IOT Home Automation with PIR Sensor Security using ESP8266 WI-FI Chip and GSM

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Abstract— **Internet of Things is widely used in connecting the devices to the digital world for secured and flexible data access. For achieving the above objective, we shall have a proposal to automate the devices (On or Off) with relay control by accessing the mobile applications using ESP 8266 Wi-Fi module (NODE MCU). This also helps to provide secured transmission. In this process, the devices are also monitored by sending communication to LPC 2148 microcontroller where GSM (Global System for Mobile Communication) will provide alert message and call from module to mobile about the information of the appliance. This information is also displayed as status in LCD 16X2 display. The PIR (Passive Infrared Radiation) sensor which is a human sensor is used to detect the movement by observing the human radiation. Once the movement of stranger is sensed, the status is sent to mobile and LCD display. Home security is thus provided nevertheless of human absence by getting call from the sensor.**

Key words— Automation, Embedded System, GSM, IoT, Mobile Application, Security

I. INTRODUCTION

The IoT (Internet of Things) is the network of physical devices, vehicles and other things which is embedded with electronics, software, sensors, actuators and network connectivity by collection and exchange of data [6],[8]. This IoT allows things to be sensed and actuated from remote place over the network infrastructure. This creates an opportunity for computerized world which results in improved efficiency, accuracy and economically beneficial. Instance of cyber security system is made when IoT is augmented with sensors and actuators to have smart technology[6].

IoT is the key technology for shaping the evolution of internet [9]. The light bulbs are used in the proposed system with the connectivity of relays, ESP8266 Node MCU (Microcontroller Unit) which is a Wi-Fi chip, LPC 2148 microcontroller, LCD (Liquid Crystal Display) 16X2 display, GSM (Global System for Mobile communication) and PIR (Passive Infrared Radiation) sensor. These management for bulbs and sensors are detected and gathered as an alert in LCD display and remotely accessed in mobile application [7], [13]. This shows the responsibility of network layer for connectivity, transmitting and processing sensor data where this mobile application is responsible for deploying IoT [11], [12].

In physical layer, PIR sensor is used for sensing and gathering the information about the human presence in the environment. This also carries the perception layer [11].

Each characteristics encompasses set of capabilities such as, intelligence as interaction between devices, connectivity of light bulbs, relay, microcontroller and PIR sensor with mobile application, enables interactivity with people and the environment, detect and sense the data collection from lights bulbs, Wi-Fi chip and sensor, enhance the security to reduce energy and maintenance, dynamic nature as temperature of people and the environment and also heterogeneity as wide variety of network connectivity [15]-[19], [21].

This shows the pivotal feature, where the network used to communicate between devices of IoT installation whereas we introduced short range wireless technology by fulfilling the Wi-Fi Direct for peer to peer communication, eliminating the need for the access point [20].

By framing IoT design with these characteristics, multi-discipline teams can work across their domains which improves efficiency and saves time with automation of daily tasks leads to better monitoring of lights and detecting the environment by the change in temperature using PIR sensors[22]. Further, survey for the home automation and devices for automation and security is done in Section II. Section III describes the problem in existing system and Section IV describes the proposed system. The hardware and software requirements are determined in Section V. The implementation is made and results obtained are mentioned in Section VI. Finally, Section VII enumerates the conclusion for the proposed system and future enhancement.

II. LITERATURE SURVEY

A. An Overview of Home Automation Systems

An overview of current and emerging home automation systems consists of a microcontroller for controlling and monitoring the home appliances by sending a text message from the mobile phone. Using Bluetooth, flexible and low cost system is made which results in drawback in short range of wireless network [1].

B. Secure and Efficient Protocol for Route optimization in PMIPv6 Based Smart Home IoT (SH-IOT) networks

In SH-IOT, PMIPv6 (Proxy Mobile Internet Protocol version 6) was used, considered as core solution to handle extreme mobility. But it cannot support secure route optimization for SH-IOT services, where mobile nodes communicate with IoT devices. By this, secure protocol was introduced with pre-established trust relationship between gateway and PMIPv6. They made reduction in handover latency, end to end delay and packet loss, provided with high throughput and transmission rate. So, it does not send any SMS (Short Message Service) from the corresponding appliances to the user [2].

C. GSM Based Home Security System Using PIR Sensor

Securing a home is an indispensable task due to burglary incidents. In today's context, most people chose the home security system for protecting the home when they are out of home [3].

That leads to introduction of PIR sensor which detects the infrared rays that is heat energy emitted from human body. That rays are not visible to our eyes but can be detected by electronic sensors. Microcontroller was used to control the appliances and the GSM was used here, for sending SMS (Short Message Service) and calling purposes. Here, there was no automation and alert (ON or OFF) sent from the appliances [3].

D. Home Automation on ESP8266

Smart homes refer to energy efficient, time saving and thus reduce the human efforts. ESP8266 chip is accessed to cloud platforms which facilitates to reduce the rental cost of server, efficiency and inexpensive and thus acts as the key objective for content providers. Thus, the challenges in reducing the cost of accessing the cloud platforms were addressed earlier. It acquires low power consumption and low cost for accessing the cloud with ESP8266. But there was no intimation to mobile application with respect to security [4].

III. PROBLEM STATEMENT

"Smart" is becoming a common and popular now-a- days. We are coming through the smart TV, smart phone and so on. This provides us the interactivity and autonomously managing the appliances freely and smartly that is to control remotely using ESP 8266 (Wi-Fi chip) at anytime and anywhere.

By the survey, we found that there is no status and no alert message and call for the automation of appliances. And also, security is not maintained, when the owner is out of home. So, there is no notification about the culprit entering the home in owner's absence. This shows vulnerability and insecurity in the owner's absence.

IV. PROPOSED SYSTEM

By the survey about smart things, automation and security, we have selected a light bulbs for the enhanced work for smart home automation. The main idea behind the implementation is to propose the IoT based Smart Home automated and secured system. The mobile application is invoked by IP address generated by Wi-Fi chip for the specified contact number where in automating the light bulbs and detecting the human temperature by the PIR sensor is acclaimed.

The monitoring of the light bulbs is sent to LPC2148 microcontroller where GSM will provide alert message and call from module to mobile about the device's information.
The PIR sensor is used to protect home in the absence of owner by detecting the radiation of stranger's heat temperature. So, immediately this sensor will send the alert message and automatic call is also made to the specified contact number. Simultaneously, this status about automation and detection of radiation is displayed in LCD display.

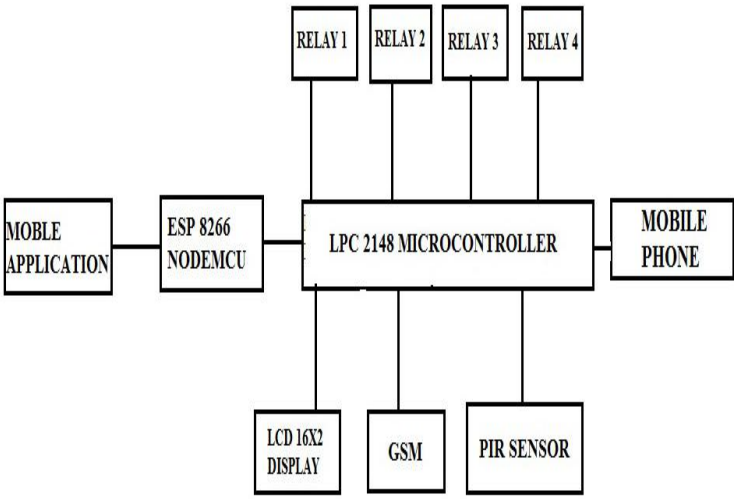

Fig. 1 System Architecture

Hence, the home system is automated remotely at anytime and anywhere with the secured interactivity by the owner. And also, alert during automation and radiation detection is done. So, this mechanism shows the smart home automation here.

V. SYSTEM REQUIREMENTS

A. Node MCU ESP8266

NodeMCU is an open source IoT platform which includes firmware runs on ESP8266 Wi-Fi module. 3V – 5V is provided for utilizing the power and can use Arduino IDE using Arduino Cpp code. This firmware uses Lua scripting commands instead of AT commands. Features of this NodeMCU ESP8266 are interactive, programmable, low cost, simple, smart, Wi-Fi enabled, USB TTL included and plug and play. Using Wi-Fi chip, IP address is allotted automatically to access the specified mobile application [26].

B. LPC 2148 Microcontroller

This IC (Integrated Circuit) is pre-loaded with many inbuilt peripherals making more efficient and reliable. Specifications included are

- 8 to 40 kB of on-chip static RAM
- 32 to 512 kB of on-chip flash memory
- 128 bit wide interface or accelerator
- Single flash sector or full chip erase in 400 ms and programming of 256 bytes in ms
- Embedded ICE RT and Trace interfaces offer real time debugging with Real time monitor software
- USB 2.0 full speed compliant device controller with 2kB of endpoint RAM (Random Access Memory)
- 1 or 2 10 bit A/D converters
- 1 10 bit D/A converter
- Two 32 bit timers, PWM unit and watchdog
- Low power real time clock with 32 kHz clock input
- 2 UARTs, 2 fast I2C bus, SPI and SPP with buffering and variable data length capabilities
- Vectored interrupt controller
- Up to 45 of 5V tolerant fast general purpose I/O pins

- Up to 9 edge or level sensitive external interrupt pins
- On-chip integrated oscillator
- Power saving modes include idle and power down
- Individual enable /disable od peripheral functions
- Processor wake up from Power down mode
- Single power supply chip with POR (Power-On Reset) and BOD (Brown Out Detect) circuits [27].

C. Low Level 5V 4 Channel Relay Interface Board

Each channel needs 15 to 20 mA current. It is used to control various appliances and equipment with large current which is equipped with high current relays. That work under AC250V 10A or DC30V 10A where it can be controlled directly by microcontroller.

TESTING SETUP: To signal terminal of the 4-channel relay, when a low level is supplied, the LED (Light Emitting Diode) at the output terminal will turn ON. Otherwise, it will turn off. If a periodic high and low level is supplied to the signal terminal, you can see the LED will cycle between on and off [28].

D. GSM

It is a digital mobile telephony system which uses a variation of Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). It digitizes and compresses data, then sends via channel at each own time slot which is operated at either the 900 MHz or 1800 MHz frequency band. A GSM network components includes

A Mobile Station: It is just a mobile phone which consists of the transceiver, the display and the processor. It can be controlled by a SIM card which is operated over a network.

Base Station Subsystem: An interface is made between the mobile station and the network subsystem. It include

- Base Transceiver Station which contains the radio transceivers and handles the protocols for mobile communication.
- Base Station Controller which controls the Base Transceiver station and acts as an interface between the mobile station and mobile switching centre.

Network Subsystem: Network connection is made in mobile stations. It consists of

- Home Location Register and the Visitor Location Register which provides the call routing and roaming
- Equipment Identity Register which maintains an account of all the mobile equipment where each mobile is identified by its own IMEI (International Mobile Equipment Identity) number [29].

E. PIR Sensor

PIR sensor senses a human being moving within approximately 10m distance from the sensor. But the actual detection range is between 5m and 12m. It is made of a pyro electric sensor which detects various levels of infrared radiation. They are incredible, flat control and minimal effort with wide lens range. There are three pins where one pin will be ground, another pin will be signal and the last pin will be power with up to 5V supply [30].

On a single I/O pin, the motion can be detected by checking for a high signal. Once the sensor detects radiation, the output will remain high for a couple of seconds and then it return low. If motion continues, the output will be made in cycle [30].

In presence of human IR radiations, the sensor detects the radiations and converts it directly to electrical pulses, which is fed to the inverter circuit. Based on the input received, it controls the motor driver and then controls the motion of the motor [30].

F. LCD 16X2 Display

LCD modules are used in most embedded projects, the reason being its cheap price, availability and programmer friendly. This displays in our day to day life to provide the information [31].

G. Arduino IDE

The Arduino IDE supports the languages C using special rules of code structuring. It supplies a software library which provides common input and output procedures for wiring projects. It requires only two basic functions that is for starting the sketch and the main program loop. They are compiled and linked with a program stub main() into an executable cyclic executive program. Then, it employs the program to convert the executable code into a text file in hexadecimal encoding. That is text file is loaded into the microcontroller by a loader program in the board's firmware [32].

H. Keil Micro Vision

Keil Micro Vision is a free software which solves many of the pain points for an embedded program developer. This software is an Integrated Development Environment (IDE), which integrated a text editor to write programs, a compiler and it will convert your source code to hex files too [33].

To start working with Keil Micro Vision, this can be used for

- Writing programs in C language
- Compiling and debugging program
- Creating Hex file and testing the program without real Hardware [33].

I. Flash Magic

Flash Magic is a Windows software from the Embedded Systems that allows easy access to all the ISP features provided by the devices. These features include

- Erasing the Flash
- Programming the Flash memory
- Modifying the Boot Vector and Status Byte
- Reading and performing a blank check on a section of Flash memory
- Reading the signature byte
- Reading and writing the security bits
- A new baud rate is directed to load

- Sending commands to keep device in boot loader mode [33].

VI. IMPLEMENTATION AND RESULTS

Keil Micro Vision and Arduino IDE are installed and library file is added. HTML and C code is added in Keil Micro Vision and Arduino where specific Wi-Fi ID and password is maintained in the code. A physical setup using the lights, LPC2148 Microcontroller, ESP 8266, GSM, PIR sensor, LCD display and relay is made. The C code is embedded in the microcontroller and compiled for the execution. By making a google search for IP address generated by Wi-Fi chip for the specified ID and password which is used to open the mobile application and make an access here.

Fig. 2 Mobile Application by accessing the IP address

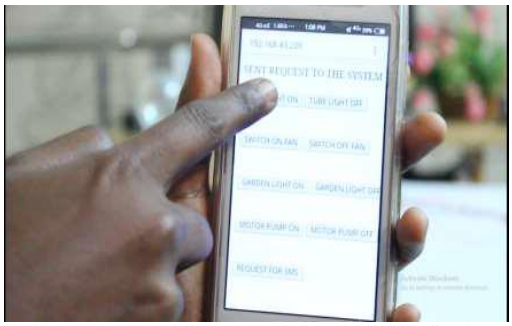
Fig. 3 Turn ON Light1 remotely in Mobile Application


Fig. 4 Light1 is ON after remote access via Mobile Application

Fig. 5 Status of lights in LCD 16X2 display

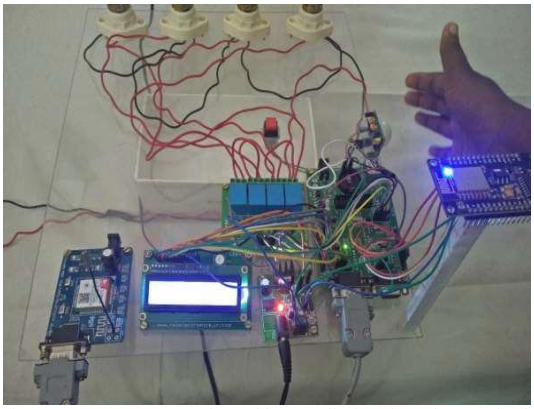
Fig. 6 PIR sensor Detection of heat radiation from human body

Fig. 7 Status for human presence in home

Fig. 8 Message alert obtained in specified contact number

- Light bulbs are turned ON/OFF using mobile application remotely. This alert is intimated as SMS to the specified contact number. And the LCD displays the status of each light bulb.
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- When the owner is leaving the home, he should turn on the PIR sensor. By that, if any stranger is accessing the home in the owner's absence, it will sense the heat radiation. So, this sends alert SMS and call is made to the contact number and also displays the status in LCD Display.

VII. CONCLUSION AND FUTURE ENHANCEMENT

The proposed system is designed and implemented by interfacing ESP 8266 NODEMCU, LPC 2148 Microcontroller, Power divider, GSM, LCD 16X2, Relays, PIR Sensor. The automation of appliances has been performed and the alert message (status) and call is send to mobile and LCD Display. The human radiations (stranger) are detected using PIR Sensor and similarly alert message and call is send to mobile.

Further, we can display readings of electricity consumed in LCD display. By this, we can know the electricity used till the date and we can reduce our consumption rate. When we reduce our usage of electricity, we can save electricity for our future generation.

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Pavithra M, pursuing Master of Technology in Network and Information Security, Department Of Computer Science, Pondicherry University, India. I have started my career in networking domain with respect to their security concern. And also, I have completed a project in Internet of Things which includes both hardware and software. This work made me to look forward and to work in cyber security where I wish to see myself with fulfilled heart by doing further works respectively.