

Research Paper

WEB BASED REAL-TIME HOME AUTOMATION AND SECURITY SYSTEM

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In today's world automation plays a very important role and in this project an automated way of controlling home appliances through human interaction as well as through self-control of the system itself is provided. The manual mode helps user to control home appliances automatically using PC or any Wi-Fi enabled Mobile phone in the same local area network. In automated mode the system controls the appliances itself depending on some sensor reading, thus making it fully automated. Another feature of the automated mode is the security mode. Through this mode user will be alerted if any intruder enter the main door when the system is active.

Keywords: Home automation, Arduino Uno, Wi-Fi, Low cost, Human interfaced system

INTRODUCTION

With advancement of internet technology lifestyle of every person is changing constantly. Internet of Things is a concept where user can connect distinct physical objects and control their operations through internet to make life more flexible and efficient. The idea of "Internet of Things" was first applied by Kevin Ashton (1999). The concept of the "Internet of Things" has a close relation with the blossoming home automation. The use of such system is growing at an enormous rate since the advent of it. Overall Internet usage has seen tremendous growth. During the first decade of 21st century, the headcount of Internet users globally

increased about 5 times. In the year 2014 the number of Internet users in the world exceeded 3 billion. According to Euromonitor, by the year 2020 about 43.7% of the world's inhabitants will be using Internet (Srisikanthan *et al.*, 2002).

To begin the era of wireless control Bluetooth came to light in automation system to control appliances while data is send in Bluetooth frequencies. Though the system can work well in a small range, it cannot be used in long distance as signal attenuation is high and another problem is signal interference with multiple devices in use in small vicinity (Shepherd, 2001; and Bharanialankar and Manikanda Babu (2014). Then there was GSM

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system where messages can be sent from a mobile to control devices. Although this design was much efficient but not very cost effective (Naresh Jawarkar *et al.*, 2008; and Prakash Kumar and Pradeep Kumar, 2013). Another important way to control many devices, is to use remote controller using infrared signal to communicate with devices which is well available in the market (Rifat Shahriyar *et al.*, 2008). There was also an idea to control household appliances using voice command. Such system uses voice modulation in mobile to decrypt our voice and thus commanding different devices (Ahmed El Shafee and Karim Alaa Hamed, 2012). So the path of Wi-Fi connectivity was chosen, using a router, to communicate with central device and control them (Bader *et al.*, 2014). This system is very effective and can be used to control from a far-away point (within the range of the router) using many devices at a time with less cost involved.

Keeping all the precursory articles in view, a design hypothesis for a low cost real-time home automation system using Arduino Uno microcontroller with Wi-Fi router are proposed in this prototype. The suggested Arduino-Uno micro-controller introduced in this project provides a simple execution of the system as compared to the other types of controllers. This system utilizes static IP based communication. Here user can employ a router to provide an IP address to the microcontroller based device through an Ethernet module that helps in internet based communication via router. This system has three operational modes: the first one of them is based on any web supporting device which is termed as manual mode, the second one

is based on sensor readings considered an automated mode and the third one is security mode for safety. Thus the user can use it in his/her own way or can give control to the central device which controls the house itself. It also provides security as well. A hardware implementation of the proposed system is developed to verify the reliability and limitations of the model.

There are systems that uses only Android mobiles as a control and monitoring unit (Rajeev Piyare, 2013). That also uses IP based communication with the central device where an application is used to control the appliances. This design is very useful with latest smart phone users as they can easily control home appliances using their mobile.

The rest of the paper is organised as follows. The proposed system design is explained in detail with a diagram in the section II. In this part a detailed view is given of how other devices (appliances) are interfaced with the microcontroller and the Ethernet module. In the next section (III) the hardware design is described to provide a practical view. In this section an overview different sensor used in the design is given with full picture of the design. In concluding part (IV) the future scope and applications of this design is provided.

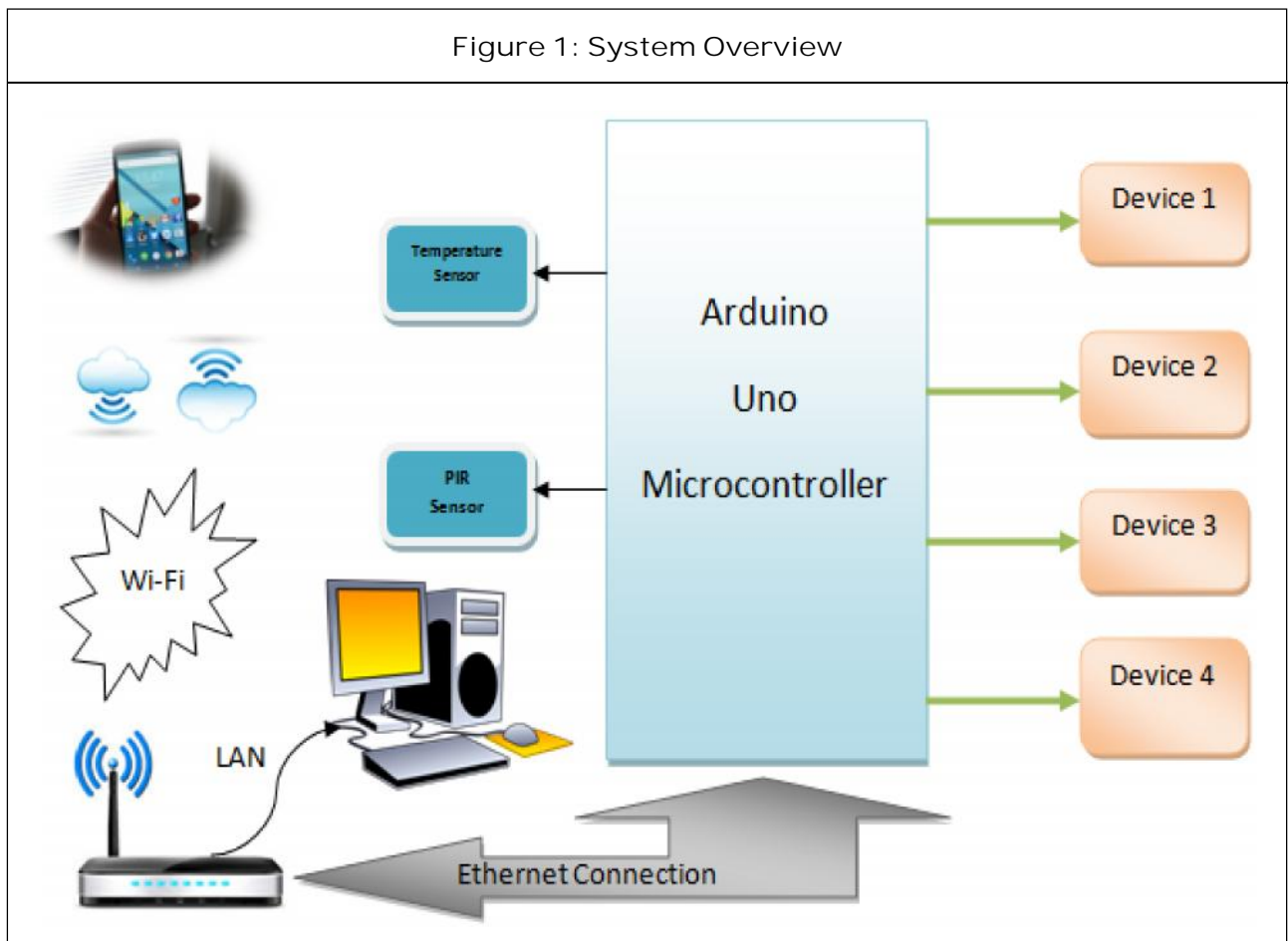
SYSTEM DESIGN

The main part of the system consists of a Microcontroller with an Ethernet module for controlling. This Ethernet module is connected to a Wi-Fi router which gives a static IP address to it so that it can use TCP/IP based communication with other

accessing devices connected to the same router. This module is connected to four appliances through relay devices to automatically turn on and off those devices. As the relay devices are current controlled device, current amplification is needed to support low current output of the microcontroller. Now that was a part which requires human control. To make this design more efficient an automatic system has been designed as well. For this automated system there is a temperature sensor which senses its immediate environment (i.e., a room) and indicates current temperature. Now this temperature is shown in the GUI output and microcontroller uses it to change the speed of a fan connected to it.

As the temperature varies speed of the fan varies according to it. Then there is an IR sensor, which is connected to a door of room, senses the entry of a person. If any person enters the IR sensor changes its output state and triggers the microcontroller to put on the light of that room only. Now again when the person exits the room another IR sensor senses that and directs the controller to put off the light, increasing consumption efficiency as well as making things more fast and advanced. The security system is another important part of this automation and gives this design a little more edge. A PIR module is used for this purpose which senses any kind of intervention at the front gate to alert the user about an intruder.

Figure 1: System Overview



SYSTEM HARDWARE

The suggested Home Automation and Security system is composed of three main modules: Using Arduino as Web Server, Hardware Interface module and Human Interface which can be accessed from any PC or Wi-Fi enabled phone. In case of long distance communication without using wires, Wi-Fi router provides convenient and cost-effective way of communicating with our sensors and actuators from webpage. The different Input Output devices are controlled using TCP/IP over the IEEE 802.11 standard protocol. Data being gathered from sensors, such as PIR sensors, temperature sensors, IR transmitter and receiver is being processed on an Arduino UNO micro-controller as a server and then disseminate with an attached Ethernet Shield using the TCP/IP protocol via Wi-Fi router. Arduino has a statically assigned IP address. Each time a request is passed to that IP address, an HTML page is sent as a response with implemented functionality and status of the devices.

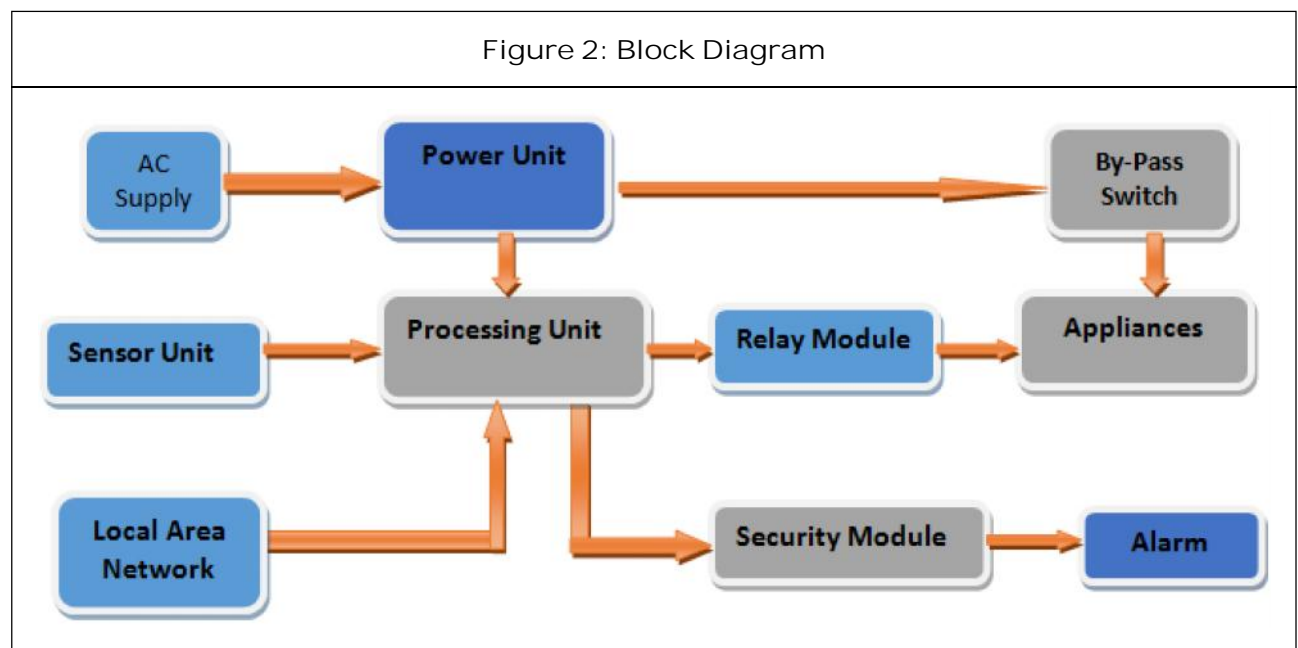
One of the merits of using HTML is that, data can be observed from any Tab or Smart-phone regarding all of the sensors in one location. Output devices such as power strip plugs can be remotely managed also.

Each of the Modules is Explained in Details

Web Server on Arduino

This platform is the brain of the proposed Home Automation and Security system. Being an open-source electronic framework Arduino empowers us to design interactive electronic appliances. Arduino UNO consists of a microcontroller (ATMEGA 328P-PU) based on the AVR core architecture with complementary components to facilitate programming and incorporation into other circuits.

A code written in C language can be transferred to the controller using PC via USB port. This is connected to the Wi-Fi router using Ethernet shield which is an add-on module for Arduino. This Ethernet shield has the capacity to be used as a client or a server. Here the



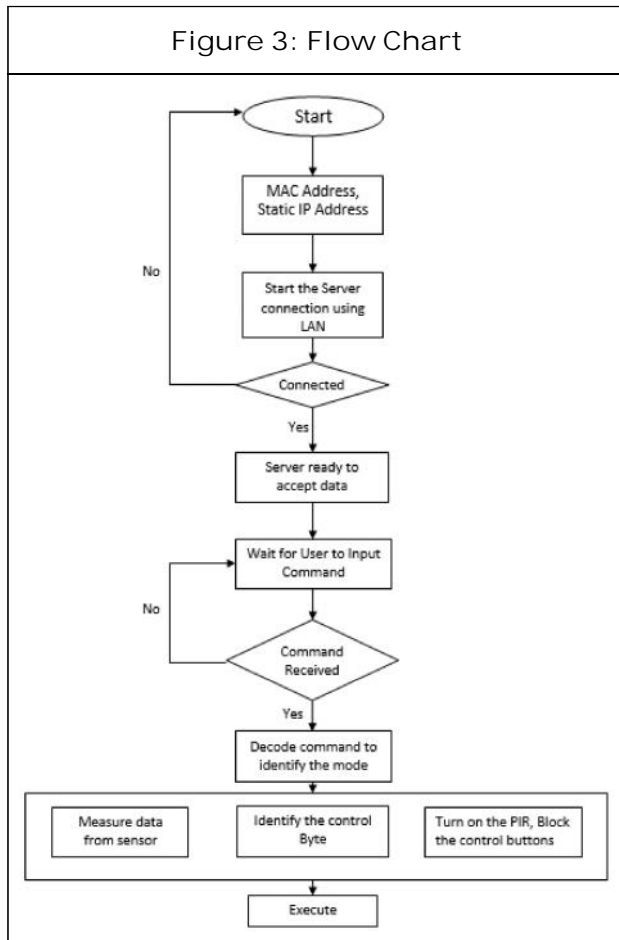


Figure 4: Arduino Uno with Ethernet Shield



Arduino is programmed to use the Ethernet shield as a server. During the initialization stage, which is the first step to connectivity, the Ethernet module initiates connection with Local Area Network (LAN) utilizing a static IP address.

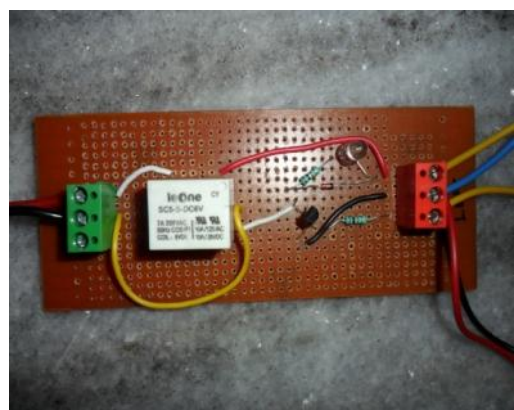
Based on the encountered Uniform Resource Locator (URL) from the internet browser which contains embedded strings that has a control byte, once picked by the server, will be executed as a specific command attached to the string. A manually assigned IP address is assigned to the server which is in this case 192.168.0.155. Initializing the server will make a request to the server to open a listening connection and after receiving a URL such as 192.168.0.155/? (Control Byte) it will display the current state of sensors and I/O devices and provides manual control, i.e., Human Interface.

Hardware I nterface Module

This module is the heart of the proposed Home Automation and Security system. It is made up of the sensors and the actuators.

Temperature Sensor: LM35 temperature sensor is used to measure the ambient temperature and it is active for all the time the system is on. It is used to display the room temperature to the user when the user interface is refreshed. In the automated mode this sensed temperature is employed to control the speed of fan connected at the output pin.

Figure 5: Relay Board

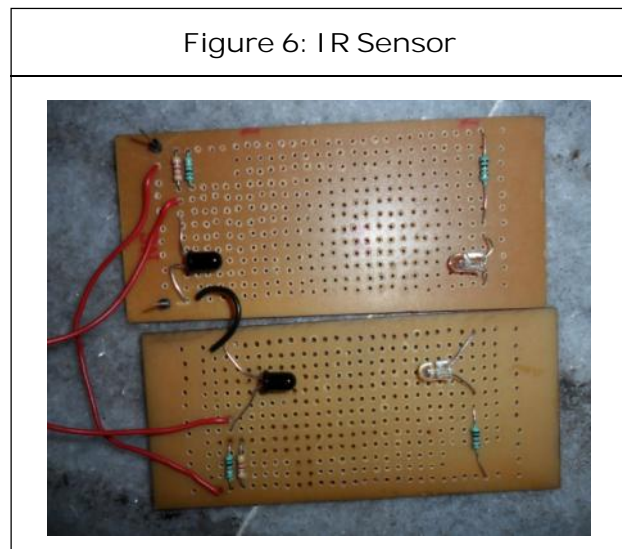


Relay: This unit is responsible for actual control of load. It consists of a 6VDC-240VAC relay and protection diode to protect against counter electromotive force (CEMF).

Relay is used to switch power the power socket and is controlled via the Arduino. The appliances connected to the socket can be controlled from the user interface and the status can also be monitored.

PIR Sensor: Passive Infrared sensor is an electronic sensing device that senses infrared (IR) light emitted from entities in its field of view and used to detect motion in its range. It is activated only in the security mode to detect any unwanted motion at the entrance. If any unwanted movement is detected then it will signal the microcontroller to take necessary steps.

IR Sensor: It will be activated in the automated mode to detect person entering or coming out of the room and set a counter based on that. If the counter show there is a person inside it will light up the room automatically and turn on the AC depending upon the temperature reading.

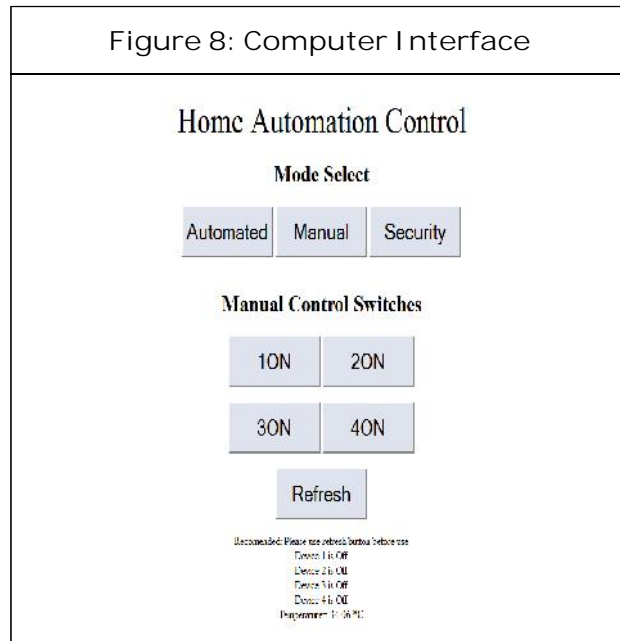


Alarm: It will only be activated in the security mode when some intruder is detected by the PIR motion sensor.

Human Interface

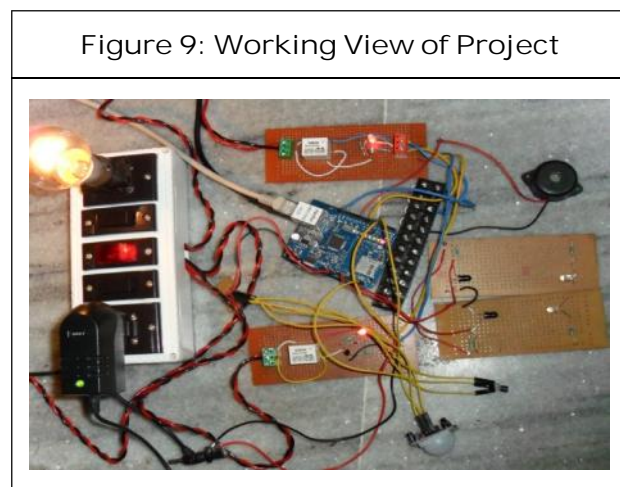
This is the thing that the user sees while using it. A customized HTML web page is designed and embedded in the microcontroller program. The webpage consists of several control buttons as required by user, to control the devices connected to the server, to control the mode of working and to display the present status of the Home Automation system. This provides a graphical user interface for controlling the instruments at home from web enabled devices through server real IP. As the HTML page is resided in the server many client can access it at the same time and control the devices. To know the current status of the system user has to use the refresh button on





the web page to update the status. As a Wi-Fi router is used as the access medium the user has to connect to it either via direct LAN or Wireless network which is password protected. So, only some authorised users can access the system. There are three different modes of operation.

In Automated mode the user relinquishes the manual controls and the light and other appliances based on the input sensor values. In Manual mode the user can use the buttons in the web page to control the devices. When



the security mode is turned on, the access to the web page is blocked and no further interaction is possible until a hardware button is pressed by the user to reactivate the web page. During this time the system will retain the last status before the security mode was turned on. This ensures the security as only the owner can reactivate the webpage access.

CONCLUSION

In the proposed design, a Wireless automated home control with security features is presented. This design is very simple in nature. Arduino Uno microcontroller is the central part of the design where the server program for controlling is burned. Thus all the controlling is done by it. For the web application the Html part is provided inside the program thus it doesn't require any other application to be developed for different gadgets. The security mode is very invulnerable where nobody can access the system without deactivating the security system from the activating device. The automated mode makes life easier for users by complete automation of necessary appliances without any human effort. The application of the system could be:

1. In case of lighting control, it is possible to conserve energy in both residential and commercial applications by automatically controlling intensity of light depending on the presence of anyone inside the room.
2. It could be useful for old aged/especially able people as appliances can be controlled by merely a touch. It is also possible to control the system using voice commands using Android. It is safe because there is no chance of getting electric shock.

3. Security system has motion sensors that will detect any kind of unapproved movement and alert the user through the alarm and via web page.
4. Security cameras can be installed which will monitor the premises, allowing the user to observe activity around the house.

Here wires are used to connect to the switching devices for appliances but use of small Wi-Fi modules can make the system fully wireless. 🌀

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