

Embedded System Perspectives to fuse Internet of Things [IoT]

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Abstract

Sensors which sense the physical events in the real world have to be analyzed and proper actuation signals have to be fed to avoid wastage of energy in a timely manner. This paper provides an insight in to the sensory signals in different domains. Starting from a home automation system to global health care monitoring system, sensors are required to observe the events from the real world scenario. We present a home automation system which can be used for controlling the home appliances either through an android device or can be operated remotely regardless of the location of event. We designated an embedded system approach to collect and control the data remotely. We provide necessary solutions to embed sensor data with IoT, as Internet of things is a concept of collecting sensor data from physical layer and control the data through network layer based on the requirements of the application.

Keywords: *Android, IoT, Sensor, Home Automation, Remote Control.*

1. Introduction

Home automation is the automation of the home and household activity which includes centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, automatic provision of security locks of gates and doors and other systems which are in use, to provide improved convenience, comfort, energy efficiency and security. Home automation system will provide easy way of living for the elderly and disabled which can provide increased quality of life for persons who might otherwise require caregivers or institutional care. The affordability and simplicity through smartphones and tablet connectivity makes people to enjoy life with easy press button mechanism. As one step ahead, the concept of the "Internet of Things" has tied in closely with home automation. A home automation system integrates electrical devices in a house with each other which are required for people's comfortness in day to day life.

1.1 Literature Review

The techniques employed in home automation include building automation and the control of domestic activities,

such as home entertainment systems, houseplant and yard watering, pet feeding, changing the ambiance "scenes" for different events, lighting control system, and the use of domestic robots. Devices may be connected through a home network to allow control by a personal computer or through a Smartphone and may allow remote access from the internet. Through the integration of information technologies with the home environment, systems and appliances can communicate with each other for convenience and with energy efficiency and safety benefits.

The authors have developed a low cost home automation system which has a flexible home device control mechanism using Arduino micro WebServer. This device controls the home appliances after getting inputs from the light switches, temperature sensors, humidity sensors, current sensors, smoke detectors and sirens. This is an ongoing project where the results were not mentioned in the paper. [1]

There are various smart home systems existing in the world as of now, and the controlling mechanism is through Bluetooth, internet etc. [2] The controlling mechanism is done through wireless communication between the arduino board and the appliances. [3] As Bluetooth is being used in many of the home automation mechanisms, this technology is operating over unlicensed globally available frequency of 2.4 GHZ. The devices within the range of 10-100 meter can be connected through Bluetooth. [4] The authors presented architecture for a home automation network. This paper presents how to solve home automation problems at software level and there were no hardware solutions prescribed. [5]

The authors designed home automation techniques with a remotely controlled, energy efficient mechanism. It consists of a set of sensors and actuators and fixed control structures for alert mechanisms. The authors used wireless technologies to control devices to ensure resource constraints as considerations. [6] The authors in their paper prescribed a new scheme of utilizing Wi-Fi signals to

control home appliances with limited resources. [7] The research proposed in this paper was a cost effective home automation system. It uses GSM modem through which SMS will be sent, if any home device is on. The system used kernel level security in addition. [8]

The research proposed in the paper is an electronic system to control temperature via SMS. The system measures the ambient temperature and if the temperature is less or above the threshold set up, the control signal as SMS will be sent to the user..[9] Mobile SMS based applications are plenty in nature. This paper reviews the basic operational model of SMS based applications. [10] Remote control through telephonic system using microcontroller was presented by the authors. During that time, it provides the basis for remote control applications. [11] When the type of remote control mechanism was thought of initially, the authors proposed the mechanism for controlling oven, air conditioner and computer remotely. [12]

HVAC application monitoring and control design was presented by the authors but it was so costlier and not economically feasible solution for remote control applications.[13] The authors presented a JAVA based home automation system in which the low level details of the hardware connections were not presented, whereas the software connections and approach was presented [14].

The system level approach of controlling the household devices with a centralized controlling mechanism through cloud does not exist as of now. So there is a need to interconnect the sensor data to internet and make the control aspects based on the threshold level of the devices or based on the presence or absence of the humans in the current location does not exist and it is the need of the hour. This research proposes a system which interconnects the sensor data to cloud and provides suggestions for internet of things.

The organization of the paper is as follows: Section 2 presents the proposed system architecture. Section 3 provides the design principles and the description of the proposed system. Section 4 initializes software control features. Section 5 presents the embedded system perspectives. Before conclusion, section 6 describes the salient features of the proposed system to fuse sensor data in to IoT.

II. PROPOSED SYSTEM ARCHITECTURE

In this research, we have implemented the design features of a low cost, flexible home automation system. The

research already existing was concentrated on using the off the shelf components to execute the results intended so for. In our research human presence is used for automating the household devices. When the human enters in to a house locality say a room, his presence is notified by the PIR sensor and accordingly the relay control mechanism switches on the light, fan and air conditioner. When there is no human presence, all these electronic appliances are made off, in the house. The full functionality of the home automation system can be further extended to Internet, where any user wants the control of their household electrical appliances can be controlled with proper authentication mechanism.

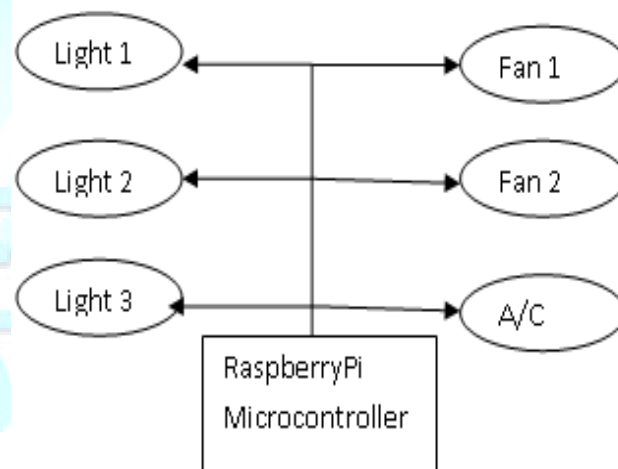


Figure 1: Proposed Home Automation System

The home automation system consists of two modules which are smart phone and the microcontroller. The microcontroller chosen is the RaspberryPi. The microcontroller RaspberryPi interconnects the mobile phone and the electrical devices to be controlled. The Smartphone is encoded with python script through which the microcontroller is able to communicate with the electrical devices as shown in figure 1. The electrical devices which have to be controlled can be selected using a timer/priority scheduler mechanism. RaspberryPi is a small, low cost circuit board. It consists of a microcontroller, timer and I/O slots. Peripherals can be interconnected through the I/O slots. The microcontroller can be used for dimming control, speed control, on-off control applications. So that RaspberryPi is chosen for controlling lights, fan, doors and air conditioner. Home automation involves a degree of computerized control or automatic control to certain electrical and electronic systems at home.

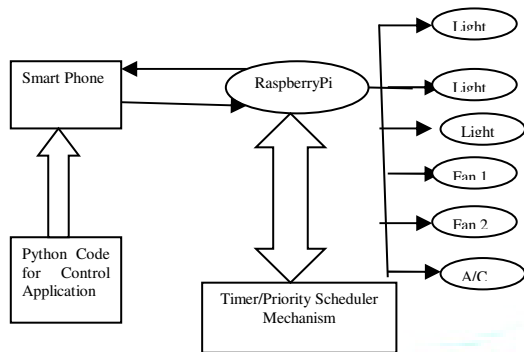


Figure 2: Timer to control ON/OFF mechanism

The client modules communicate with the host controller which is the microcontroller through a wireless device with a relay mechanism as in figure 2. The wireless device is the android mobile phone. The Bluetooth module BLE112 is a low power module which consists of sensors and accessories along with low power consumption. It also has a wake up schedule mechanism in the order of ms. Relays are used to control a circuit through a signal. They are used to protect the circuit under overload conditions after getting an input from the circuit as shown in figure 3.

Applications:

1. Email Monitoring
2. Timer to trigger applications
3. Doors/Wireless Monitoring
4. Fire/Smoke/Alarm, Water droplets monitoring
5. TV/YouTube On/Off Controls

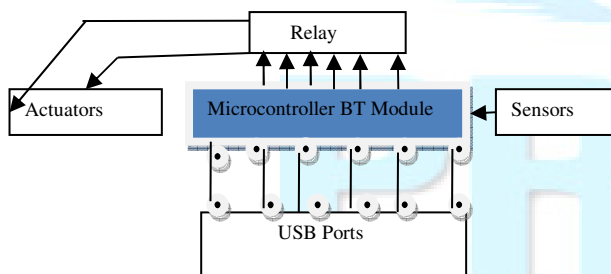


Figure 3. Sensors and Actuators through Relay

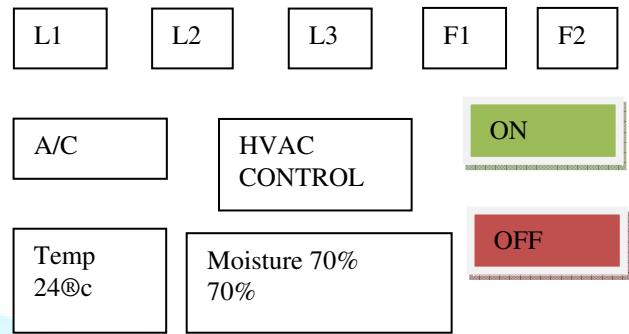


Figure 4: Output Screen for control appliances

III. DESIGN PRINCIPLES

The design principles involve the following guidelines

- Create a WebServer
- Create a JAVA based application server
- Interface GPIO ports with RaspberryPi.
- The node application server will process ON/OFF requests coming from the browser.
- It then switch the desired GPIO pin ON/OFF
- A relay is driven by GPIO (1 or 0) will switch the corresponding external circuit.

IV. SOFTWARE CONTROL FEATURES

The software control features of the proposed system incorporate the following code. The I/O slots port numbers 12,13, 14, 15, 16, 17 have been used for on off control of light1, light2, light3, fan1, fan2 and A/C of the house. 1 indicates the appliance to be on and 0 indicates the appliance to be off as shown in figure 4.

```

Import RPi.GPIO as GPIO
GPIO. Set mode (GPIO.BOARD)
    
```

```

GPIO. Setup (12,GPIO.OUT)
GPIO.Output (12,1) – Light 1 ON
GPIO.Output (12,0) – Light 1 OFF
    
```

```

GPIO. Setup (13, GPIO.OUT)
GPIO.Output (13, 1) – Light 2 ON
GPIO.Output (13, 0) – Light 2 OFF
    
```

```

GPIO. Setup (14,GPIO.OUT)
    
```

GPIO.Output (14, 1) – Light 3 ON
 GPIO.Output (14,0) – Light 3 OFF

GPIO. Setup (15,GPIO.OUT)

GPIO.Output (15,1) – Fan 1 ON
 GPIO.Output (15,0) – Fan 1 OFF

GPIO. Setup (16,GPIO.OUT)

GPIO.Output (16,1) – Fan 2 ON
 GPIO.Output (16,0) – Fan 2 OFF

GPIO. Setup (17,GPIO.OUT)

GPIO.Output (17,1) – A/C 1 ON
 GPIO.Output (17,0) – A/C 1 OFF

V.EMBEDDED SYSTEM PERSPECTIVES TO IoT

Embedded system brings the future home technologies today. Some of the perspectives through which embedded system can enter in to home are,
 Controlling lights/water heater/water droplets

- Turn on lights inside the room/hall
- Automatic doorbell, if human presence is found
- Control lights and appliances remotely through the Internet or telephone
- Automatic A/C, Thermostat for the room based on the outside climatic conditions
- Home security [Fire, smoke, flood]

REMOTE CONTROL:

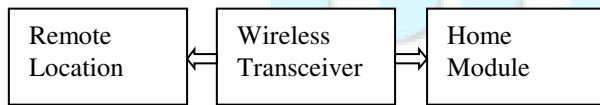


Figure 5. Remote Control through Cloud

Home Automation is a much flexible concept, which can be incorporated in to IoT. The future if Home Automation will imply self configured, embedded sensors and actuators that can be controlled remotely through Internet as shown in figure 5

Through IP gateways, home automation system can be interfaced with an IPv4 enabled Ethernet socket.

Every home must have a unique access point. The access point can have the IP gateway in the Internet, so that all the devices which we want to control can be monitored and controlled through Internet. The assigned IP is a common address for the home network.

A software module has developed to enable any home automation device to interface and interact via IPv6 network protocol. All home automation devices can interact actively with the surrounding world through their IPv6 address and identifies uniquely on the Internet.

Thus the system is a fully controllable system regardless of the location of the user.as shown in figure 6.

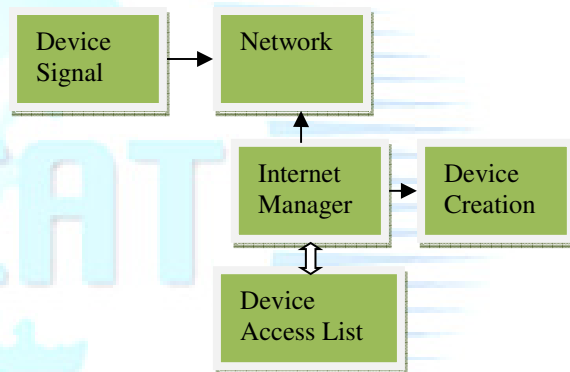


Figure 6. Future Development of Home Automation System

Internet of things designed for homes will standardize at a faster rate than retail and large office IoT, but it may be many years before enough people are comfortable having these devices in their homes and in workplaces as shown in figure 7.

VI. SALIENT FEATURES OF THE SYSTEM

- Global control over home appliances is possible
- No location dependency
- High level security mechanism runs behind
- No wastage of energy
- Optimized control of resources
- Anywhere, Anything, Anytime Concept is established
- It leads to smart house projects
- Elderly and disabled people feel comfortable
- Remote control mechanism of home appliances.

- Simple programming logics
- Smartphones are easy to handle and operated for control applications

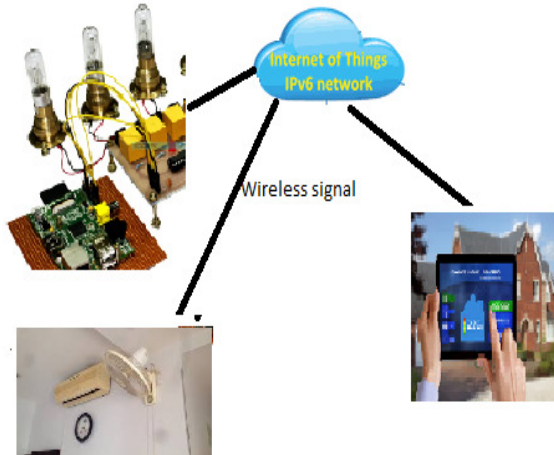


Figure 7. Data Transfer through Cloud

VII.CONCLUSION

In this research, we have implemented the design features of a low cost, flexible home automation system. The research earlier proposed was intended with the uses of existing technology, whereas in our research, human presence is used for automating the household devices. When the human enters, the presence is notified by the system and accordingly the relay control mechanism switches on the lights, fan and the air conditioner. When there is no human presence, all the electric appliances are off in the house. Full functionality of the home automation system can be further extended to Internet, where any user wants to control their household appliances; they can be controlled remotely with proper authentication mechanisms.

Acknowledgments

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