

FINAL YEAR TECHNICAL SEMINAR REPORT

Home Automation & Fault Detection

Submitted in partial fulfilment of the degree of Bachelor of Technology
Rajasthan Technical University



By

PANKAJ SHARMA
(PIET/15/CE/070)

DEPARTMENT OF COMPUTER ENGINEERING POORNIMA
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RAJASTHAN TECHNICAL UNIVERSITY

POORNIMA INSTITUTE OF ENGINEERING AND
TECHNOLOGY

CERTIFICATE

This is to certify that Final Year Seminar Report entitled “**Home Automation & Fault Detection**” has been submitted by “PANKAJ SHARMA (PIET/15/CE/070)” for partial fulfilment of the Degree of Bachelor of Technology of Rajasthan Technical University. It is found satisfactory and approved for submission.

Date:

25/03/2019

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DECLARATION

I hereby declare that the seminar report entitled “**Home Automation & Fault Detection**” was carried out and written by me under the guidance of Dr. Megha Gupta Professor, Department of Computer Engineering, Poornima Institute of Engineering & Technology, Jaipur. This work has not been previously formed the basis for the award of any degree or diploma or certificate nor has been submitted elsewhere for the award of any degree or diploma.

Place: Jaipur

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ABSTRACT

Home automation systems are quite popular in today's scenario due to the comfort and features it provides to the users. This paper reviews the different Home Automation & Fault Detection which is prevailing today. Nowadays most of the home automation systems make use of a smartphone and a microcontroller such as Arduino. Such systems also use a specialized smartphone app that can be used to interact with the appliances. In this paper different home automation systems have been studied and their working along with their advantages and disadvantages has been compared with one another.

Keywords: internet of things, smart home, home automation, fault detection system

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LIST OF ABBREVIATION

1. IoT; Internet of Things
2. SCADA; Supervisory Control and Data Acquisition
3. IIoT; industrial IoT

CHAPTER 1

INTRODUCTION OF HOME AUTOMATION SYSTEMS

1.1 INTRODUCTION

Home automation systems are getting very popular in today's world. This hike in home automation system is due to its simplicity and the comfort it provides afterwards. The term home automation is self-explanatory, to put it simply it means automation of your home where you can control different appliances with just a few taps on your smartphone. Compatible appliances can be controlled using a variety of devices such as laptops, smartphones or tablets. Most of the home automation systems makes use of a smartphones in order to control the appliances because a smartphone is usually in the possession of owners most of the time. Home automation system provides a wide variety of advantages to home owners such as controlling the appliances, video surveillance, security and it even provides beautification to interiors. Home automation systems are very useful for disabled and elderly people as they reduce human effort. This paper talks about the various methodologies involved in home automation and also tries to explain the underlying working principal of different home automation systems.

Automation is, unsurprisingly, one of the two main characteristics of home automation. Automation refers to the ability to program and schedule events for the devices on the network. The programming may include time-related commands, such as having your lights turn on or off at specific times each day. It can also include non-scheduled events, such as turning on all the lights in your home when your security system alarm is triggered.

Once you start to understand the possibilities of home automation scheduling, you can come up with any number of useful and creative solutions to make your life better. Is that west-facing window letting in too much light? Plug your motorized blinds into a "smart" outlet and program it to close at noon each day. Do you have someone come by at the same time each day to walk the dog? Program your home automation system to unlock the front door for them, and lock it up again when they're done.

History of Home Automation

A home automation system typically connects controlled devices to a central hub or "gateway". The user interface for control of the system uses wall-mounted terminals, tablet or desktop computers, a mobile phone application, or a Web interface, that may also be accessible off-site through the Internet.

Early home automation began with labour-saving machines. Self-contained electric or gas powered home appliances became viable in the 1900s with the introduction of electric power distribution and led to the introduction of washing machines (1904), water heaters (1889), refrigerators, sewing machines, dishwashers, and clothes dryers.

In 1975, the first general purpose home automation network technology, X10, was developed. It is a communication protocol for electronic devices. It primarily uses electric power transmission wiring for signalling and control, where the signals involve brief radio frequency bursts of digital data, and remains the most widely available. By 1978, X10 products included a 16 channel command console, a lamp module, and an appliance module. Soon after came the wall switch module and the first X10 timer.

By 2012, in the United States, according to ABI Research, 1.5 million home automation systems were installed. As per research firm Statista more than 45 million smart home devices will be installed in U.S. homes by the end of the year 2018

According to Li et al. (2016) there are three generations of home automation:

1. First generation: wireless technology with proxy server, e.g. ZigBee automation;
2. Second generation: artificial intelligence controls electrical devices, e.g. Amazon Echo;
3. Third generation: robot buddy who interacts with humans, e.g. Robot Rovio, Roomba.

Home Automation Components

What kinds of things can be part of a home automation system? Ideally, anything that can be connected to a network can be automated and controlled remotely. In the real world (outside of research labs and the homes of the rich and famous), home automation most commonly connects simple binary devices. This includes “on and off” devices such as lights, power outlets and electronic locks, but also devices such as security sensors which have only two states, open and closed.

Where home automation becomes truly “smart” is in the Internet-enabled devices that attach to this network and control it. The classic control unit is the home computer, for which many of the earlier home automation systems were designed. Today’s home automation systems are more likely to distribute programming and monitoring control between a dedicated device in the home, like the control panel of a security system, and a user-friendly app interface that can be accessed via an Internet-enabled PC, smartphone or tablet.

Manufacturers have produced a wide variety of “smart” devices, many of which are full of innovative features but few of which offer the kind of integration needed to be part of a complete home automation system. Much of the problem has been that each manufacturer has a different idea of how these devices should be connected and controlled. So, while you may have a “smart” TV, washing machine, refrigerator, thermostat, coffee maker or any of the other Internet-ready household devices on the market, the end result is usually a separate control scheme for each device.

In the near future, home automation may be standardized to let us truly take advantage of all of these additional possibilities. For the time being, the home security providers that specialize in home automation have focused on the most critical and useful parts of a connected home. At a basic level, this means the doors and windows and environmental devices (thermostat, smoke detectors, temperature, humidity, fire and carbon dioxide sensors) that keep you safe and comfortable. For additional real-time security, convenience and control, home automation systems from security providers should also include options for video cameras. With the best systems, you’ll also be able to include lights and individual electrical outlets into your home automation package.

CHAPTER 2

TECHNOLOGY SPECIFICATION

Benefits of Home Automation

The benefits of home automation typically fall into a few categories, including savings, safety, convenience, and control. Additionally, some consumers purchase home automation for comfort and peace of mind.

Here's a closer look at some of the biggest benefits that home automation provides.

Savings: Smart thermostats and smart lightbulbs save energy, cutting utility costs over time. Some home automation technologies monitor water usage, too, helping to prevent exorbitant water bills. Certain devices even offer rebates.

Safety: Many home automation technologies fall under the umbrella of home security. Consumers purchase these devices because they want to make their homes safer and more secure. Automated lighting thwarts would-be burglars, and motion sensors help people enter doors and walk hallways late at night.

Security cameras offer benefits through either remote monitoring of package deliveries or real-time video of home inhabitants or unwanted visitors.

Convenience: Because home automation technology performs rote tasks automatically, end users experience great convenience. Lots of smart gadgets are compatible with one another, and you can set different triggers between devices to automate regular home processes. For instance, you could set your smart locks to turn on your smart lighting when you unlock the front door.

Control: Consumers also choose smart home devices to better control functions within the home. With home automation technology, you can know what's happening inside your home at all times.

Comfort: Some people use smart technology to record shows or to play music throughout the home. Connected devices can also help create a comfortable atmosphere—they provide intelligent and adaptive lighting, sound, and temperature, which can all help create an inviting environment.

Peace of Mind: Finally, many consumers invest in home automation technology for peace of mind. A new mom or dad can check on their little one thanks to smart cameras and other technologies. Or, if you can't remember whether you closed the garage after you left, you can verify remotely with an app.

Home Automation & Fault Detection

WI-FI

Undoubtedly, Wi-Fi is a fixture in nearly every home, so it goes without saying that a wide range of automated devices are already compatible with this standard and thus its advantages are numerous. Nearly everyone has access to Wi-Fi and many, if not all, consumers considering home automation systems have it installed. Wi-Fi was designed to handle large amounts of data traffic, so bandwidth to control your home devices is not an issue. From a security perspective, Wi-Fi Protected Access (WPA and WPA2) encryption has been shown to provide reasonable security for home users when activated and implemented.

However, Wi-Fi's limited bandwidth is an issue. Its connection speeds can be lowered or even disrupted by having other Wi-Fi devices in the same general area. Thus, you can expect slower response times. The good news is that most home automation endpoints are not bandwidth hogs, so response time may not matter. Battery consumption is also problematic, as Wi-Fi consumes much more power than other technologies, and when combined with its limited bandwidth, it may not be an optimal solution.

Wearable devices with sensors and software can collect and analyze user data, sending messages to other technologies about the users with the aim of making users' lives easier and more comfortable. Wearable devices are also used for public safety -- for example, improving first responders' response times during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters' vital signs at life-threatening sites.

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely to use the data that's generated and analyze it. Hospitals often use IoT systems to complete tasks such as inventory management, for both pharmaceuticals and medical instruments.

BLUETOOTH SMART

Bluetooth Smart, or Bluetooth Low Energy (BLE), is a energy efficient version of Bluetooth wireless technology often seen in smartphones, and ideal for use with a headset. Though its range is limited, its energy usage is quite low. Its energy efficiency, combined with its compatibility with existing

smartphones and other devices, makes it easy for developers and OEMs to create solutions that can immediately be added to existing systems.

Although it uses different channels, BLE operates in the already crowded 2.400 GHz-2.4835 GHz ISM band and the required data compression diminishes audio quality. If BLE is primarily used within the home or in close proximity, its low energy usage and extensive battery life make it a viable option.

GSM Based

using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper. The proposed research work is focused on functionality of the GSM protocol, which allows the user to control the target system away from residential using the frequency bandwidths. The concept of serial communication and AT-commands has been applied towards development of the smart GSM-based home automation system. Home owners will be able to receive feedback status of any home appliances under control whether switched on or off remotely from their mobile phones. PIC16F887 microcontroller with the integration of GSM provides the smart automated house system with the desired baud rate of 9600 bps.

Internet of things (IoT) based home automation system

IoT is one of the blooming fields in computer science which is growing at a rapid pace. Since the computing power is considerable these days the ease and number of connecting appliances also grows. With the help of IoT based home automation the home owner can control the appliances from anywhere in the world. Provided they may have internet access. The term IoT refers to the internet of things, which is a network of appliances interconnected to one another, these appliances can be provided with a unique IP address which enables data transmission over the internet, allowing the user to control these devices.

The IoT based home automation system makes use of an android application which connects to a cloud server. The Arduino board installed at home is in constant communication with this cloud server and fetches commands from there. Depending on what commands it has received the Arduino will toggle the desired appliance, hence allowing the user to control devices from anywhere in the world.

Future of home automation

Home of the future is a space for the digital natives. With the invention of lots of automation technologies featuring IOT and AI, home automation has become a reality. One can implement several of their tasks with just a single command of verbal instructions. These technologies can be used to build a fully functional home automation system and control smart home devices including smart lights, connected thermostats, and appliances.

There are several new technologies which can become a part of home in the near future:

- **Increased efficiency, control, and customization:** Artificial intelligence is set to make you lazy in the near future. Technology will become much more efficient and one will be able to control everything from volume to security from one central place. The devices will work automatically and you don't need to waste your energy; it will act upon user's preferences. AI would revolutionize home by automatic threat detection and proactive alertness.
- **Integration of Smart home devices:** One can command it to control small things of home through voice and Smartphones. All the tech giants are working in the field of IoT to bring advancements in the home automation devices. In near future, homes will be equipped with such IoT devices which will make your daily lives work faster, smoother, and more accurate. Mark Zuckerberg came up with a goofy proof-of-concept video showing off an idealized version of how his Jarvis system actually works. Google Home, which is Google's smart speaker loaded with Google Assistant, was updated at last year's Google I/O with a bunch of new features, including "proactive assistance", also known as push notifications, hands-free calling, Spotify, SoundCloud, and Deezer integrations, and more. Also, more recently, Google launched two more Google Home speakers, Home Max and Home Mini.
- **Smart spaces outside homes:** Smart parking through sensors will help to recognize whether the parking is available or not. Camera monitoring can be done and with the help of artificial intelligence and computer vision, both parking facilities and security can be provided. It would be a faster and smoother process and act as a reference for other smart systems to be built accordingly. Streetlights can also be automated through sensors and built for effective use for the people nearby.
- **Development of smart appliances:** The devices which we use to use like television, refrigerator, and even the mirror is getting smarter today with evolution of technology. The smart mirror should not only act as a face video but also help to other tasks like listening to music and stuff. Televisions have become part of a centralized entertainment and can also be used for social media. The refrigerator has been upgraded to sense the temperature outside and

- operate accordingly. The washing machine will wash the clothes according to the clothes material and switch off after drying. They will keep on advancing as the technology evolves.
- **Personal home delivery:** Drones will be used to deliver the packages at the right time. They will replace the normal salesman job. They might also be used for several other tasks like monitoring the weather outside the home, returning something back to a relative's home nearby and so on.

They can also be used for monitoring the traffic in our locality.

One can build several amazing projects using the concepts of home automation. There are several projects already done by developers and available on the Internet. They might help you to start the work with IoT. You can add new skills to own smart device. You can make your smart home device work according to your life works and habits. Even we can build many projects around it by discovering new areas of the internet of things and make the world a smarter place to live in.

CHAPTER 3

RESEARCH PAPER

HOME AUTOMATION & FAULT DETECTION

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Abstract: As a part of Internet of things (IoT), serious concerns are raised over the connectivity of devices. Once the devices are connected together, they enable more smart processes that support the essential home energy management and automation. Thus networking of things has gained attention due to its integration into everyday life. In the recent years, Energy conservation and energy audit has proved to be invincible in the world. Our framework provides means for energy management at home through IoT. The proposed smart home features in monitoring the status of the appliances and accessing them using internet.

We provide a methodology to sense the environmental conditions by using different type of sensors like Light, temperature, humidity, vibration, current etc. for provide important information to automatic adjust and provide comfort in home by optimizing use of energy. We use some prediction algorithm like naïve Thomas byes classifier to automatic detect and determine any problem with in devices. If service of device is needed then system will send email, SMS or audio to technician and owner.

Keyword – internet of things, smart home, home automation, fault detection system

1. Introduction

Today, over two billion people around the world use Internet for browsing Web, sending and receiving emails, accessing multimedia system content and services, playing games, social networking applications and many other tasks.

From the old chestnut, “A world wherever things will automatically communicate to computers and every alternative providing services to the benefits of the human kind”,

lot explain different type of technologies and disciplines that achieve out into the real world to implement on physical objects.

lot is represented as connection of objects like phones, TVs, Sensors etc. to the internet wherever the devices are joined and make new kind of communication between people and things.

Any person can connect to anything from anywhere and anytime and except that these connection extend and work completely on advance dynamic network.

This technology can be applied to generate new ideas and develop many areas to make home smart, comfortable and to enhance standards of life.

Internet of Things builds on 3 pillars, associated with the flexibility of good objects:

- (i) First pillar is it will be identifiable.
- (ii) Second pillar is it will be communicational.
- (iii) Third pillar is it will be intractable.

The 3 characteristics of IoT :

- (i) To anything communicates: good things have the flexibility to wirelessly communicate among themselves and kind networks of interconnected objects,
- (ii) To anything identifiable: good things are identified with a digital name. Relationships among things will be specified within the digital domain whenever physical interconnection can't be established and
- (iii) To anything intractable: Good things will be interacted with native atmosphere by using sensing and effort capabilities whenever present.

2.smart home system

In our regular life, state of affairs comes wherever it's troublesome to regulate the house appliances just in case once nobody is accessible at home or once the user is much far from home or once the user leaves home forgetting to switch off some appliances that result in spare wastage of power and additionally might result in accidents. Sometimes, one can also need to observe the status of the home appliances, staying far from home. Altogether the higher than cases the presence of the user is necessary to observe and control the appliances that aren't potential all the time.

This short coming can be eliminated by connecting the home appliances to the user via some medium. However, connectivity can be established with the help of GSM, internet, Bluetooth, Zigbee. It is reliable to connect devices via internet so that the remote user can monitor and control home appliances from anywhere and at any time around the world. This increases the comfort of the user by connecting the user with the appliances at home, to monitor the status of the home appliances through a mobile app, to control the appliances from any corner of the world, to understand the power consumption of each appliance and to estimate the tariff well in advance.

2.1 automation system

The appliances square measure classified consistent with the character of their operation / control. Appliances like Geyser and Toaster got to be switched ON/OFF at specific time intervals. For efficient utilization of the appliance, the device needs to be switched ON and OFF suitably. AN RTC primarily based system will performs the management exactly which boosts the appliance's life and saves the ability. Once the match takes place between the loaded time and therefore the real time, the controller activates the appliance and equally once the period gets over, the controller turns OFF the appliance. Therefore the appliances square measure controlled as per the time schedule outlined by the user.

Some appliances got to work solely throughout human presence. During this planned work, human movements are detected exploitation PIR sensing element and therefore the necessary automation is completed. The required intensity in the room will be established exploitation sensible Lamp. The lamp should turn on and OFF solely throughout human presence that is enforced exploitation motion sensing element primarily based lighting system.

These system's performance is increased by switch them solely there is no enough light and so the sunshine will not activate throughout daytime.

This is often done by together with LDR within the system. The specified close intensity is ready by varied the brightness of the lamp exploitation PWM techniques that helps in energy saving. By correct positioning of LDR, the sunshine intensity of the space will be maintained as shown in below figure.

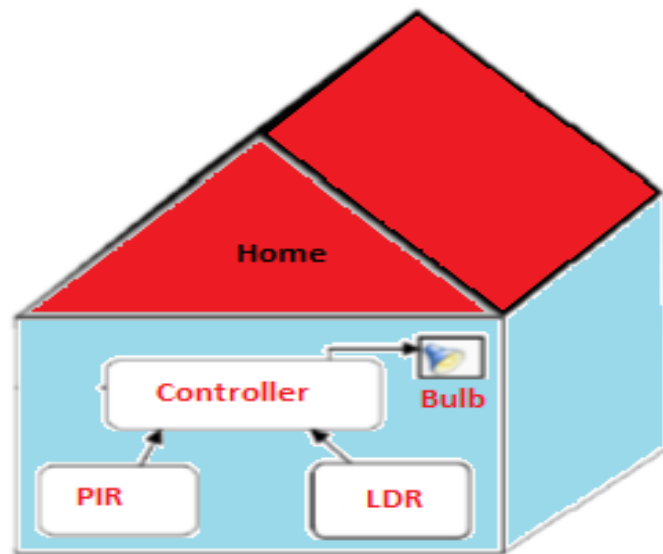


Fig. 1 Smart Lamp control using LDR

2.2 Monitoring system

After going from home few meters away, the user could have doubts relating to the status of the appliances at home. In such cases, returning back to our home and checking for its status won't be troublesome. Once the gap extends to about few miles, returning back becomes tedious. Just in case of emergency, the user needs to come, that disrupts the user's routine. The appliance may be left as such, which can lead to severe damage to the device, just in case of motor or geyser. These cons are overcome by remote observation of the house appliances.

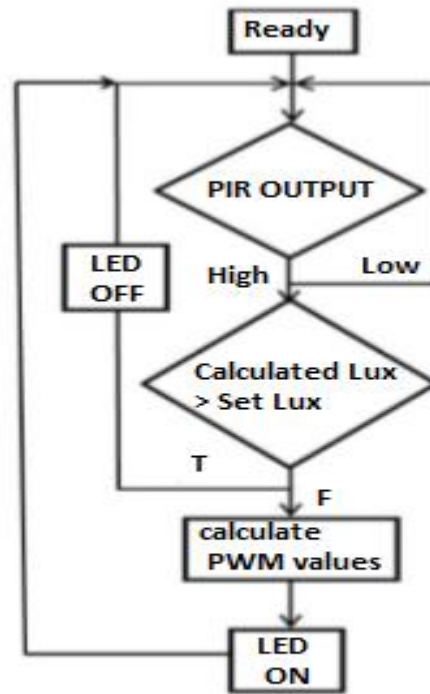


Fig. 2 Monitoring flow chart

Thus the PIR sensor put in at the precise points at the house senses the location of the user at the house permanent to the location awareness system that makes use of a floor mapping algorithmic rule for one user. The meant usage of the PIR detector is to observe the human presence. The light Dependant Resistor (LDR) placed at appropriate locations determines light intensity of the place at the placement and sends the worth to the system for any interpretation. Therefore LDR enhances the feature cited in by creating use of sensors to observe the surroundings factors and accommodates identical desired by the user. The sensible plug associates to the work drawn in .These sensible plugs enhance the feature of planning the devices likewise as dominant the power consumption of lamps like crystal rectifier lamps.

The device status should be monitored sporadically and once the user sends missive of invitation, the status of the appliance is given. The status observation of the appliances are often realised with the assistance of a flow chart shown in Figure 2. When the device is in standby mode, as presently because the PIR sensor detects the human presence the controller calculates the room luminousness value and compares with the prefixed value. Based on the results, the lamp is either switched ON or switched off with the given brightness and also the cycle continues.

2.3 ALGORITHM

1. **IF** Room Temperature ($\leq 25^{\circ}\text{C}$).
Then
 Fan OFF
Else
If Room Temperature ($\geq 25^{\circ}\text{C}$).
Then
 Fan ON (Speed of the fan increases according to the temperature)
End IF
End IF
2. **IF** PIR sensor sensed Motions.

Then
Tube light ON
Else
Continue Sensing.
End IF

3. IF Gas value (≥ 1000) MQ5.

Then
Alarm Start.
Else
Continue Sensing.
End IF

4. IF current sensors not detected current.

Then
Alarm Start.
Else
Continue Sensing.
End IF

5. IF Door sensor lost the line of sight connection for 20 sec.

Then
Alarm Start.
Else
Continue Sensing.
End IF

4. CONTROLLING AND FAULT DETECTION SYSTEM.

3.1 CONTROL SYSTEM

Remote controlling of the appliances may be performed. Once the user sends a command, betting on the command received, the appliances is switched ON and OFF Consequently. Generally there arises a discrepancy wherever no device has been connected or fault within the existing device. In such case, associate degree electrical circuit prevails. With the assistance of a current sensing mechanism, fault detection is performed. this could be enforced by sensing the present flowing to the appliance with the assistance of a current detector as shown in Fig.3.This helps in any saving energy similarly because the appliances from any damage.

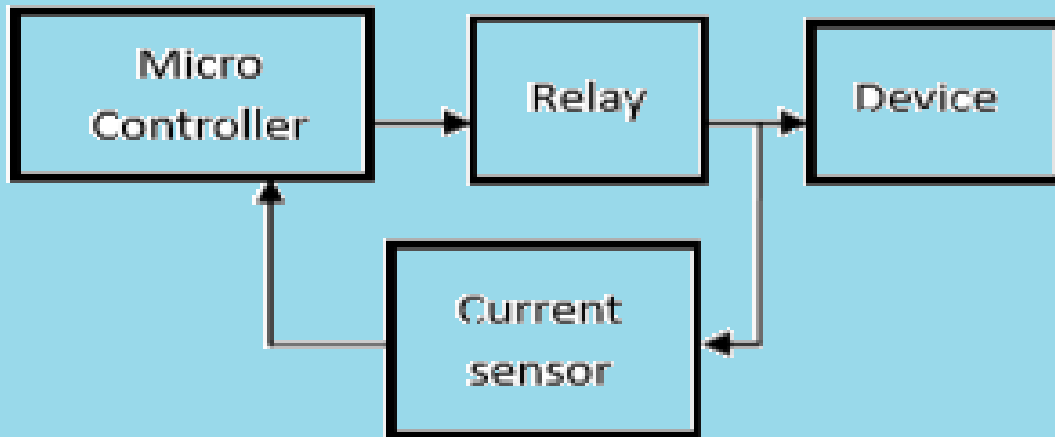


Fig. 3 Block diagram depicting the working of current sensor

When the intensity of the light is increased then brightness of the light is adjusted hence the power consumption is reduced. Simulation Result provide the relationship between light intensity and power consumption of the LED light are depicted in the given figure

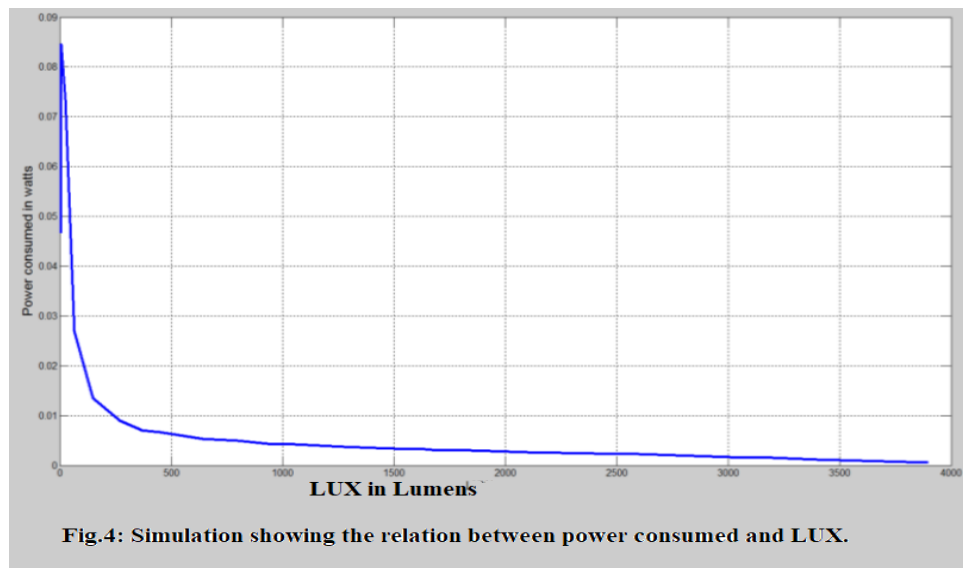


Fig.4: Simulation showing the relation between power consumed and LUX.

A user friendly atmosphere is made at home with the assistance of a LCD and input device to let the user to enter the beginning and the period that the device has got to stay switched ON. The same may be supplied with the assistance of the mobile application at the user finish. Hence associate LDR primarily based adaptive lighting

system is employed to avoid wasting power by varied the PWM for LED lamps instead of victimization fluorescent lamps with mounted power consumption.

Table 1:

Desired Lux Lumens	obtained Lux using LED(Lumens)	power consumed by LEDS(Watts)	obtained Lux using Tube light (Lumens)	Power consumed by Tube Light(Watts)
1057	1057	1.951	3450	36
1420	1420	2.82	3450	36
1700	1700	4.2	3450	36
2100	2100	5.41	3450	36
2600	2600	7.08	3450	36

Table 1: Power and LUX comparison between LED using LDR and Fluorescent Lamp

The results tabulated in Table 1 were obtained by inserting the LEDs at a distance of regarding two feet from the lamp and both are opposite to every alternative. Regarding sixty LEDs were utilized in the setup. the ability consumed by the LEDs at a Lux of 2600 Lumens is about seven watts whereas the ability consumed by a lamp is thirty six watts. This protects power at a rate of thirty three watts/hour.

The results illustrating the distinction in power consumption between the LED lamp and lamp determined with the assistance of check setup is shown in Fig.5. Once light-weight is employed for an amount of eight hours/day, a complete of 264watts/day are going to be saved. On a median, 7.92KW power is going to be saved for a month that prices regarding Rs.45/month. For a year, this sums up to a price of Rs.540. Hence, through the implementation of LDR alongside LEDs, energy consumption will with efficiency be handled.

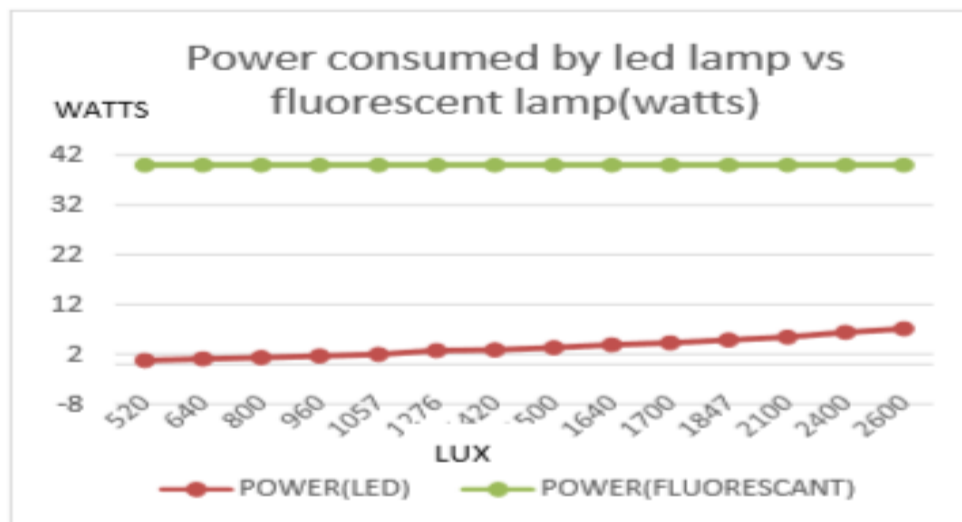


Fig.5 Results showing the comparison between LED and Fluorescent lamps

3.2 PROPOSED DESIGN FOR FAULT DETECTION

- To detect any fault in device and to know the environmental condition we use some sensors like Light ,Temperature, humidity, vibrations, current etc..
- All the devices work according to the person's demand.
- Laptop or computer continuously take the data from the sensors and manage the device according to the value of sensors.
- During the analysis of the sensor it found any problem or fault in the system then it send the feedback to the cloud server.
- User can change the settings according to the requirement and see our device functionality & how it is working.
We make an application where user, technician, supplier and vendor can do registration on it. All of them have to enter details regarding their service and service time etc.
- When data set is ready then we apply mining using cloud server.
- About any problem it mail or SMS to technician and send these message details to the owner also.
- By using cloud server we can connect wide range of user and it support multiuser functionality.
- Many users connect to cloud server via desktop, laptop or android devices.

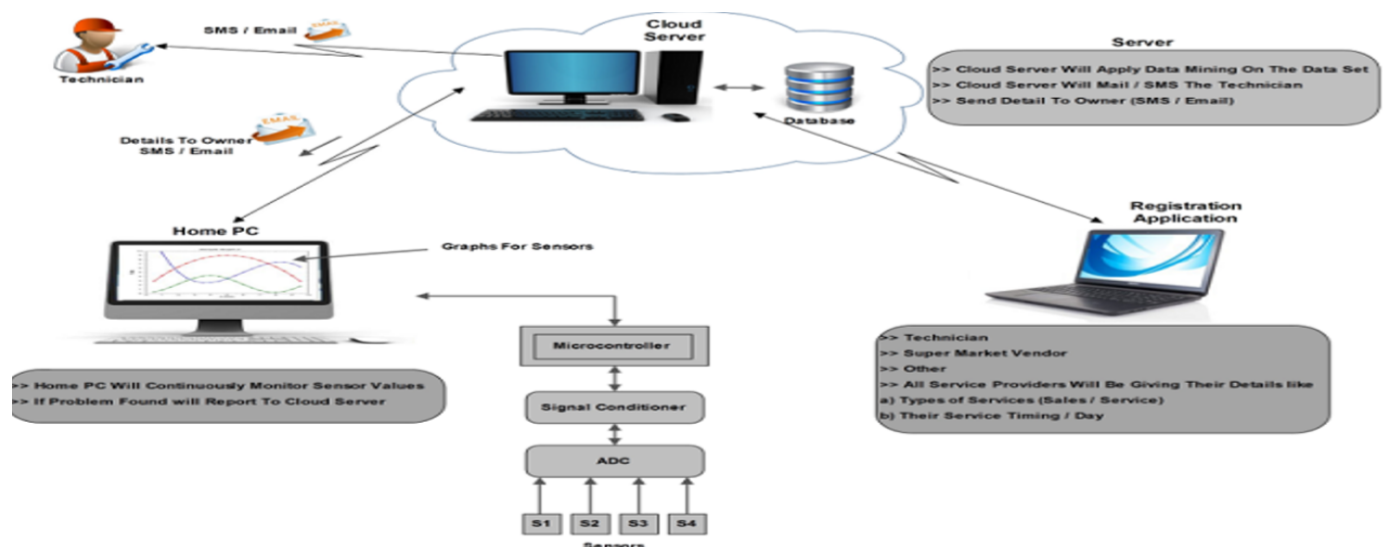


Fig. 6 Proposed Architecture

IV FUTURE WORK

The proposed work can further be improved in the future by developing an application that comprises a Speech Recognition System that mitigates the need for physical contact between the user and the smart phone.

V CONCLUSION

In this projected work, we've established a sensible system for controlling home appliances. Sensible devices are connected using net thereby increasing the dependableness of the product. we additionally examined the contribution of every answer towards up the potency and effectiveness of consumers" life style yet as of society normally. Potency in managing power has been improved by turning OFF the appliances throughout unnecessary times and accidents are avoided just in case of any nonfunctional of the device. Archetype of the projected sensible home systems is additionally performed. Sensible experiment was supervised to demonstrated that the developed archetype works well which the planned sensible smart home systems provide an excellent performance of appliances and considerable energy saving. Automating the appliances with the assistance of RTCs, LDRs and PIR is additionally done. We also define a system which not only monitor environmental conditions but also act according to the person requirement. It send message to the user when any type of error detect in device by SMS or send mail or Audio message and if user want then it can also send message to the supplier. By using this system we can eliminate human interaction, able to manage low price, versatile sensible home to regulate and resolve its errors with energy saving.

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AppendixA

Temperature sensors

By definition, “A device, used to measure amount of heat energy that allows to detect a physical change in temperature from a particular source and converts the data for a device or user, is known as a Temperature Sensor.”

These sensors have been deployed for a long time in a variety of devices. However, with the emergence of IoT, they have found more room to be present in an even greater number of devices.

Only a couple of years ago, their uses mostly included A/C control, refrigerators and similar devices used for environmental control. However, with the advent of the IoT world, they have found their role in manufacturing processes, agriculture and health industry. In the manufacturing process, many machines require specific environment temperature, as well as device temperature. With this kind of measurement, the manufacturing process can always remain optimal.

On the other hand, in agriculture, the temperature of soil is crucial for crop growth. This helps with the production of plants, maximizing the output.

Followed is some sub-categories of Temp Sensors:

Thermocouples: These are voltage devices that indicate temperature measuring with a change in voltage. As temperature goes up, the output voltage of the thermocouple rises.

Resistor temperature detectors (RTD): The resistance of the device is directly proportional to the temperature, increase in a positive direction when the temperature rises resistance going up.

Thermistors: It is a temperature sensitive resistor that changes its physical resistance with the change in temperature.

IC (Semiconductor): They are linear devices where the conductivity of the semiconductor increases linearly and it takes advantage of the variable resistance properties of semiconductor materials. It can provide a direct temperature reading in digital form, especially at low temperatures.

Infrared sensors: It detects temperature by intercepting a portion of emitted infrared energy of the object or substance, and sensing its intensity, can be used to measure temperature of solids and liquids only, Not possible to use it on gases because of their transparent nature.

Proximity sensor

A device that detects the presence or absence of a nearby object, or properties of that object, and converts it into signal which can be easily read by user or a simple electronic instrument without getting in contact with them.

Proximity sensors are largely used in the retail industry, as they can detect motion and the correlation between the customer and product they might be interested in. A user is immediately notified of discounts and special offers of nearby products.

Another big and quite an old use -case is vehicles. You are reversing your car and are alarmed about an obstacle while taking reverse, that's the work of proximity sensor.

They are also used for parking availability in places such as malls, stadiums or airports.

Following are some of the Proximity Sensors sub -categorised:

Inductive Sensors: Inductive proximity sensors are used for non -contact detection to find out the presence of metallic objects using electromagnetic field or a beam of electromagnetic radiation.

It can operate at higher speeds than mechanical switches and also seems more reliable because of its robustness.

Capacitive Sensors : Capacitive proximity sensors can detect both metallic as well as non - metallic targets. Nearly all other materials are dielectric different from air. It can be used to sense very small objects through a large portion of target. So, generally used in difficult and complicated applications.

Photoelectric Sensors : Photoelectric sensor is made up of light-sensitive parts and uses a beam of light to detect the presence or absence of an object. It is an ideal alternative of inductive sensors. And used for long distance sensing or to sense non -metal object.

Ultrasonic Sensors: Ultrasonic sensors are also used to detect the presence or to measure the distance of targets similar to radar or sonar. This makes a reliable solution for harsh and demanding conditions.

Pressure sensor

A pressure sensor is a device that senses pressure and converts it into an electric signal. Here, the amount depends upon the level of pressure applied.

There are plenty of devices that rely on liquid or other forms of pressure. These sensors make it possible to create IoT systems that monitor systems and devices that are pressure propelled. With any deviation from standard pressure range, the device notifies the system administrator about any problems that should be fixed.

Deployment of these sensors is not only very useful in manufacturing, but also in the maintenance of whole water systems and heating systems, as it is easy to detect any fluctuation or drops in pressure.

Water quality sensor

Water quality sensors are used to detect the water quality and Ion monitoring primarily in water distribution systems.

Water is practically used everywhere. These sensors play an important role as they monitor the quality of water for different purposes. They are used in a variety of industries.

Following is a list of the most common kind of water sensors in use.

Chlorine Residual Sensor: It measures chlorine residual (i.e. free chlorine, monochloramine & total chlorine) in water and most widely used as disinfectant because of its efficiency. Total organic carbon Sensor: TOC sensor is used to measure organic element in water.

Turbidity Sensor: Turbidity sensors measure suspended solids in water, typically it is used in river and stream gaging, wastewater and effluent measurement.

Conductivity Sensor: Conductivity measurements are carried out in industrial processes primarily to obtain information on total ionic concentrations (i.e. dissolved compounds) in water solutions.

pH Sensor: It is used to measure the pH level in the dissolved water, which indicates how

acidic or basic (alkaline) it is. **Oxygen-Reduction Potential Sensor :** The ORP measurement provides insights into the level of oxidation/reduction reactions occurring in the solution.

Smoke sensor

A smoke sensor is a device that senses smoke (airborne particulates & gases) and its level.

They have been in use for a long period of time. However, with the development of IoT, they are now even more effective, as they are plugged into a system that immediately notifies the user about any problem that occurs in different industries.

Smoke sensors are extensively used by manufacturing industry, HVAC, buildings and accommodation infra to detect fire and gas incidences. This serves to protect people working in dangerous environments, as the whole system is much more effective in comparison to the older ones.

Common Type of Smoke Sensors

Smoke sensors detect the presence of Smoke, Gases and Flame surrounding their field. It can be detected either optically or by the physical process or by the use of both the methods.

Optical smoke Sensor (Photoelectric): Optical smoke sensor used the light scatter principle trigger to occupants.

Ionization smoke Sensor: Ionization smoke sensor works on the principle of ionization, kind of chemistry to detect molecules causing a trigger alarm

IR sensors

An infrared sensor is a sensor which is used to sense certain characteristics of its surroundings by either emitting or detecting infrared radiation. It is also capable of measuring the heat being emitted by the objects.

They are now used in a variety of IoT projects, especially in Healthcare as they make monitoring of blood flow and blood pressure simple. They are even used in a wide array of regular smart devices such as smartwatches and smartphones as well. Other common use includes Home appliances & remote control, Breath analysis, Infrared vision (i.e. visualize heat leaks in electronics, monitor blood flow, art historians to see under layers of paint), wearable electronics, optical communication, non-contact based temperature measurements, Automotive blind-angle detection.

Their usage does not end there, they are also a great tool for ensuring high-level security in your home. Also, their application includes environment checks, as they can detect a variety of chemicals and heat leaks. They are going to play an important role in the smart home industry, as they have a wide-range of applications.

Image sensors

Image sensors are instruments which are used to convert optical images into electronic signals for displaying or storing files electronically.

The major use of image sensor is found in digital camera & modules, medical imaging and night vision equipment, thermal imaging devices, radar, sonar, media house, Biometric & IRIS devices.

Two main types of sensors are used in: CCD (charge-coupled device) and CMOS (complementary metal-oxide semiconductor) imagers. Although each type of sensor uses different technology to capture images, Both CCD and CMOS imagers use metal-oxide semiconductors, having the same degree of sensitivity to light, and no inherent quality difference

An average consumer would think that this is a regular camera, but even though this is not far from the truth, image sensors are connected with a wide range of different devices, making their functionality much better.

One of the best-known uses includes the car industry, in which imagery plays a very important role. With these sensors, the system can recognize signs, obstacles and many other things that a driver would generally notice on the road. They play a very important role in IoT industry, as they directly affect the progress of driverless cars.

They are also implemented in improved security systems, where images help capture details about the perpetrator.

In the retail industry, these sensors serve to collect data about customers, helping businesses get a better insight into who is actually visiting their store, race, gender, age are only some of the useful parameters that retail owners get by using these IoT sensors.

Motion detection sensors

A motion detector is an electronic device which is used to detect the physical movement(motion) in a given area and it transforms motion into an electric signal ; motion of any object or motion of human beings

Motion detection plays an important role in the security industry. Businesses utilize these sensors in areas where no movement should be detected at all times, and it is easy to notice anybody's presence with these sensors installed. These are primarily used for intrusion detection systems, Automatic door control, Boom Barrier, Smart Camera (i.e motion based capture/video recording), Toll plaza, Automatic parking systems, Automated sinks/toilet flusher, Hand dryers, energy management systems(i.e. Automated lighting, AC, Fan, Appliances control) etc.

On the other hand, these sensors can also decipher different types of movements, making them useful in some industries where a customer can communicate with the system by waving a hand or by performing a similar action. For example, someone can wave to a sensor in the retail store to request assistance with making the right purchase decision.

Even though their primary use is correlated with the security industry, as the technology advances, the number of possible applications of these sensors is only going to grow.

Following are key motion sensor types widely used:
Passive Infrared (PIR) : It Detects body heat (infrared energy) and the most widely used motion sensor in home security systems.

Ultrasonic : Sends out pulses of ultrasonic waves and measures the reflection off a moving object By tracking the speed of sound waves.

Microwave : Sends out radio wave pulses and measures the reflection off a moving object. They cover a larger area than infrared & ultrasonic sensors, but they are vulnerable to electrical interference and more expensive.

Humidity sensors

Humidity is defined as the amount of water vapour in an atmosphere of air or other gases. The most commonly used terms are “Relative Humidity (RH)

These sensors usually follow the use of temperature sensors, as many manufacturing processes require perfect working conditions. Through measuring humidity, you can ensure that the whole process runs smoothly, and when there is any sudden change, action can be taken immediately, as sensors detect the change almost instantaneously. Their applications and use can be found in Industrial & residential domain for heating, ventilating, and air conditioning systems control. They can also be found in Automotive, museums, industrial spaces and greenhouses , meteorology stations,Paint and coatings industries, hospitals & pharma industries to protect medicines

Optical sensors

A sensor which measures the physical quantity of light rays and convert it into electrical signal which can be easily readable by user or an electronic instrument/device is called optical sensor. Optical sensors are loved by IoT experts, as they are practical for measuring different things simultaneously. The technology behind this sensor allows it to monitor electromagnetic energy, which includes, electricity, light and so on.

Due to this fact, these sensors have found use in healthcare, environment monitoring, energy, aerospace and many more industries. With their presence oil companies, pharmaceutical companies and mining companies are in a much better position to track environmental changes while keeping their employees safest

Their main use can be found in Ambient light detection, digital optical switches, optical fibers communications, due to Electrical isolation best suited for oil and gas applications, civil and

transportation fields, High speed network systems, elevator door control, assembly line part counters and safety systems.

Following are key type of optical sensors:

Photo detector: It uses light sensitive semiconductor materials like photocells, photodiodes

or phototransistors to work as photo detector

Fiber Optics: Fibers optics carry no current, So its immune to electrical & electromagnetic interference and even in damaged condition no sparking or shock hazard happens.

Pyrometer: It estimates the temperature of an object by sensing the color of the light and Objects radiate light according to their temperature and produce same colors at same temperature.

Proximity & Infrared: Proximity use light to sense objects nearby and Infrared are used where visible light would be inconvenient.

Appendix B

Node MCU

NodeMCU is an open source IoT platform. Which includes firmware which runs on the ESP8266 Wi-Fi Module from Espressif Systems, and hardware which is based on the ESP-12 module. The term “NodeMCU” by default refers to the firmware rather than the dev kits. NodeMCU firmware was developed so that AT commands can be replaced with Lua scripting making the life of developers easier. So it would be redundant to use AT commands again in NodeMCU. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif.

ESP8266 Feature:

- Open-source
- Interactive
- Programmable
- Low cost
- Simple
- Smart
- WI-FI enabled
- USB-TTL included
- Plug & Play

Advantages

- Low energy consumption
- Integrated support for WIFI network
- Reduced size of the board
- Low Cost

Disadvantages

- Need to learn a new language and IDE
- Less pinout

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