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HOME AUTOMATION USING IOT

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***Abstract* –Internet of Things (IoT) is a concept that envisions all objects around us as part of internet. As a part of IoTs, serious concerns are raised over the connectivity of devices. Once the devices are connected together, they enable more smart processes that supports 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. This work also provides a means of automation through smart lamp system and scheduling of the appliances on daily or weekly basis which helps in smoothening the load curve. It is developed in such a way that the user can access the appliances from a remote place using internet through smart phone and cloud services. This paper shows the different perspective of internet which gives an insight into the field of automation.**

Keywords: Internet of Things, Smart Home, Home energy management.

I.INTRODUCTION

Today, over two billion people around the world use Internet for browsing Web, sending and receiving emails, accessing multimedia content and services, playing games, social networking applications and many other tasks. From the saying, ‘‘A world where things can automatically communicate to computers and each other providing services to the benefit of the human kind”, it is predictable that, within the next decade, Internet will exist as a seamless tool for classic networks and networked objects. The Internet of Things (IoT) is a network of networks where a massive number of objects/things/sensors/devices are connected through communication and information infrastructure to provide a value-added service[10]. The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service”[10][11]. The innovation of IoT will be enabled by the embedding of electronics into everyday physical objects, making them ‘‘smart’’ and letting them integrate and operate within the physical infrastructure.

Over the last thirty years, energy demand has shown a huge increase in residential as well as industrial sectors. Electricity demand in EU-27 increased by 70% between 1980 and 2008 [1]. Therefore, creating intelligent home energy management systems which are able to save energy while meeting user preferences has become an interesting research topic. Due to their relatively low-cost, wireless nature, flexibility and easy deployment, wireless sensor networks represent a promising technology for providing such systems. This ability to control usage is called as Demand Side Management (DSM).Thus the system furnishes the need for a heterogeneous Information fusion technology of IoT in the smart home [8]. DSM plays a major role in reducing the electricity usage cost by altering the system load shape [12].
In the study of dynamic DSM, different techniques and algorithms have been proposed, where the basic idea has been to reduce the energy bill corresponding to the time-of-use(TOU) tariffs incentives offered by the utility [13].In the study of the appliance scheduling, the smart home aims to offer the appropriate services to the user based on resident’s lifestyle[9].

IoT builds on three pillars, related to the ability of smart objects: (i)to be identifiable (ii)to communicate and (iii)to interact–either among themselves, building networks of interconnected objects, or with end-users. The Three characteristics of IoT are (i) Anything communicates: Smart things have the ability to wirelessly communicate among themselves and form networks of interconnected objects, (ii)Anything identifiable: Smart things are identified with a digital name. Relationships among things can be specified in the digital domain whenever physical interconnection cannot be established and (iii)Anything interacts: Smart things can interact with the local environment through sensing and actuation capabilities whenever present[11].

This paper is organised into VI sections. Section II describes the objective of the proposed smart home system. The objective has been explained in terms of 3 sectors namely automation, monitoring and control. Section III describes the working of the smart home system and its efficient performance in saving energy compared to the existing appliances. Section IV discusses the cloud storage used in this work. Conclusions and Acknowledgement is in Section V and VI respectively.

II. THE PROPOSED SMART HOME SYSTEM

In our day-to-day life, situation comes where it is difficult to control the home appliances in case when no one is available at home or when the user is far away from home or when the user leaves home forgetting to switch off some appliances which leads to unnecessary wastage of power and also may lead to accidents. Sometimes, one may also want to monitor the status of the household appliances, staying away from home. In all the above cases the presence of the user is mandatory to monitor and control the appliances which are not possible 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.

A. AUTOMATION SYSTEM

The appliances are classified according to the nature of their operation / control. Appliances like Geyser and Toaster have to be switched ON/OFF at particular time intervals. For efficient utilization of the appliance, the device has to be switched ON and OFF appropriately. An RTC based system can performs the control precisely which enhances the appliance's life and saves the power. When the match takes place between the loaded time and the real time, the controller turns ON the appliance and similarly when the duration gets over, the controller turns OFF the appliance. Thus the appliances are controlled as per the time schedule defined by the user.

Some appliances need to work only during human presence. In this proposed work, human movements are detected using PIR sensor and the necessary automation is done. The desired light intensity in the room can be established using Smart Lamp. The lamp must switch ON and OFF only during human presence which is implemented using motion sensor based lighting system. This lighting system's performance is increased by switching them only when there is no sufficient light and the light will not switch ON during daytime. This is done by including LDR in the system. The desired ambient light intensity is set by varying the brightness of the lamp using PWM techniques which helps in energy saving. By proper positioning of LDR, the light intensity of the room can be maintained as shown in Fig 1.

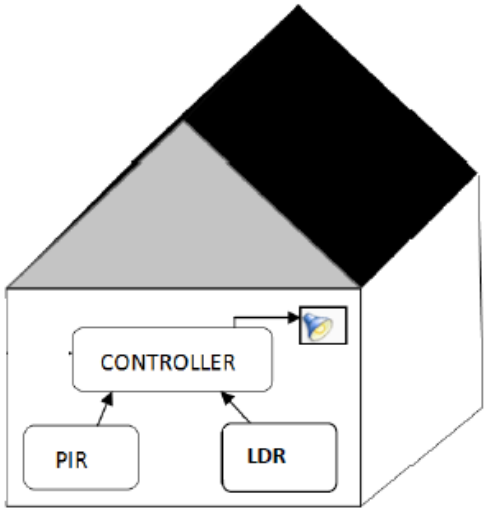


Fig. 1 Block diagram describing Smart Lamp control using LDR

B. MONITORING SYSTEM

After leaving home few metres away, the user may have doubts regarding the status of the appliances at home. In such cases, returning back to our home and checking for its status will not be difficult. When the distance extends to about few miles, returning back becomes tedious. In case of emergency, the user has to return, which disrupts the user's routine. The appliance may also be left as such, which may result in severe damage to the device, in case of motor or geyser. These cons have been overcome by remote monitoring of the home appliances.

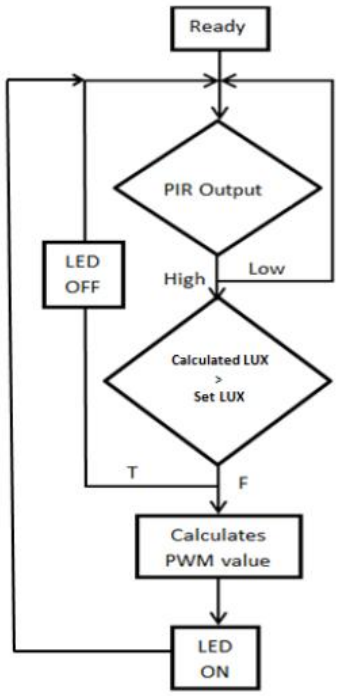


Fig.2 Flow chart on Status monitoring

Thus the PIR sensor installed at the specific points at the home senses the location of the user at the home abiding to the location awareness system [9] which makes use of a floor mapping algorithm for a single user. The intended usage of the PIR sensor is to detect the human presence. The Light Dependant Resistor(LDR) placed at suitable locations determines Luminance intensity of the place at the location and sends the value to the control system for further interpretation. Thus LDR enhances the feature cited in [3] by making use of sensors to detect the environment factors and adjust to the same desired by the user. The smart plug associates to the work represented in [14].These smart plugs enhance the feature of scheduling the devices as well as controlling the power consumption of lamps such as LED lamps.

The device status has to be monitored periodically and when the user sends a request, the status of the appliance is presented. The status monitoring of the appliances can be realized with the help of a flow chart shown in Fig.2.When the device is in standby mode, as soon as the PIR sensor detects the

human presence the controller calculates the room luminance value and compares with the prefixed value. Based on the results, the lamp is either switched ON with the given brightness or switched OFF and the cycle continues.

C. CONTROL SYSTEM

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	1.9512	3450	40
1420	1420	2.829	3450	40
1700	1700	4.27	3450	40
2100	2100	5.4173	3450	40
2600	2600	7.0896	3450	40

Remote controlling of the appliances can also be performed. When the user sends a command, depending on the command received, the appliances can be switched ON and OFF accordingly. Sometimes there arises a discrepancy where no device has been connected or fault in the existing device. In such case, an open circuit prevails. With the help of a current sensing mechanism, fault detection can be performed. This can be implemented by sensing the current flowing to the appliance with the help of a current sensor as shown in Fig.3.This helps in further saving energy as well as the appliances from further damage.

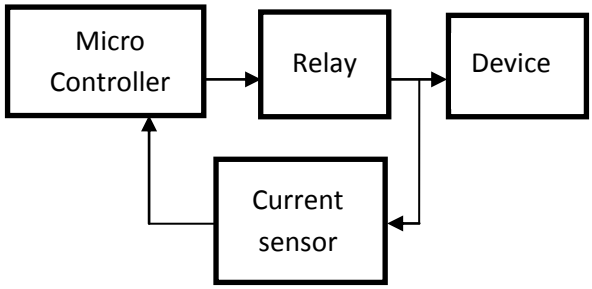
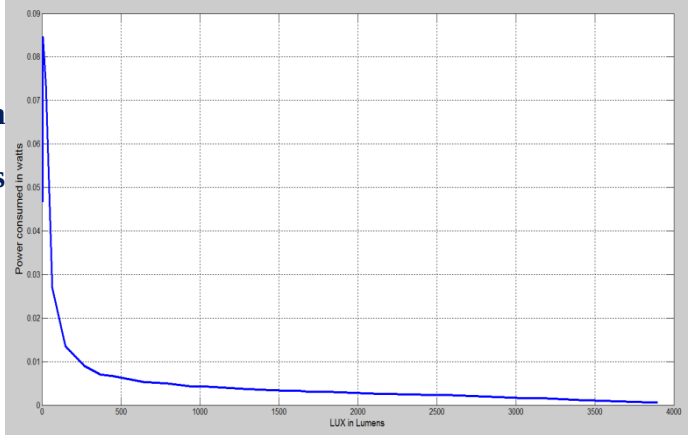


Fig.3 Block diagram depicting the working of current sensor

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

As the light intensity increases, the brightness of the lights are adjusted and hence the power consumption is reduced.The simulation results providing the relation between the light intensity and the power consumption of the LED lights



aredepicted in the Fig.4. A user friendly environment is created at home with the help of a LCD and Keypad to let the user to enter the starting time and the duration for which the device has to remain switched ON.The same can be provided with the help of the mobile application at the user end.Hence an LDR based adaptive lighting system is used to save power by varying the PWM for LED lamps rather than using fluorescent lamps with fixed power consumption.

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

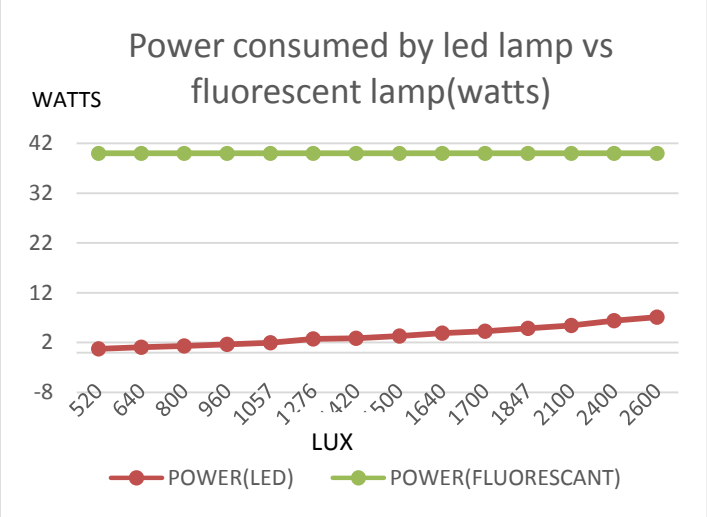


Fig.5 Results showing the comparison between LED and Fluorescent lamps

The results tabulated in Table 1were obtained by placing the LEDs at a distance of about 2 feet from the fluorescent lamp and both are opposite to each other. About 60 LEDs were used in the setup.The power consumed by the LEDs at a LUX of 2600 Lumens is approximately 7 watts whereas the power consumed by a fluorescent lamp is 40 watts. This saves power at a rate of 33 watts/hour.The results illustrating the difference in power consumption between the LED lamp and Fluorescent lamp observed with the help of test setup is shown in

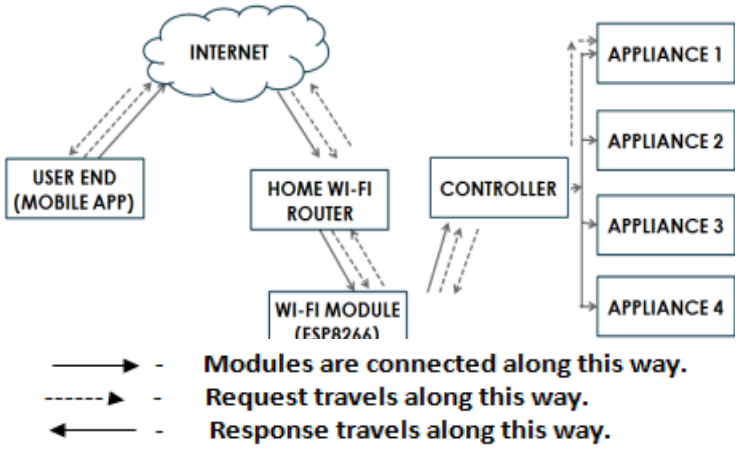


Fig.6 Block diagram depicting the proposed smart home system

Fig.5. When light is used for a period of 8 hours/day, a total of 264watts/day will be saved. On an average, 7.92KW power will be saved for a month which costs about Rs.45/month. For a year, this sums up to a cost of Rs.540. Hence, through the implementation of LDR along with LEDs, energy consumption can efficiently be handled.

III.IOT IN SMART HOME

As already stated, with the usage of motion sensor, brightness sensor, and LEDs, a smart lamp setup have been established along with smart plug installations for the appliances in the home. The installations are connected with the main controller unit whose accessibility can further enhanced by incorporating IoT features into the Home control system. Thus an internet connection is established for the Home control system through the Wi-Fi module [15]. The IP address of the internet

connection is stored in the cloud storage application and the user IP address also gets stored. When the system intends to upload data into the cloud, it sends the data through the Wi-Fi module to the cloud through HTTP request commands. In the similar way, user sends the commands to the cloud which shall then be re-routed to the home system through the home Wi-Fi router and the Wi-Fi module. Depending on the message received, the controller responds to the query or it accesses the intended appliances. The response is also sent back to the user through the Wi-Fi module in the opposite direction as shown in the Fig.6. For instance, when the user sends a command to turn ON a particular device and if the device has already been turned ON, then the controller sends a message to the user that the device is already ON. Thus the redundancy check can be performed with feedback and the fault detection also gets notified by the Home system instantaneously. User can also check the power consumption of the devices. Thus when the user sends the command to enquire the power consumption and cost, the results are displayed to the user. The working of a smart home system is depicted in Fig.6.

Security becomes a big issue in Internet based control. Because who ever knows the IP address of the user's internet can obtain an access to the smart home system.This may lead to the misuse of appliances in the absense of the user which can be avoided by a password protection. The user can set a password thereby avoiding unauthorized usage. Incase if anyone enters a wrong password, then the user gets notified about the illegal entry.

IV. THING SPEAK APPLICATION

Thing Speak is an open source Internet of Things application and API to store and retrieve data from the devices using the HTTP protocol over the internet. Thus Thing Speak enables for sensor data logging, location tracking and appliance access in case of Smart Homes. Thing Speak cloud storage provides for secure means to store and retrieve data by providing 10 characters read and write keys and is also password protected. It acts as a cloud storage for the data being logged by the user for accessing the appliances at home and also stores the sensor readings and the statuses of the appliances at home through the internet. The sensor readings are logged into the cloud intermittently while when the user sends a command to access the appliance or to monitor the status of the appliance, the command is being read from the cloud storage by the home control system and the appropriate response is generated which gets uploaded into the cloud for user reference. The operation status of the Air Conditioner logged into the cloud storage channel is presented in the Fig.7 along with the Luminance intensity of the living room being read from the LDR and calibrated to give the output in terms of Luminance intensity(Lux) as depicted in Fig.8.

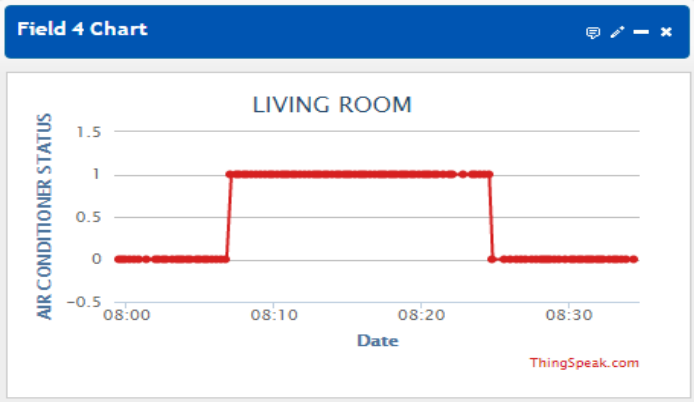


Fig.7 Status of the Air conditioner logged into the cloud channel

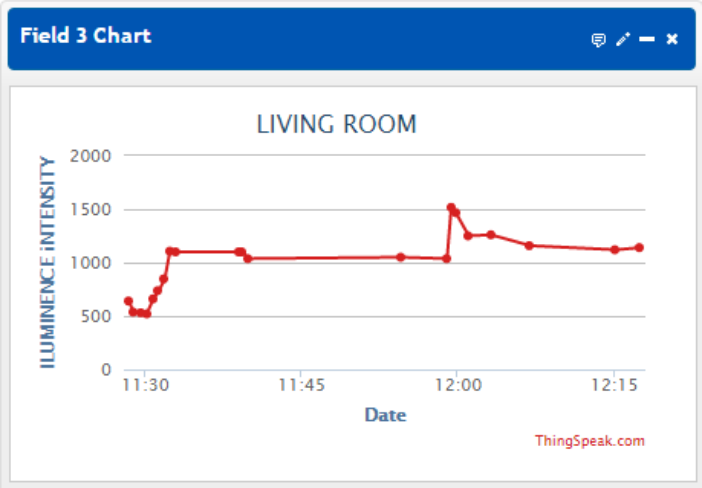


Fig.8 Luminence intensity of living room logged into the cloud

V. CONCLUSIONS

In this proposed work, we have established a smart system for controlling home appliances. Smart devices have been connected using internet thereby increasing the reliability of the product. We also examined the contribution of each solution towards improving the efficiency and effectiveness of consumers' lifestyle as well as of society in general. Efficiency in managing power has been improved by turning OFF the appliances during unneccessary times and accidents are avoided in case of any malfunctioning of the device. A prototype of the proposed smart home control system is also implemented. Practical experiments were conducted to demonstrate that the developed prototype works well and that the proposed smart home control system provides an outstanding performance of appliances and considerable energy saving. Automating the appliances with the help of RTCs, LDRs and PIR is also done.

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. The future work also seeks to investigate the transfer of multimedia messages.

VI. ACKNOWLEDGEMENT

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