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Indoor Monitoring and Controlling System using Lora (IoT)

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***Abstract*—In our day-to-day life, human of us were running for our works without having enough time. Our routine is fixed and we are living according to it. In olden days, people need to do the work on their own manually without the help of any things or gadgets. But nowadays, our life is becoming automated with the help of several tools and machines. The technology is growing faster and faster every day in all the fields. We are upgrading our lifestyle in every aspect with the help of certain technologies. From waking up till going to bed, we are using several gadgets from electric toothbrush to alarm clocks for making our routine easier, convenient and efficient. The purpose of making new inventions is to make our work in an easier manner, to consume the time we spent on every job, to reduce the cost we spend and so on. There are several technologies like Artificial Intelligence, Machine learning etc. Of these, Lora is one the most effective and useful technology emerged among all the technologies. This paper well explains about the automation of indoor system like home or office and controlling the appliances present in those indoor systems using the LoRa technology.**

***Index Terms*— Artificial Intelligence, Indoor Monitoring, Automation, Lora Technologies, IoT.**

I. INTRODUCTION

Technologies can help the world to make peaceful, justifiable and fairer. The term technology arises in each period from the stone tools to the genetic engineering or the information technology we are using today. There is rapid growth in the field of science, history, economics. As the population increases, the technology development is also increasing every day. For a sustainable lifestyle, the mankind introduced several automation and updates in their works. We may think that the home or indoor automation system is of the most recent and effective development. But it is not absolutely true. The real history of home or indoor automation goes back several years in the beginning of the popular culture. For years and years, several innovators and scientists have worked for indoor automation systems for making the home life much affordable and efficient. We can say the Nikola Tesla's Remote-control boat as the first invention after the independence of US from England. Also, a Serbian-American inventor who is also an electrical and mechanical engineer has made certain breakthroughs in the production of electric power and its transmission and application process. He is the one who developed the first Alternating current and motor without which the smart home technology is impossible. In the early 1900's, Industrial revolution has paved the way for innovating home appliances. There were several inventions in home appliances like the clothes dryer, clothes

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iron, washing machine, home refrigerators, vacuum cleaners and so on. In 1966, ECHO IV was invented which is an electronic computing home operator that controls indoor systems. In 1981, the wireless technology was introduced in the form of 1G technology. Throughout the period form 1990's to 2000's, the smart home technologies and automations emerged and development for the betterment of living in a simpler way with comfort, convenient and energy saving. This technology helps us to live a sophisticated life. One of the best ways for automation is by using the Internet of Things. The term "Internet of Things" and its concept was appeared first in a speech made by Peter T Lewis to the Congressional Black Caucus Foundation during the 15th Annual Legislative Weekend in Washington which was published in the year 1985.According to him "The Internet of Things or IOT is the integration of people, processes and technology with connectable devices and sensors to enable remote monitoring, status, manipulation and evaluation of trends of such devices. Most of the indoor automation system uses IoT and Wi-Fi technology as major component as it can control the devices automatically in one place. But here we are using a technology or a device called LORA as a major tool for controlling and monitoring home or indoor appliances.

II. Literature Survey

In Smart Monitoring and Controlling of Appliances[1] Using LoRa Based IoT System, Monitoring and controlling appliance/equipment at home from a long distance with low power consumption, the results were Data loss during transmission while using android applications, particularly at longer distance which can be addressed by employing multiple gateways. To reduce the data loss and controlling the appliances by human activities. IoT based Door open or close monitoring for home security with emergency notification system using LoRa Technology, Monitor the status of the door using digital lock and checks whether it is open or closed and based on the status further actions like alarming, sending an emergency notification are done to notify and alert the owner and to improve security, It is designed to monitor the status of a single door only, To monitor the status of two or more doors using fingerprint system[2]. In The Design of Application for Smart Home Base on LoRa, A GUI interface for LoRa based smart home and implement a smart home system using applications that can control LoRa-based household electronic devices. Server communication tool and the ESP8266 Module is used as a liaison between the server and the user through the GUI interface created, Used only for the monitoring of appliance, Including controlling of appliances by monitoring[3]. Smart Buildings and Homes using Low-Power Wide-Area Network (LoRa WAN)[4], Smart home automation is the process which all the home appliances can be controlled, monitored and maintained automatically by the knowledge of devices, Controls only the electronic appliances available in the building or home, Adding other controlling methods like doors, windows etc. In AI Remote Smart-Home Monitoring System Using LoRa, A LoRa based system is used for remote monitoring and maintenance of sensors and devices using artificial intelligence, Users need to control the appliances using smart devices, Automatic control of appliances[5]. In Design and Implementation of Real time monitoring[6] Using Arduino based Indoor Artificial Environment, Controlling, monitoring and providing environmental parameters, This process is implemented using Arduino technology, Introducing LORA technology and microcontrollers for better performance.

III. Methodology

The below diagram describes the component setup of the indoor automation system. The Lora shield acts as a major component in this system. The other sensors like the PIR sensors, DHHT 11 sensors and the fingerprint sensors are connected to the Lora shield Lora gateway is present in the Lora shield where the indoor or home appliances[7] like the light, fan, air conditioners and the door system were connected to it. When we take a look at the flowchart presented below, we can get a deep understanding about the step-by-step process of the module. Firstly, the working starts when we place our finger in the fingerprint sensor. If it is able to identify our fingerprint, the door will open, otherwise the door remains closed [8]. When the person enters into the room after the door is opened, the sensors start detecting the movement of the person inside the room by turning on the actuator. This actuator remains in on state until the person leaves the room. Finally, the work stops when the person exits from the room and the actuator will be turned off.

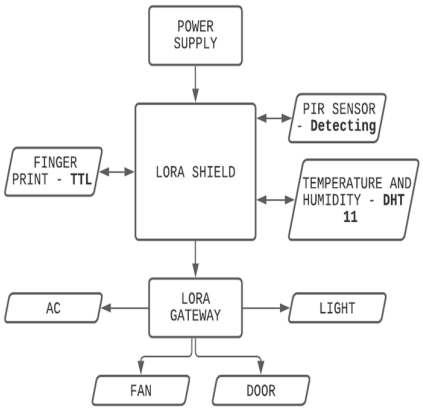

Fig. 1. Block Diagram

IV. System Architecture

The components used in this project are:

- LORA Module
- PIR Sensor
- Fingerprint Sensor
- Motor Driver
- DTH 11
- ESP 12-E Wi-Fi Module
- Relay
- DC Fan
- Node Mcu development board

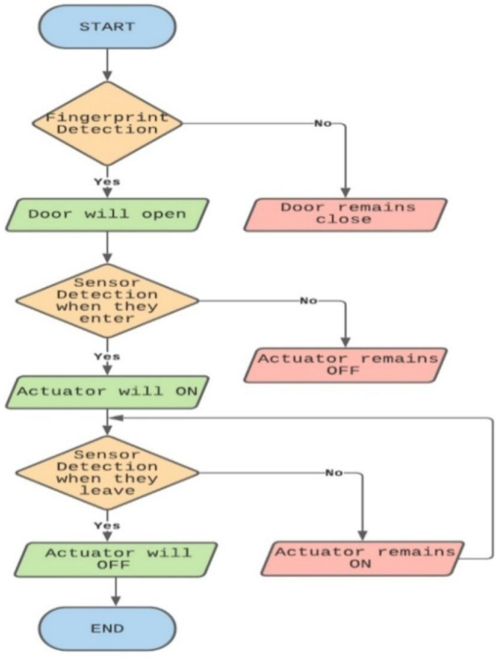

Fig 2. Flow Chart

A. Lora module

LoRa is abbreviated as Long Range is a low power wide area modulation process or a technique. It is a smart technique which was derived from CSS (Chirp spread spectrum). This LoRa works by moving the RF tone for a particular period of time in a very linear way. It operates at a distance between 5 to 13 kilometers. LoRa networks and devices namely the Lora WAN [9] that enables to solve some of the IOT applications with biggest challenges that are attaining in our globe such as:

- energy management
- natural resource reduction
- pollution control
- infrastructure efficiency
- disaster prevention.

This LoRa devices is used for numerous application and cases like smart cities, automation of homes and buildings, bigger communities, agriculture, metering technology, supply chain logistics and more where hundreds of devices were connected to networks in more than 100 countries and growing, LoRa is creating a smarter and wiser planet. The main purpose of using LoRa technology [10] is that it covers large distance with low power consumption so that we can save battery life. The connection is circuited between electronic components and a controller through Wi-Fi is present and the sender and the LoRa module is placed at the receiver end.

B. PIR sensor

PIR sensors are used to sense the motion and detect whether a human has moved in or out of the sensors range. These sensors are very small, low cost, uses low-power, very easy to use and it don't wear out. Only For that reason they are most commonly and widely found in some of the gadgets and appliances that we are using in homes or businesses areas. The other names of this PIR sensor are "Passive Infrared", "Pyroelectric", or "IR motion" sensors. The basic material used in PIRs are pyroelectric sensor which can detect certain levels of infrared radiation. Everything emits some low-level radiation, and the hotter something is, the more radiation is emitted. The motion detector of the sensor is actually split in two halves. The two halves can cancel each other out as they are wired up so if one half sees more or less IR radiation than the other, the output will show high or low.

C. Dht 11 sensor

The DHT11 sensor has a resistive-type humidity measurement component called an NTC temperature measurement component and a high-performance 8-bit microcontroller inside that provides calibrated digital signal output. The advantages of using this sensor are that It has high reliability and excellent long-term stability. Each DHT11 is strictly calibrated and it is extremely accurate on humidity calibration. The calibration coefficients are stored as programs in the OTP memory and are used by the internal signal detecting process of the sensor. There is a single-wire serial interface which makes the system to integrate quickly and easily. It is small in size, consumes low power up-to-20-meter signal transmission. This sensor is the best choice for various applications, including those most demanding ones. The component consists of a 4-pin single row package. It is convenient to connect and according to users request, the special packages can be provided.

D. Fingerprint sensor

Fingerprint sensors were considered to be a very costly and has high end technology. Mostly, we have seen these kinds of sensors only in thriller and sci-fi movies. But now, these devices have been used up in almost all places like offices, police stations and even in our laptops. One can also get to buy fingerprint USB scanners in low cost. There are mainly two types of scanning methods in this fingerprint technology. One is an optical scanner and the other one is a capacitance scanner that are used to scan and make a picture of our finger. Even Though both the methods produce the same type of image, the making of these methods is completely different. To use this fingerprint sensor[7], you need to scan and register your fingerprint for once. This scanned image is then compared with your registered finger print to get the correct identity. The comparison is carried out by the processor and made between the valleys and ridges. Though the steps of using these methods are simple, very complex algorithms must be needed to perform this operation. Even though your whole fingerprint is already recorded, the computer refers only the parts of the print to compare with some other records.

E. Node MCU development board

The Node MCU is very cost efficient and can be powered in many ways. The main thing about the boards is it is always offered on the internet that they are largely the same. It's a kind of an ESP-12E version which can be differed from others. This is an open-source LUA based firmware and development board which is mainly used in the field of internet of things (IoT) and its applications. It includes a firmware that always runs on the ESP8266 Wi-Fi SoC taken from Espresso Systems, and a hardware that is based on the ESP-12 module. The Node MCU[8] gives an access to the GPIO (General Purpose Input/Output). The pin mapping table is part of the API documentation that can only be used for GPIO read/write. It does not support open-drain or interrupt or PWM or I²C or 1-Wires.

F. Motor driver:

The motor driver IC can be used to run Two DC motors with the same IC. In this driver, the Speed and Direction control can be done. The Motor voltage varies from 4.5V to 36V.The Maximum Peak motor current obtained in this motor driver is 1.2A. This IC has a Maximum Continuous Motor Current of range 600mA.The Supply Voltage to Vcc varies from 4.5V to 7V. The approximate Transition time can be declared as 300ns (at 5Vand 24V). In this system, the Automatic Thermal shutdown is present. The process can be Available in 16-pin DIP, TSSOP, SOIC packages. This motor driver IC is used to drive high current Motors using Digital Circuits and it can be used to drive Stepper motors. We can drive or obtain High current LED from the source. There is a possibility of doing Relay Driver module or Latching Relay.

G. ESP 12-E wi-Fi module:

This ESP-12E is a kind of miniature Wi-Fi module present in the market. It is mainly used for establishing a wireless network connection for microcontroller or a processor. It has the ability to embed with Wi-Fi capabilities and systems to function as a standalone application. The cost is very low low-cost and[9] it is helpful for developing IoT applications. This module does not have any circuit complexity or any programming difficulties. So, using this module is really very easy.
Some of the applications of this wi-fi module are

- Weather station
- IoT applications
- Home appliances
- Toys and Gaming applications
- Wireless control systems
- Home automation
- Security ID tag

H. Relay

A relay is nothing but an electrically operated switch. The Current flowing through the coil of the relay creates a magnetic field that attracts a lever and changes the switch contacts. The coil current can be either in on or off state so that relays can have two switch positions and they can act as double throw switches. Relays allow one circuit to switch a second circuit which has no link between them. There is no electrical connection inside the relay between the two circuits, the link between is magnetic and mechanic. Most of the relays are designed and used for PCB mounting. Relays can switch AC between DC and vice versa and can switch high voltages. If you need to switch large currents, you can choose relays which is a better choice as they can switch many contacts at once.

V. WORKING PRINCIPLE

The overall setup of the project is displayed above. The indoor appliances like the light, fan and the air conditioner are connected to the lora gateway through the Wi-Fi module. The cloud server is connected at the other end of the gateway. The fingerprint sensor is kept on the door. Whenever a person wants to enter the home, they need to recognize their fingerprint. Only ate the verification of the fingerprint, the door will open and monitors human detection, temperature and humidity of the room and also switching on and off of the appliances like fan, light, air conditioner etc. If we go through the circuit diagram, we can clearly understand the process that was happening inside the prototype.

Figure 3. System Architecture

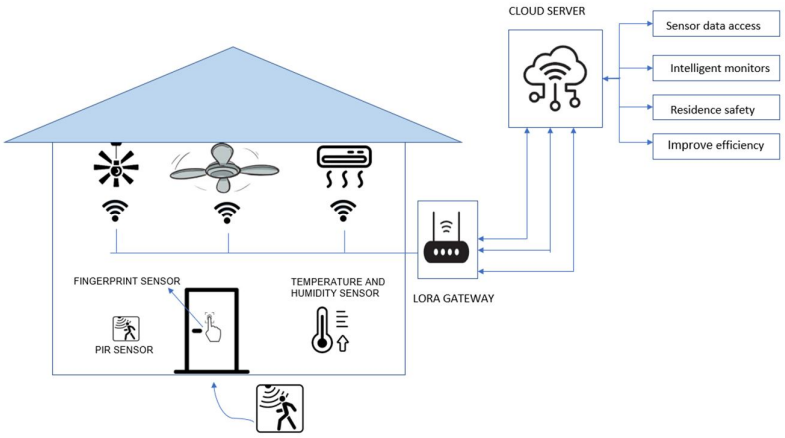

Fig 4. Set Up

Result Analysis

For each and every action, the LCD displays the appropriate action and shows to the user. For example, if you place your finger in the sensor, the lcd shows whether it detected or not and displays the function of the gate i.e., Opened or closed. Thus, we can identify the action easily that was happening in the circuit.

The software used in this project are MQTT client and MQTT dash. An MQTT client is any kind device used from a micro controller to a full-time server. It is then runs the MQTT library which is connected to an MQTT broker over a network client. It is mainly used for data exchange between constrained devices and server applications by keeping the bandwidth to the minimum and handles network communication. MQTT Dash is an MQTT client for Android. The main purpose of this product is to create dashboards that displays incoming information.

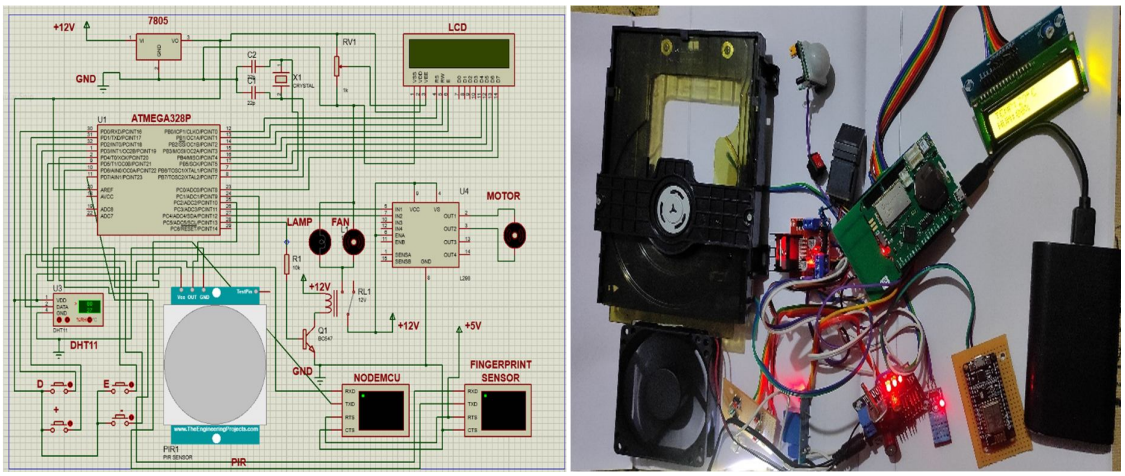

Fig 5. Circuit Diagram and Hardware Implementation

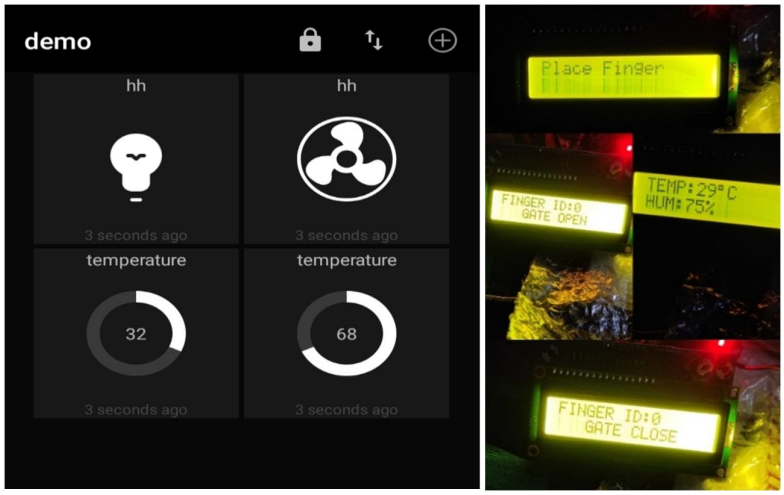

Fig.6. Result Analysis

VI. CONCLUSION

Due to the technology development, many automation techniques have been established in our country. From the survey it is clearly known that the most of the indoor automation and application system uses Arduino or Wi-Fi module as the major component. But this Lora has many advantages while comparing with the other components. With the help of this technology, it is very efficient and useful for monitoring indoor appliances and controlling them. It is very important to implement automation techniques in all the fields like homes, office and so on. For well-established and for a better future.

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