ISSN:2348-2079

Volume-7 Issue-1

International Journal of Intellectual Advancements and Research in Engineering Computations

Lights flash in your garage when someone rings the doorbell

S.Natarajan[1], M.Vignesh[2], Sonu Kumar[2], Vignesh S[2], Jaibalaji.M[2]

[1]Assistant Professor, EEE Department, Vel Tech, Avadi, Alamthi Road, Chennai 600062, Tamilnadu, India.

[2]UG Students, EEE Department, Vel Tech, Avadi, Alamthi Road, Chennai 600062, Tamilnadu, India.

ABSTRACT

This motivated us to develop a new solution which controls some home appliances like light, fan, door cartons, energy consumption, and smoke sensor temperature sensor using raspberry pi. The proposed solution uses the sensor and detects the presence or absence of a human object in the housework accordingly. Our solution also provides information about the energy consumed by the house owner regularly in the form of IOT. Also, it checks, room temperature and to control smoke in house with help of IOT. The proposed solution is deployed and tested for various conditions. Finally, in this paper, the working model of our proposed solution is developed as a prototype and explained as a working model.

Keywords: Smart Home, Iot, Home Automation; Smoke Sensor Raspberry Pi

INTRODUCTION

The Internet of Things [1] is the interconnection of the various computing devices embedded in the daily appliances to the internet, thus enabling them to communicate with each other. This enhances the end users quality of life and to improve efficiency and sustainability in the day to day activities. In shortly, many of the smart devices will be communicating over IoT [2] The analyst firm Gartner predicts that by 2020 there will be more than 20 billion devices connected to the Internet of Things. As we will approach that value, it is predicted that around $6 billion will flow into the various domains of IoT like application development, device hardware, system integration, data storage, security, and connectivity. Nearly $6 Trillion will be spent on IoT solutions by 2025.

We are living in a world that is rapidly evolving regarding automation. Automation is the ability to schedule events for the devices connected to the local network or the internet.

From large industries to small offices, everywhere the concept of automation are being implemented to reduce human intervention and to improve energy efficiency and productivity. Home automation or domestics is the process of automating the various appliances inside a house thus converting it into a smart house [3, 4]. It involves the automation of heating, lighting, ventilation, climate control as well as various other embedded system devices that can be connected to the internet. Another major characteristic of the present generation of home automation is the remote monitoring and access of the automated appliances. With the evolution of smartphones and tablets and the development of various communication technologies like Wi-Fi, Bluetooth and ZigBee we have gained the ability to connect to our home network while we are away indeed. There are many advantages associated with home automation. One of the advantages is the immense potential for energy conservation and cost saving.

Author for correspondence:
EEE Department, Vel Tech, Avadi, Alamthi Road, Chennai 600062, Tamilnadu, India.

The efficient home automation system is proposed in this paper. The significant contributions of this paper are as follows:

Initially, we automate the functioning of some essential home appliances like fans, lights, air-conditioners and water heaters by the readings received by various sensors installed at different parts of the house.This paper is henceforth is organized as follows. The existing home automation solutions are explained in Section II. Motivation is described in Section III. Section IV discusses the proposed work. Finally, the paper is concluded in Section V.

RELATED WORK

Home Automation has been on the rise in the recent times. Starting from agriculture, to the cities having the tallest of the skyscrapers are inclined towards automation. In this section, we will discuss the various existing solutions proposed by different research papers.

In [5] the author uses 433 MHz radio frequency control module to control the home appliances directly. Gadgets like Smart phones and tablets can be directly connected to the central controller using the Wi-Fi interface. The only problem with radio signals is that they can be easily intercepted and are prone to distortions due to interference.

In [6] the author uses the Blue tooth 4.0 protocol to establish communication between the "smart home appliances" and the user. The user can use cell-phones or tablets to control these appliances remotely. The only disadvantage of using Blue tooth technology is that the devices can only be controlled from short range. As an Example in [7], the author's proposed Blue tooth based home automation systems. In this solution, the home appliances are controlled based on Android smartphones without the Internet controllability. All the home appliances are physically connected to the Blue tooth controller and it is controlled by using Smartphone. However, in this solution, the home appliances are not remotely connected and not able to operate remotely.

IoT based home automation using android phones [8] is proposed. In this, the authors used two types of home automation, i.e., Blue tooth and Ethernet-based. Also, the customized Android-based mobile application was used to control the home applications like Fan, TV, AC, etc. Nonetheless, data sources in the prototype is not clear and it leads deadlock situation when multiple Android phones try to access same web portal.

In [9] a smart data acquisition system and energy management system has been created which displays the necessary data on a web page with the help of SMS, GPRS and email alerts. The RASPBERRY PI microcontroller has been used for controlling the devices and for wireless communication. The system was designed based on the IEEE1451 protocol which focuses on defining transducer electronic data sheet for all the transducers used.

The low cost, flexible and ubiquitous smart home system is presented [10]. In this, Raspberry pi Ethernet is used to communicate over the Internet with the customized application installed in on Android mobile. The Raspberry pi device is integrated with various sensors like humidity sensors, temperature sensors, smoke/gas sensors. All these sensors are controlled by the mobile application used by the user. The proposed prototype is tested and has analyzed the efficiency. However, the proposed system generated alerts in the form e-mail messages, when the particular home application reaches the given threshold.

In [11] an Ethernet-based smart home automation and energy management system has been proposed based on the Intel Galileo development board. Various sensors have been used to control the home appliances as well as to maintain the security of the house.

In [12] a TI Wi-Fi CC3200 Launchpad has been integrated with a PIR sensor to detect motion and send a voice call to the owner of the house. The owner can then decide whether to disable the security system or not. He can also remotely control the home appliances. This implementation also does very little regarding automation.

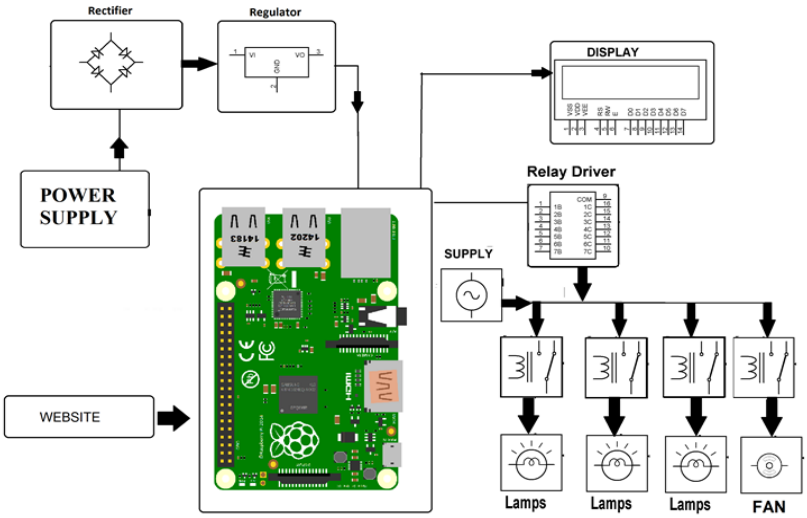

Fig. 1: Proposed System Configuration

MOTIVATION

Home Automation has been on the rise in the past few years. With ever-evolving technology, there have been smarter and more advanced solutions in the domain of home automation. To enhance the standard of living, the appliances need to be wholly automated without any user intervention in any form whatsoever. This enables the end user hassle-free interaction with the appliances as the appliances learn and react as per the user's requirements without him physically pressing a button. Wired sensor systems are more difficult to handle and also require much amount of wiring the sensors at different locations. Thus, the importance of wireless sensor node has been on the rise and is a critical factor for efficient implementation of home automation. Energy saving is one of the significant advantages of automating home appliances. Thus, the user must be kept aware of the energy consumption of the automated appliances. In a developing country like India, where people have busy life schedules, providing efficient energy saving and comfort at low prices and higher efficiency is of utmost importance.

PROPOSED SYSTEM

The proposed system configuration and prototype is shown in Fig. 1 and 2. The following sections explain about the working modules, involved in the proposed solution.

System Design

Our proposed prototype mainly consists of three layers of implementation, namely:

- Sensor Node Layer
- Sensor Data and Database Interface Layer
- Server and Notification Layer

Sensor Node Layer

The sensors, namely, light sensor, IR sensor and temperature sensor are connected to the NodeMCU ESP8266. The CT sensor, HX711 ADC module and the load cell are connected to the Raspberry pi coupled with Ethernet shield. The sensors acquire the data of the variables of the home environment and send the data to the NodeMCU. The NodeMCU then

Fig. 2: Proposed Prototype design

Triggers the relays connected to the lights, blinds, fan, air conditioner and the heater as and when the necessary conditions are met. A microcontroller is a control device that comes embedded with peripherals, memory and a processor. The remote controlling and automation of the appliances are made possible by the microcontroller which is programmed to process the response produced by the various sensors and to trigger the appliances according to the automation architecture. The two microcontrollers used in the project are:

Raspberry pi Uno

Raspberry pi Uno is a microcontroller board based on the ATmega328P microprocessor. It has 14 digital I/O pins, six analog inputs along with various other ports and jacks. The Raspberry pi can be powered directly by the computer with the help of the USB cable provided, or it can be powered using an AC-to-DC adapter or a battery. The Raspberry pi can be programmed using the Raspberry pi IDE which is based on the C programming language. It is a relatively compact and easy to handle the device with many processing capabilities.

Node MCU ESP8266

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability produced by a Shanghai-based Chinese manufacturer, Espressif Systems. The low cost, compact size and the presence of an inbuilt Wi-Fi module were the reasons for selecting this microcontroller.

Sensor Data and Database Interface Layer

The CT sensor (non-invasive current sensor) sends its data to the Raspberry pi coupled with the Ethernet shield. The data received is processed by the Raspberry pi (Raspberry pi IDE commands) and as a result, the energy consumed, and the price for the units consumed is sent to the database using the connected Ethernet shield. The load cell and the ADC module sense the weight of the gas cylinder, and when the value reaches less than the set field, the weight is then sent to the database for further utilization. The sample Database structure is shown in Figure 3.

Server and Notification Layer

The above mentioned data is received by the database in respective tables. At the start of the month, the user is notified about the weight of the gas cylinder and the cumulative units consumed by the automated appliances. The user is also notified about the new gas booking along with its ID if the weight of the gas reaches less than the threshold value. Sample notification messages about no units consumed, electricity charge and status of the Gas cylinder are shown in Figure 4.

Objectives

The sensor node senses the real-time changes in all the variables in the room using various sensors. The microcontroller assimilates the sensors data and then triggers the relays connected to the appliances, thus automating them without any user intervention. The energy of the automated appliances along with the units consumed, the total

price and a reminder of booking a new gas cylinder beforehand is sent to the database. The PHP program then notifies the user about the price incurred for every 15 days and a reminder for booking a new gas cylinder day before completion of the existing one.

IMPLEMENTATION DETAILS

Data Flow Diagram (DFD)

The working model is shown in the form of DFD as given in Figure 5 and explained below:

- The sensors in the sensory nodes detect the values of the variables in the environment and send it to the Analog to Digital Converter.
- The ADC relays the converted data to the microcontroller which processes the obtained value set.
- The microcontroller controls the relays which are connected to the fan and light depending on the sensor value received.
- Then, the microcontroller flashes the information on the serial monitor which in turn is sent to the database.
- A local server is created using XAMPP to transmit the information in the database to the user and thus notify him about the price of the electric bill for every 15 days and the requirement for a new gas cylinder.

Hardware

In the hardware implementation of the system, we are using NodeMCU ESP8266 as the main microcontroller coupled with Raspberry pi. NodeMCU ESP8266 comes 128k bytes memory and 4MB of storage. Relays act as a medium between the microcontroller and appliances for their automation. The appliances are turned ON and OFF based.

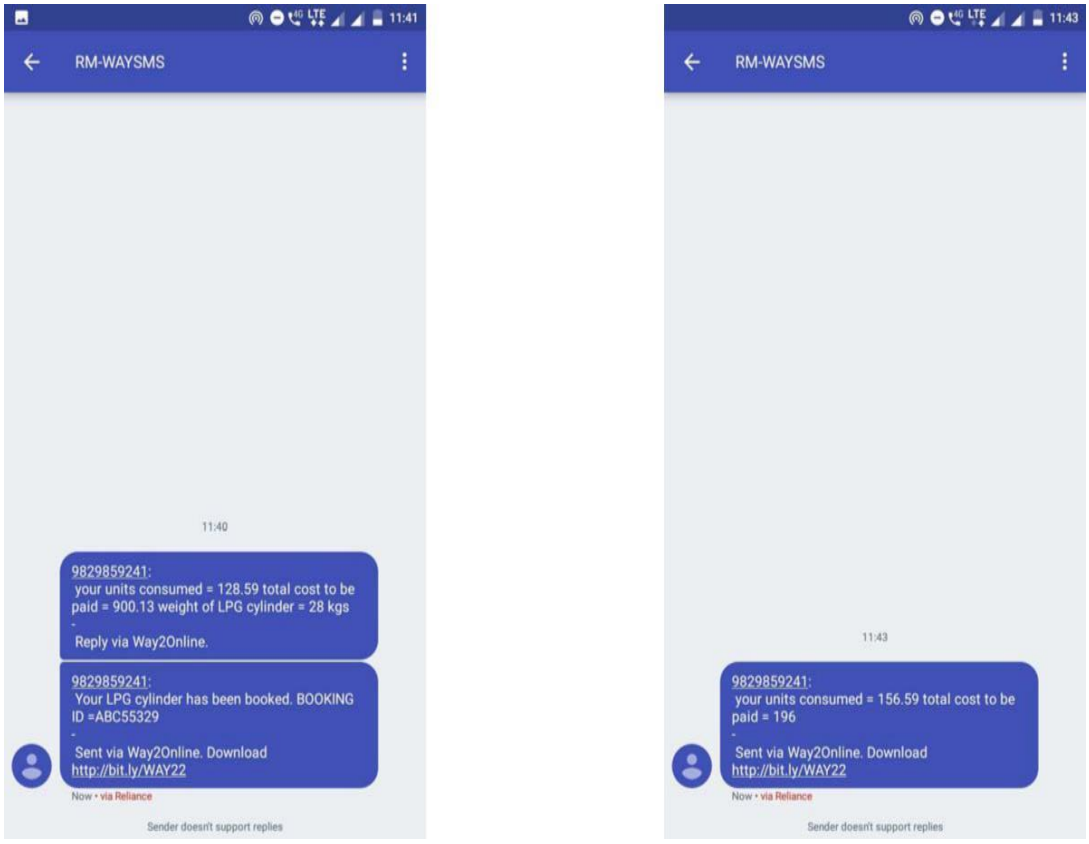

Fig. 4: User notification messages about Electricity bill and Gas Booking reference No

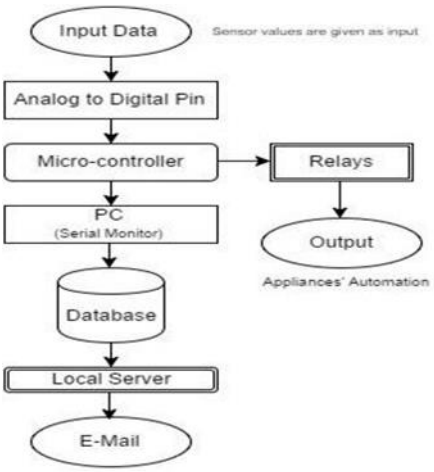

Fig. 5: Data flow diagram of the proposed system

On the obtained sensor values. Total specifications are given TABLE 1.

Table I: hardware module specification

Parameters / Microprocessor	ESP 8266 Node MCU	Raspberry pi UNO
Memory	32-bit	NA
Processor	LX 106	AT mega 328P
Processor clock	80Mhz 160 MHz	16 MHz
RAM	< 45 KB	8 KB
Storage	16 MB	32 KB
Built-in WiFi	2.4GHz supports 802.11 b/g/n	NA
ADC PIN	1 (10-bit resolution)	6
GPIO Pins	10	14
Operating Voltage	33.6 V	7-12 V

Software

The main software components of the implementation are as follows:

Microcontroller programming

Both the Raspberry pi UNO and Node MCU ESP8266 have been programmed using the Raspberry pi IDE. The CT sensor, temperature sensor, and Load cell have been connected to the Raspberry pi. The Irms value from the CT sensor is used to calculate the total units consumed. The load cell calculates the amount of LPG in the cylinder and stores it in a local variable. The temperature sensor is used to automate the air conditioner. The Raspberry pi Uno code does all these calculations. The IR sensor and LDR have been connected to Node MCU ESP8266. These are used to control the blinds and lights by triggering the relays. The main advantage of using ESP8266 is that once it is connected to the internet it can be controlled remotely form anywhere in the world by using its unique IP address. The Algorithm-1 and 2 describe the working procedure of Node MCU ESP8266 and functionality of Raspberry pi.

Database and Server Programming

XAMPP has been used to create a local server on the host PC. The database related programming has been done in PHP and MySQL. The sensor data is read into the table created in MySQL is shown in Sample database structure. To send the browser client information to the local server, we use the GET method. In this, the information is encoded using a scheme called URL encoding. The Raspberry pi program appends this encoded information to the page request thereby sending this information to the PHP program where these values are stored in local variables. Using SQL queries, these values are appended into the database which is being administered by PHPMyAdmin. The PHP program then notifies the user about the units consumed, expected cost and the unique booking ID through SMS using the Way2SMS API.

CONCLUSION

In this paper, the home automation is improved by considering a Wireless sensor node. A smart home integrates various electrical appliances in the home and automates them with no or minimum user intervention. The smart home keeps track of different environment variables present and guides the appliances to work according to the needs of the user. Not only automating the home appliances of daily usage but also notifying the user about the price of his electric bill in regular interval and automatically booking the gas cylinder, if the level of the gas reaches lower than the threshold. By considering, the above features, we have developed the prototype and tested. We achieved the development of Smart Home by using the Internet of Things technologies. From the experiment, it was found that we can manage to make low cost, flexible and energy efficient smart home for the better and greener future.

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