact that various studies have been conducted to solve these issues, the detection rate of fires remains inadequate, and the reliance of these systems on machine vision implies that more photographs are required to develop the algorithms. Other approaches have several drawbacks, such as slow reaction times and poor precision. Unlike many others that have relied extensively on the network, this study aims to minimize the incidence of false alarms while maintaining reaction speed. The following are our contributions: i) Devised and built a system that detects fire and activates the fire alarm. and ii) The system uses the Ubidots platform to analyze the procured data, allowing for a faster response. As a result of these two characteristics, the proposed system is superior in terms of cost-effectiveness, efficiency, and flexibility. The remaining portions of this work are organized as follows: Section 2 describes the research method and experimental model that will be employed in the proposed study. Section 3 discusses the findings, and Section 4 provides a summary and ideas for further study.

II. LITERATURE SURVEY

A. *Smart Fire Detection and Monitoring System Supported by the Internet of Things:*

The annual death toll from flames is frightening, and the injuries they cause are equally so. The major goal of the fire alarm system is to warn people to get out of harm's way, which it achieves by sending a warning to a user's phone through the web and recognizing the ESP32's online motions using the Arduino IDE. With the addition of PIR motion sensors, an ESP32-based Telegram operator may be constructed to send out warning messages via a Telegram account when no visible motion is detected. Fire detectors can utilize the image and temperature to generate an alarm through the telegraph channel.

B. *A sensor-based Internet-of-Things (IoT) fire detection system:*

Many research and studies have been done over the last several decades to improve security systems and increase the standard of protection they give in a range of settings. A fire is one of the most dangerous risks that security officers must deal with since it may start anywhere—in a house, a school, a factory, etc. IoT technology is utilized to stop, or at least minimize, the harm caused by fire outbreaks. A network of hardware, such as sensors and switches, connected to a main computer or gateway is referred to as the Internet of Things (IoT).

In this Paper, used an Arduino device and a temperature sensor known as a (flame sensor) to detect fires and calculate the amount of heat intensity created by a fire in a certain space, whether it be a house, workplace, or anywhere [12, 13]. These sensors will act as an early warning system, sending an email to our phones, the fire department, and hospitals if a fire starts because it can take the fire department some time to arrive at the location of a fire and start quenching it. This will help us understand the situation clearly and take action to prevent further harm from being done to the structure in the event that the fire is not noticed until it has already started to spread.

III. PROPOSED SYSTEM

A. *Existing System:*

With the use of fire sensors, can detect fires and prevent dangerous incidents. Sensors can be utilized to alert the proper authorities in the case of a fire.

In order to decrease the damage introduced by fires—both in terms of lives lost and financial costs associated with damage repair—they are utilized.

B. *Proposed System:*

In comparison to more traditional security systems, wireless sensor networks have various advantages, including lower equipment and installation costs in the case of a fire. In this proposed system, the working block diagram is shown in the figure 1.

When a fire occurs in the vicinity of the sensors [14], the smoke sensor detects it before the flame sensor does. The smoke sensor sends a signal to the NodeMCU. Based on the programming in the controller, when the sensor senses a signal, it will activate a buzzer and send an alert message via Blynk app to property owners, emergency services, and local police stations using IOT. Similarly, the fire sensor detects and sends signals to the camera module. As per the coding in the Arduino IDE, when a fire is detected, the camera captures images and sends those images via a telegram link to indicate the severity of the fire. And monitor the status of the situation on the LCD display.

The Internet of Things (IoT) technology and the systems and elements that make it work, like the wireless sensor network is use for security—specifically, fire protection [15]. Wireless sensor networks are now widely acknowledged as a practical alternative to the security systems that can detect and prevent fires, which have received a lot of attention [16].

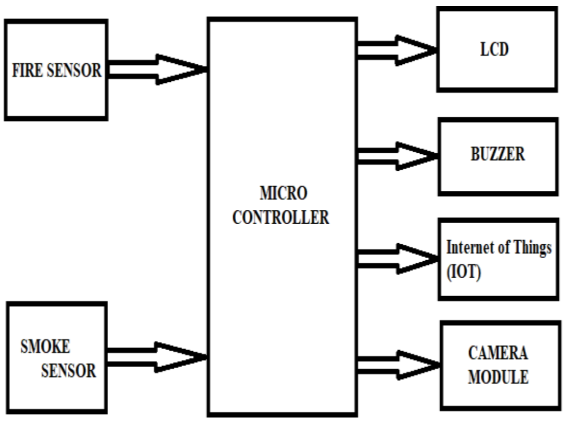

Fig-1: Block diagram

IV. FUNCTIONAL BLOCKS OF PROPOSED SYSTEM

A. ESP8266 Node MCU Pinout:

There are a total of 30 pins on the ESP8266 NodeMCU that connect it to the outside world. The connections are as follows:

- Power Pins: There are four power pins: one VIN pin and three 3.3V pins. If you have a regulated 5V power source, you may utilize the VIN pin to directly feed the ESP8266 and its peripherals. An on-board voltage regulator's output is connected to the 3.3V pins. Power can be provided to external components via these pins.
- GND: It is a ground pin on the development board for the ESP8266 NodeMCU.
- I2C Pins: All different types of I2C sensors and peripherals are connected to Paper using I2C pins. It supports I2C master and slave. The I2C interface may be implemented programmatically, and the maximum clock frequency is 100 kHz. It is important to remember that the I2C clock frequency must be faster than the slave device's slowest clock frequency.
- GPIO Pins: The 17 GPIO pins of the ESP8266 NodeMCU may be dynamically allocated to a variety of tasks, including I2C, I2S, UART, PWM, IR remote control, LED lighting, and buttons. The internal pull-up, pull-down, or high-impedance configuration options are available for each digitally enabled GPIO. It may also be set to edge-trigger or level-trigger when setup as an input to produce CPU interrupts.

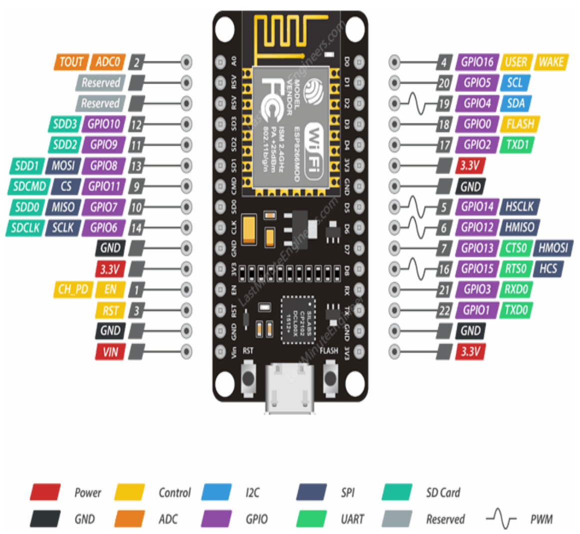

Fig-2: Pin Configuration of Node MCU

B. ESP32-CAM Camera Module:

A compact, low-power camera module based on the ESP32 is called the ESP32-CAM. It has an inbuilt TF card slot and an OV2640 camera. This board contains 4 MB of PSRAM, which is used to buffer photos from the camera into video streaming or other operations, allowing you to take photographs of greater quality without the ESP32 becoming damaged.

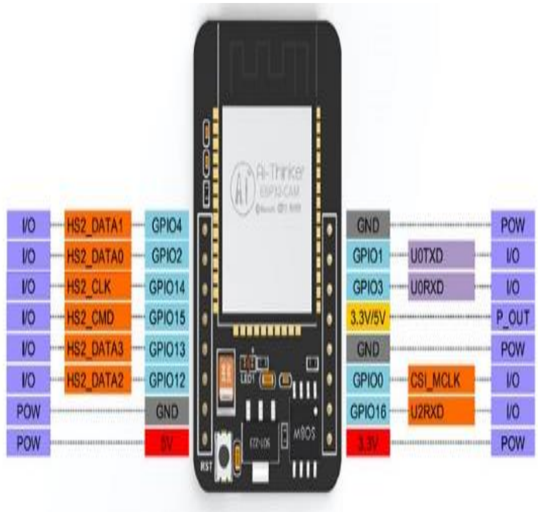

Fig-3: ESP32-CAM Pinout

It has many GPIOs for connecting peripherals, as well as an inbuilt LED for flashing. The elements are as follows:

- Power Pins: The ESP32-CAM has three GND pins, which are coloured in black, and two 3.3V and 5V power pins, which are coloured in red. The ESP32-CAM may be powered by either the 3.3V or 5V pins.
- Power output pin: The pin is also marked VCC on the silkscreen (coloured with a yellow rectangle). The ESP32-CAM should not be powered by that pin. The pin is for output power. It has two output options: 3.3V or 5V.
- Serial Pins: The serial pins are GPIOs 1 and 3 (TX and RX, respectively). You must connect to the board and upload code using these pins because the ESP32-CAM lacks an integrated programmer. After uploading the code, by using GPIO 1 and GPIO 3 may attach additional peripherals like outputs or sensors.
- GPIO 0: GPIO 0 controls whether or not the ESP32 is in flashing mode. Internally, this GPIO is coupled to a 10K Ohm pull-up resistor. You may upload code to the device when GPIO 0 is connected to GND and the ESP32 enters flashing mode. GPIO0 is connected to GND, and the ESP32-CAM is blinking.
- Flashlight (GPIO 4): The ESP32-CAM includes a powerful built-in LED that may be used as a flash for capturing images. Internally, that LED is coupled to GPIO 4. The torch will light up while using the microSD card because that GPIO is also wired to the microSD card port; therefore, you can run into issues if you try to use both at once.

C. LIQUID CRYSTAL DISPLAY (LCD):

Liquid Crystal Display is referred to as LCD. Due to the following reasons, LCD is increasingly being used in place of LEDs (seven-segment LEDs or other multi-segment LEDs):

- The LCDs' reduced cost
- This has the capacity to show pictures, letters, and numbers. In comparison, LEDs can only display a few letters and digits.
- By including a refresh controller in the LCD, the CPU would no longer be responsible for managing the

display. On the other hand, the LED must be updated by the CPU in order to continue showing the data.

- Graphics and character programming are simple.
- Since these components are "specialized" for use with microcontrollers, they cannot be triggered by normal IC circuits. They are used to display various messages on a small LCD.

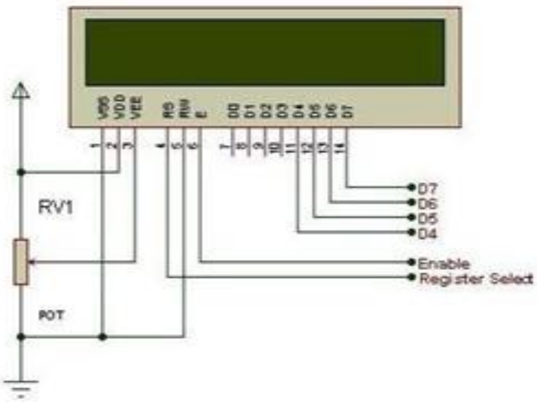

Fig-3: LCD Pin configuration

The model detailed here is the one that is most commonly utilized in practice due to its low cost and extensive capabilities. It can show messages in two lines of sixteen characters each and is based on the Hitachi HD44780 microprocessor. All of the alphabets, Greek letters, punctuation marks, mathematical symbols, and so on are displayed. Symbols created by the user themselves can also be shown. Some important properties include automatic messaging on display (shift left and right), pointer appearance, lighting, etc.

D. BUZZER:

A buzzer, often known as a beeper, is a type of auditory signalling device that can be mechanical, electromechanical, or piezoelectric (piezo for short). Alarm clocks, timers, and confirmation of human input like a mouse click or keyboard press are common applications for buzzers and beepers.

Fig-4: Buzzer

E. MOTOR:

Fig-5: Electric Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy [17]. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft [18]. An electric generator is mechanically identical to an electric motor but operates with a reversed flow of power, converting mechanical energy into electrical energy [19]. Electric motors can be powered by direct current (DC) sources, such as batteries or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters, or electrical generators [20].

F. FIRE SENSOR:

A flame-sensor is one type of detector that is specifically made for both detecting and reacting to the existence of a fire or flame. The reaction to flame detection might be affected by its fit. It has a fire suppression system, a propane line, a natural gas line, and an alarm system. Industrial boilers utilize this sensor. Its primary purpose is to provide verification of the boiler's correct operation. Due to their technique for detecting flames, these sensors respond more quickly and accurately than a heat or smoke detector.

Fig-6: Fire Sensor

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G. SMOKE SENSOR


Fig-7: Smoke Sensor

A smoke detector is an instrument that detects smoke, usually as a sign of fire. The normal shape and size of smoke detector enclosures, which are made of plastic, is a disc with a 150-millimeter (6-inch) diameter and a 25-millimeter (1-inch) thickness. Both optical (photoelectric) and physical processes can be used to detect smoke (ionization). Detectors can make use of one or both types of sensing. Smoking in prohibited locations may be found and discouraged using sensitive alarms. In large commercial and industrial buildings, smoke detectors are commonly linked to a central fire alarm system.

V. HARDWARE EXPERIMENTAL RESULT

Figure 8 depicts the system is in the ON state. At which Fire, smoke, and LCD power indicators are in on active state.

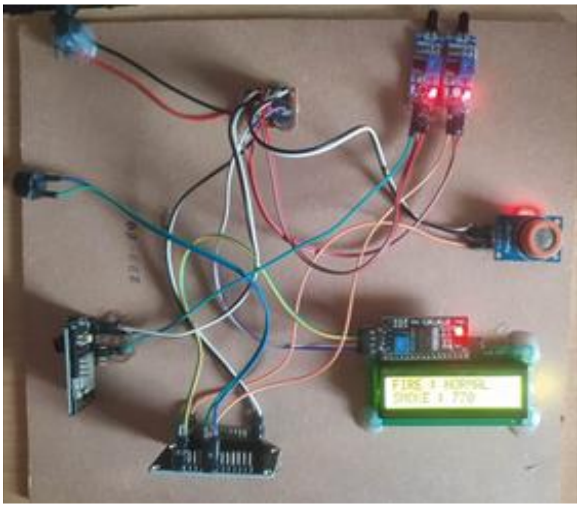
Fig-8: At Normal time

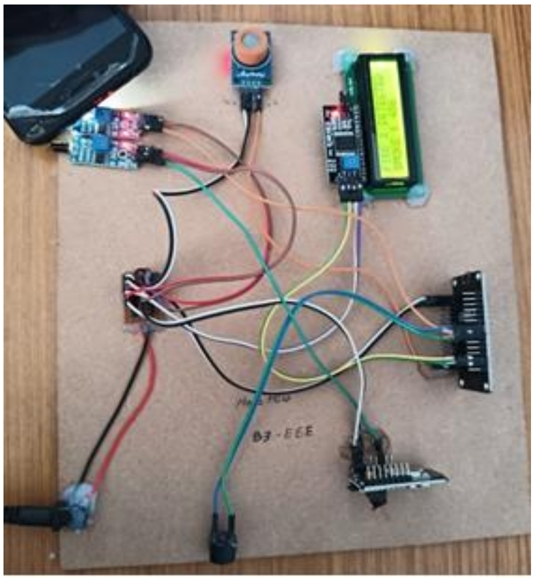
Fig-9: At the time of Fire detected

Fig-10: In BLYNK App

In figure 9, it is observed that the flame detector is on. That is, a fire has occurred. So, with the help of the IOT system, an alert message is sent to property owners, emergency services, and local police stations. And also monitored the fire status in the Blink app from where you are, as shown in Figure 10.

VI. CONCLUSION

The literature recommended fire detection devices that were used to put out fires without regard for response. In order to gather data properly and quickly, this research takes into account the current problems and develops a fire detection system that is efficient and effective and is based on IoT technology, gas, temperature, and smoke sensors. The central unit will evaluate the data using the constant measurements supplied through WIFI modules. This system layout improves the efficiency and reliability of fire detection. Also, the Ubidots platform was used in this system to speed up and ensure the accuracy of data sharing. Yet, the strategy suggested by this study was able to identify the fire and notify the property owner with an average reaction time of 5 seconds.

As a result, the suggested solution solved the problems of cost, efficacy, and responsiveness. The suggested system still requires improvements. So, one of the advancement options is combining machine learning with the system to forecast the risk of fire based on the information gathered from various sources. Instead of only detecting fire, machine learning may assist the operators in recognizing and solving the weak points in their structure.

REFERENCES

[1]. Bu, F. and Gharajeh, M. S., "Intelligent and vision-based fire detection systems: A survey," Image and Vision Computing, vol. 91, 2019, Art. no. 103803.

[2]. Saeed F., Paul, A., Rehman, A., Hong, W. H., Seo, H., "IoT-based intelligent modeling of smart home environment for fire prevention and safety," Journal of Sensor and Actuator Networks, vol. 7, no. 1, 2018, Art. no. 11.

[3]. Shokouhi, M., Nasiriani, K., Khankeh, H., Fallahzadeh, H. and Khorasani-Zavareh, D., "Exploring barriers and challenges in protecting residential fire-related injuries: a qualitative study," Journal of injury and violence research, vol. 11, no. 1, pp. 81-92, 2019.

[4]. Kodur, V., Kumar, P. and Rafi, M. M., "Fire hazard in buildings: review, assessment and strategies for improving fire safety," PSU Research Review, vol. 4, no. 1, pp. 1-23, 2019.

[5]. Salhi, L., Silverston, T., Yamazaki, T. and Miyoshi, T., "Early Detection System for Gas Leakage and Fire in Smart Home Using Machine Learning," 2019 IEEE.

[6]. Zhang, B., Sun, L., Song, Y., Shao, W., Guo, Y. and Yuan, F., "DeepFireNet: A real-time video fire detection method based on multi-feature fusion," Mathematical Biosciences and Engineering: MBE, vol. 17, no. 6, pp. 7804-7818, 2020.

[7]. Ahrens, M. and Evarts, B., "Report: Fire Loss in the United States in 2019," 2021.

[8]. Ahrens, M., "Smoke alarms in US home fires," National Fire Protection Association, Fire Analysis and Research Division, pp. 1-28, 2019.

[9]. Shah, R., Satam, P., Sayyed, M.A. and Salvi, P., "Wireless Smoke Detector and Fire Alarm System," International Research Journal of Engineering and Technology (IRJET), vol. 6, no. 1, pp. 1407-1412, 2019.

[10]. Dr.M. V. Subramanyam et al 'Multiple Sensor Data Fusion Based Top-Down Embedded System for Automatic Plant Pot WateringJournal of Algebraic Statistics,e-ISSN: 1309-3452,Marmara University Istanbul University, Istanbul, Vol. 13, No. 1,PP: 884 – 891,2022, No.3.

[11]. Saraswati, B. Alekya himabindu, Dr. M. V. Subramanyam "Multiple Sensor Data Fusion Based Top-Down Embedded System for Automatic Plant Pot Watering" Journal of Algebraic Statistics Volume 13, No. 1, 2022, p. 884 – 891.

[12]. Anwar, F., Boby, R., Rashid, M., Alam, M. and Shaikh, Z, "Network-Based Real-time Integrated Fire Detection and Alarm (FDA) System with Building Automation". IOP Conference Series: Materials Science and Engineering, 260, p.012025, 2017.

[13]. M.Yerri Veeresh, A.Mallikarjuna Prasad & U.Chaithanya, A Strategy of High Voltage Gain Switched – Capacitor DC-DC Converter with Reduced Rating Component Rating and Count Fed DC Drive System, International Journal of Engineering.

[14]. V. Ramanjaneyulu "Buck-Boost Converter Topology with Improvement in The Gain "in International Journal of Research Available, Alochana Chakra Journal Volume IX, Issue VI, June/2020 ISSN NO:2231-3990.

[15]. J.Sofia Priya darshani &, Dr.M.V.Subrtamanyam Emperor Penguin Optimized User Association Scheme for MMWAVE Wireless Communication' Wireless Personal Communications. An International Journal, ISSN 0929-6212.

[16]. V.Jyothi, Dr.M. V. Subramanyam "An Enhanced technique to improve the Network Lifetime of Cognitive Sensor Networks', International Journal of Wireless Personal Communications' pp. 12757 – 12763, May-2021.

[17]. V.Jyothi, Dr.M. V. Subramanyam "An energy efficient fuzzy clustering-based congestion control algorithm for cognitive radio sensor networks', Wireless Networksl. Oct-2022.

[18]. M.Yerri Veeresh, Dr.V.Nagabhaskar Reddy, Dr.R.Kiranmayi, Modeling and Analysis of Time Response Parameters of a PMSM-Based Electric Vehicle with PI and PID Controllers, in Engineering, Technology & Applied Science Research (ETASR), ISSN: 2241-4487, Vol. 12, Issue. 6, December 2022, PP.No. 9737-9741.

[19]. V. Ramanjaneyulu "Distribution Feeder Load Balance by using Loop Power Controllers Considering Photovoltaic Generation "International Journal of Technology and Engineering Science [IJTES]TM Volume 4 [2], pp: 8050-8056, October 2016.

[20]. K. Rajasekhar Reddy "Simulation of a Matrix Converter Fed Induction Motor" in International journal of Research science and Management (IJRSM) (ISSN: 2349-5197, PP- 51-59,Volume-2, Isuue-9, August 2015).