International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

"IoT BASED APPLIANCES CONTROL AND MONITORING SYSTEM USING LoRaWAN TECHNOLOGY"

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Abstract – *Our environment i.e., Home and society are surrounded by "things" which are connected to each other, either directly or indirectly via internet of things. IoT helps for controlling and monitoring the appliances remotely with precision within the network which is required key factor in the process of automation. There are numerous aspects in the automation that needs to be developed and enhance it. This research gives a solution for precise and direct control and automatic detection of current state of devices with the use of android application. LoRaWAN technology provides practical implementation of domestic and industrial automation and monitoring system with higher efficiency as compared to other technologies. The system based on LoRaWAN network have long range and low power consumption with data transmission from sensor node to cloud service. The system of cloud services is highly scalable and utilizes data stream for analytics purposes. This system is robust to interference.*

Key Words: Domestic and Industrial Automation, Internet of Things, LoRaWAN, Low Power Consumption, Sensor Node.

1. INTRODUCTION

Internet of things (IoT) may be very difficult to define explicitly but it can be described as a system of closely or loosely computing devices, analogous, mechanical and digital machineries, animals or people that have been uniquely tagged with identifiers. The idea of IoT was given birth to from the union of technologies that had been in existence for decades. These technologies include electromechanical systems, the internet and wireless automation. Using the idea of IoT to develop automation has become a thing to desired and have implemented. As with every technology, automation is in its developmental stages and as such requires a lot of researches and inputs from industries, academia and professionals alike. The Long-Range Wireless Area Network i.e., LoRaWAN is the technology which is latest technology which is highly efficient and simple to use.

By using LoRaWAN technology, the appliances, huge machineries, agricultural pumps, etc. can be control and check status of the equipment using internet of things and LoRa module. In this system, the status of the entire running system i.e., electrical parameters like voltage, current, power, etc., mechanical parameters, temperature, switching, etc. can be control wirelessly using LoRa. The LoRa system pusses very large range of 0 KM to 50 KM without internet facility and can have wide network with the application of IoT. In this system, there are two transceivers, one is LoRa module and another is IoT server which is situated anywhere in the system and using internet appliances can be control and monitor easily.

So, it is solution for all the problems regarding real time monitoring system for domestic, industrial and agricultural systems etc. thus the use of modern techniques in society must be equipped with sufficient usage of resources.

In a recent development, different communication alternatives had been employed in IoT deployments for various controlling and monitoring applications. These technologies include RFID, Zigbee, WSN, Cellular systems (GSM, 3G, 4G, VoLTE, etc.).

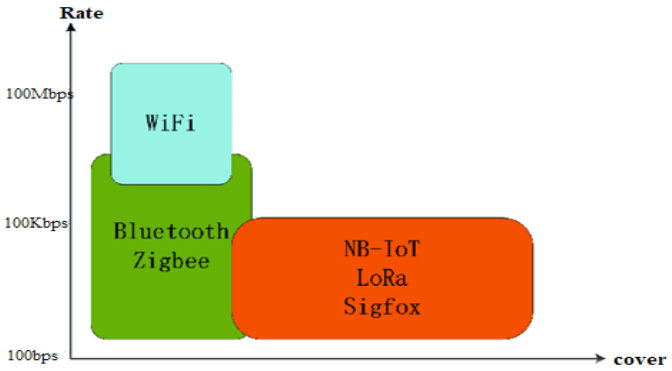

Fig.-1: Comparison of Different Communication Technologies for Communication Range and Data Transfer Rate

There are many drawbacks in monitoring applications using these technologies which includes less efficiency in terms of energy, higher cost, short rang communications, etc. Fig.-1. shows the comparison of different communication technologies for communication range and data transfer rate.

1.1 Proposed System

In proposed system, IoT based appliance control and monitoring system using LoRaWAN technology is the Long-Range Wide Area Network which transmit and receive data over large distance wirelessly with more efficiency and less expenditure and less maintenance. For controlling the appliances IoT is the best choice, but it has certain disadvantages which are overcome by using simply LoRa module. In this system, using transceiver system LoRa modules transmit and receive data and microcontroller take action on command send by user and switch on the relay system. It is long range system which transmits data wirelessly which ranges up to 20KM to 100KM depends on bandwidth. Fig.-1.1 shows block diagram of IoT based appliance control and monitoring system using LoRaWAN technology.

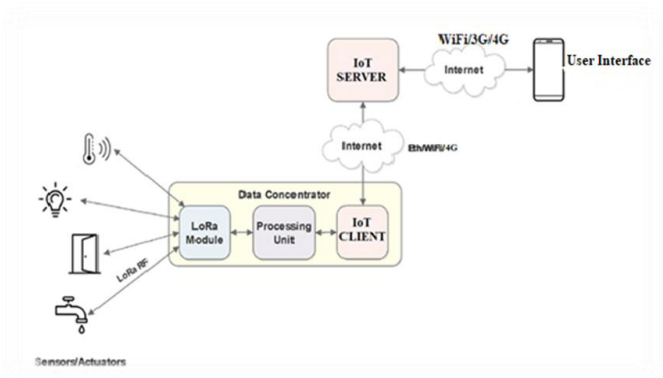

Fig.-1.1: Block Diagram of IoT Based Appliance Control and Monitoring System Using LoRaWAN Technology

The three main components used in the block are IoT server, LoRa module, Microcontroller and Magnetic relays. IoT server is used to make communication between transmitter and receiver. LoRa module is the module which establish wireless, long range communication between controlling site to server and service is free of cost. User send command to the server; server read the command and perform desired operation and feedback send to user. The system consists of two parts i.e., transmitter and receiver which is connected to the IoT server. Relays are electromagnetic switches which are used to make and break the circuit. Circuit also pusses the sensors which senses the faults and if fault occurs, trip the circuit immediately.

2. Hardware Description

2.1 Microcontroller ATmega328P

The ATmega328P is a low power high performance CMOS 8bit microcontroller with 32k bytes of in-system programmable flash memory. It also pusses 1 KB EEPROM, 2 KB SRAM, 32 general purpose working registers, 23 general purpose I/O lines, three flexible timers with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented SPI serial port, 6 channels 10-bit A/D converter, 2 wire serial interfaces, programmable watchdog timer with internal oscillator and five software selectable power saving modes. This system puss's microcontroller which is brain of the system.

Fig.-2.1: Microcontroller ATmega328P

2.2 IoT Sever ESP32

ESP32 is a series which requires minimum power and puss's low-cost system on chip microcontrollers with integrated dual-mode Bluetooth (BT) and Wi-Fi. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both single-core and dual-core variation and includes built-in antenna switches, RF balan, power amplifier, low-noise receiver amplifier, filters, and power management modules & it is created by Espressif Systems. In this seminar, ESP32 is used as IoT server.

Fig.-2.2: IoT Server ESP32

2.3 LoRa Module

LoRa (LoRa) is a less power wide area network (LPWAN) protocol developed by semtech. It is based on spread spectrum modulation techniques derived from the chirp spread spectrum (CSS) technology. LoRa module works of technology named LoRaWAN which is the communication protocols and system architecture for the networks, while the LoRa systems physical layer enables the long-range communication links. LoRaWAN also controls the communication frequencies, data rate, and power for all devices. Devices in the network are not synchronous and convey when they have data available to send. Data conveyed by an end-node device is received by multiple gateways, which forward the data packets to a centralize network server. The network server filters duplicate packets, performs security checks, and control the network. Data is the forwarded to application servers. The technology shows extreme reliability for the moderate load; however, on basis of performance, it has some issues related to sending acknowledgements.

LoRa uses license-free spectrum sub-gigahertz radio frequency bands like 433 MHz, 868 MHz (Europe), 915 MHz (Australia and North America), 865 MHz to 867 MHz (India) and 923 MHz (Asia). LoRa enables long-range data transmissions (more than 10 km in rural areas) with minimum power consumption. The technology covers the physical layer, while other protocols and technologies such as LoRaWAN (Long Range Wide Area Network) cover the upper layers. It can accomplish data rate from 0.3 Kbps to 27 Kbps depending upon the spreading factor. New LoRa chipsets were invented with reduced power consumption, increased transmission power, and reduced size compared to older generation. Lora's devices have Geological capabilities used for the trilateration positions of devices via timestamps from gateways. LoRa and LoRaWAN permits long-range connectivity for Internet of things (IoT) devices in different types of industries. Range extenders of LoRaWAN are called LoRaX.

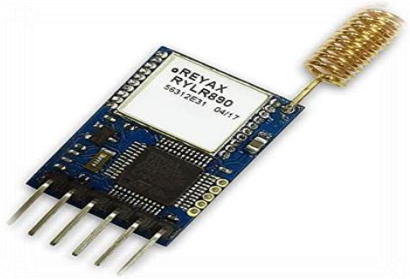

Fig.-2.3: LoRa Module

2.4 Relay

A relay is an electrically operated switch. The switch may have number of connections in multi-contact forms, such as make connection, break connection, or combinations thereof. The traditional form of a relay uses an electromagnet to open or close the connections, but other operating principles have been invented, such as the operational solid-state relays which use semiconductor criterions for control relay without the moving parts. Relays with calibrated operating criterion and sometimes multiple operating coils are used to protect electrical circuits from overload or faults these functions are performed in modern electric power systems by digital instruments still called protective relays.

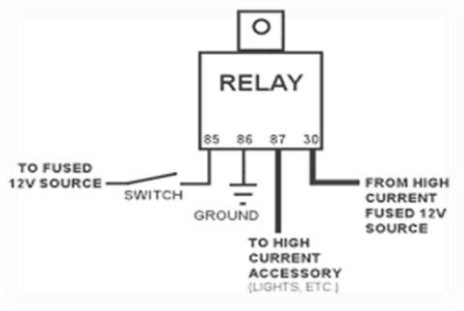

Fig -2.4: Relay

2.5 Battery Unit

Batteries produce power by chemical reaction and a physical wonder transformation technique. The supply of power might be conductive substance like a semiconductor precious stone to that polluting influences are extra.

At the point when the gem is stricken by lightweight, electrons are ousted from the surface of the previous stone and move toward the elective platform. There they're gathered as a flow of power.

Nickel Cadmium (Ni-Cd) batteries are rechargeable and requires less compared to lead acid battery.

Fig.-2.5: Battery

2.6 Software Details

In this system, some software is required for successful implementation. Arduino IDE 1.8.13 is being employed for coding and establish communication with microcontroller ATmega328P and IoT server ESP32. Arduino IDE compiler is used to convert high level language to object code.

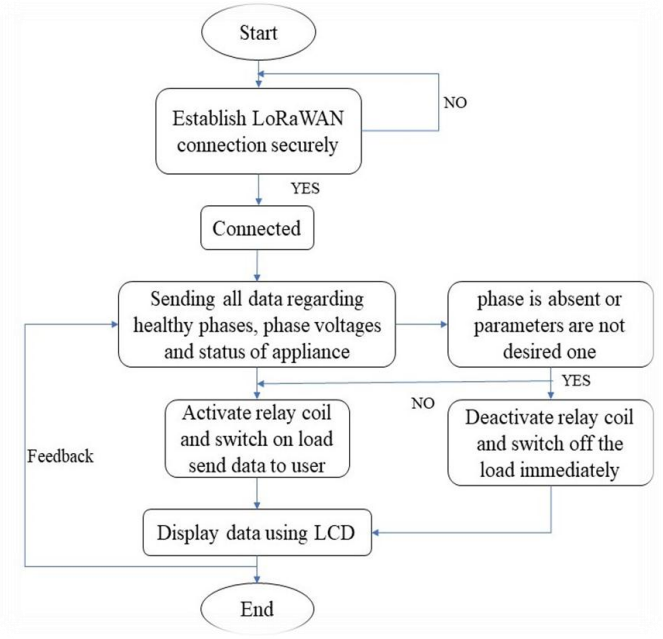

Fig -2.6: Flowchart of Software Details

In the program, first start and establish the connection with LoRaWAN. If connection not establish, system retry to connect with LoRaWAN. After secured connection with LoRaWAN, it firstly sends all the data regarding the healthy

phases, phase voltages, status of appliances, etc. when user sends command, after analyzing the parameters, the relay activate and supply is given to the load. Running status of load is continuously sends to the user. LCD display(optional) is used in the system to show the parameters directly on screen. In case any fault occurs, the relay senses the fault and suddenly trip the circuit and notification of fault sends to the user by using LoRa module. In this way, the module works.

3. CONCLUSIONS

Technologies positioned for home automation that are available in the society are based on platforms which help to connect devices or things around the home, the goal is to make the home intelligent or smart with ease. To achieve this with precision by the use of static IP addresses and having the ability to detect the current state of devices by use of state function was achieved. In conclusion, it has been seen that home automation using internet of things over LoRa technology with the help of Android application is both user friendly and cost effective. The success rate of this model is about 95% according to results obtained from the analysis. Further work on this system shall cover aspects of cost reduction in implementation and further reduction in the power consumption of such models.

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