



HOME AUTOMATION USING ARDUINO

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ABSTRACT

This paper presents a low cost and flexible home control and environmental monitoring system. It employs an embedded micro – web server in Arduino Mega 2560 microcontroller, with IP connectivity for accessing and controlling devices and appliances remotely. These devices can be controlled through a web application or via Bluetooth Android based Smart phone app. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. To demonstrate the feasibility and effectiveness of this system, devices such as light switches, power plug, temperature sensor, gas sensor and motion sensors have been integrated with the proposed home control system. The rapidly advancing mobile communication technology and the decrease in costs make it possible to incorporate mobile technology into home automation systems. We propose a mobile and internet based home automation system that consists of a mobile phone with android capabilities, an internet based application, and a home server. The home appliances are controlled by the Arduino which receives commands from the server computer, which operates according to the commands received from the mobile application via the wireless network or the internet.

Keywords: Smart Home, Home Automation, Android Smartphone, Arduino

I. INTRODUCTION

We propose a mobile and internet based home automation system that consists of a mobile phone with android capabilities, an internet based application, and a home server. The home appliances are controlled by the Arduino which receives commands from the server computer, which operates according to the commands received from the mobile application via the wireless network or the internet. In our proposed system the home server is built upon a Wi-Fi technology which receives commands from the client and the command is processed Via Arduino, which allows a user to control and monitor any parameters related to the home by using any Java

capable cell phone or via the internet. This paper presents an innovative low cost design and implementation of automated ambience control using user mood or based on weather conditions, interactive voice based response, appliance control, and, home security together with the design of android application to enable the cell phone to send commands and receive alerts through the server. In the present day, security systems play an important role in the protection of lives and investment. This is achieved by the incorporation of various subsystems into the security system with a single control unit such as surveillance, intruder control, access control, fire detection, etc. A smart home is

one that is equipped with lighting, heating, and electronic devices that can be Today's world is digitized. Starting from our handheld devices to computers to smart appliances, our world is digitized. Thus a smart home would be the next step for a better future. The system efficiently controls the lights and appliances, thus minimizing power consumption. The system makes use of the internet to control the house appliances and the lights. Apart from merely switching off and switching on the lights, the system can control it efficiently using ambient light sensors and can adjust the lights setting of the home. It enables the user to control various aspects of their appliances from a remote location through a hand held device. With the advent of mobile phones, Mobile applications development has seen a major outbreak. Utilizing the opportunity of automating tasks for a smart home, mobile phone commonly found in normal household can be joined in a temporary network inside a home with the electronic equipment. Android, by Google Inc. provides the platform for the development of the mobile applications for the Android devices. Home automation system is a mobile application developed using Android targeting its vast market which will be beneficial for the masses. Automation of the surrounding environment of a modern human being allows increasing his work efficiency and comfort. There has been a significant development in the area of an individual's routine tasks and those can be automated. In the present times, we can find most of the people clinging to their mobile phones and smart devices throughout the day. Hence with the help of his companion – a mobile phone, some daily household tasks can be accomplished by personifying the use of the mobile

phone. Analyzing the current smart phone market, novice mobile users are opting for Android based phones. It has become a second name for a mobile phone in layman terms. Home Automation System (HAS) has been designed for mobile phones having Android platform to automate an 8 bit Bluetooth interfaced microcontroller which controls a number of home appliances like lights, fans, bulbs and many more using on/off relay. This project presents the automated approach of controlling the devices in a household that could ease the tasks of using the traditional method of the switch. The most famous and efficient technology for short range wireless communication- Bluetooth is used here to automate the system. The HAS system for Android users is a step towards the ease of the tasks by controlling one to twenty four different appliances in anyhome environment.

II. METHODOLOGY

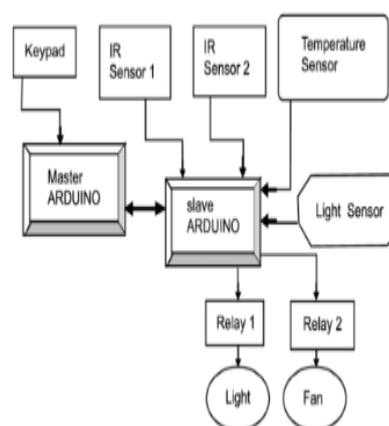


Fig.1: Proposed model of Home automation system

The end user can use their mobile phone to log into the system. An initial check is performed for whether the hardware device is ON or not. Only if the Hardware is authorized and ON then the user is authenticated. Once the authentication is done



successfully the user is able to send the control signals to the Hardware machine. At the hardware machine the SL driver program will continuously track for the change in the status & will accordingly send the signals to the Circuit. When a user select a change in the status for any of the device [i. e .. ON or Off], the data from the handheld is sent to the Web Server in a string format, where the Web – site is hosted. On the server the status is stored in the database in their respective device field. At the Hardware end, the circuit drive program a web page is [retrieve.aspx] is used to retrieve the status of the devices in a timely pattern [every 10sec]. These changes come in to form of cookies [temporary internet files] from the webserver & are stored on the computer in the name of the web site. Hence every 10 sec as the page refreshes the new cookie values are updated. The cookie values are read from the program using the VB component GETINERNETCOOKIE after a fixed delay. As the program receives any change in the Device values it send the control signal [binary data] accordingly to the required data pin of the parallel port. An “IOT based ICMS for Home Automation” is a low cost and flexible system which provides various services for remotely accessing and operating on home appliances such as lights and fan on/off automatically as well as manually through android application on smart phones, monitoring room temperature , LPG gas leakage, gate and door open/close.

The similar kind of project can be deployed for other real life applications hospitals and schools also. The components are connected to embedded micro-web server, with IP connectivity either through LAN or Wi-Fi module for accessing,

controlling and monitoring devices and appliances remotely using Android based Smart phone application. This system receives commands from remote devices that are manipulated by user. The system in turn dispatch commands to respective appliances that will perform the actions. This system also keeps track of the status of the devices. Through android application authorized user can access the system using Internet, by using router and hardware interface module. The primary function of the router for the proposed architecture is to provide data translation services between the Internet through sending and receiving requests and responses respectively. The main component is a web server based on Ethernet embedded with microcontroller. The main task of the server is to get the request, process it and then provide response back to the user. Hardware interface modules are directly connected with sensors and actuators through cables. It has the capabilities to control power management systems like lightings and security systems such as home door locks, and gate. PIC Electronic circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timers or to control a production line and many more. They are found in most electronic devices such as alarm systems, computer control systems, phones, in fact almost any electronic device.

Proposed Home Automation System Functions The proposed home automation system has the capabilities to control the following components in users home and monitor the following alarms:

- Temperature and humidity
- Gas leakage detection
- Control appliances

- The proposed home automation system can control the following appliance:
- Lights on/off/dim
- Fan on/off
- On/off different appliance
- Leakage of gas

Hardware Description

This hardware implementation contains 4 different parts.

- (i) A 16X2 LCD display for displaying status of the system and IP address of the local Wi-Fi network
- (ii) Relay for switching the load automatically,
- (iii) Arduino as decision maker and
- (iv) esp8266 version 1 for connecting to local Wi-Fi.

(i) Arduino UNO

The UNO proves to be Arduino's flagship board for beginner and also for advanced users. The system needs a micro-controller to process data and connects different modules for control. This purpose was solved by Arduino Uno which has ATMEGA328p processor. It has 6 analog input pins and 14 digital input/output pins[13]. It can operate with either 5V from USB plug or 12V from external power supply. In Arduino Uno pin 1 and 0 are used as default transmission and receiving pin.

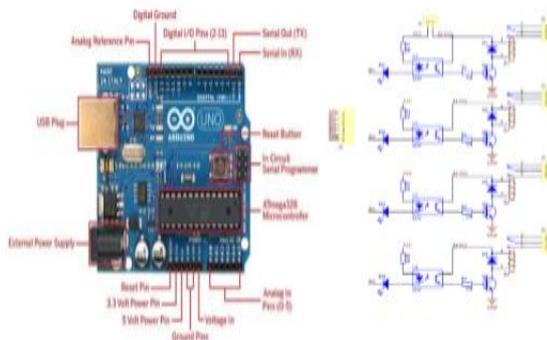


Fig.2.Arduino UNO 4-Channel Relay

(ii) 4-Channel

Relay 4-Channel relay is connected to the Arduino Uno and its output is connected to the home appliances in a sequence as (i) fan (ii) light (iii) room-heater and (iv) TV set. Relay takes low current and voltage and triggers the switch which is connected to a high voltage. 4 input pins of relay are connected to Arduino which takes 5V supply from it and can trigger up to 10A, 250V supply.

(iii) ESP8266-01

The ESP8266-01 is a highly compact board, used as a peripheral for any board through serial (RX/TX) and also as a standalone board. The board requires 3.3 V and can be programmed with any FTDI operating at 3.3 V. The pins include power (+3.3 V and GROUND), RX / TX, CH_PD to enable the chip and 2 General Purpose Input Output (GPIO) [14].

(iv) WIFI

Wi-Fi (wireless fidelity) is a wireless communication technology which is used here to provide a hotspot through which ESP8266-01 module can connect. The router will assign a unique IP address to the module for establishing a connection between smart phone and ESP8266-01.

(v) Gas Sensor

Gas sensor module detects various types of gas in an area. Here the change in value of resistance is used to calculate the gas concentration. Gases like Methane, Propane, butane, Alcohol, Smoke, LPG and also hydrogen can be detected using this module. There are 2 output pins (digital one and analog one).

(vi) Temperature Sensor

It can measure temperature as well as humidity present in a room. Its range is less than 20 meters. It has a negative temperature coefficient (NTC)



element and a humidity-sensitive element which is used to measure temperature between 0-50 degree Celsius.

Software Description

Software Design We have used three different Software for programming and controlling. IDE is an open-source software which is not only used for writing programme but also for uploading code to Arduino. Android application for ESP8266-01 is available in the play store (Android smart phone) provides a platform to control different loads. This will only work if it is connected to the IP address and the port which is provided by the ESP8266-01 module as shown in Fig.5. User can customize the application like load name, number of loads, its ON duration etc. For controlling ESP8266-01 through web browser or computer for real time notification explorer is used.

Implementation

Initially through Arduino programming, the system checks the modules as well as their connections. If any kind of error is detected by the system then it will indicate the ERROR status. If no error is found then the system will indicate the status OK and proceed for establishing the connection with the local Wi-Fi. Here the system will again check whether the ESP8266-01 module is connected to the internet. If there is no connection then the system will indicate the ERROR status or else the display will show status SYSTEM ONLINE and show the IP address. The system will wait for the signal and switch the load accordingly after receiving the command and update the display.

A low cost and efficient smart home system is presented in our design. This system has two main modules: the hardware interface module and the software communication module. At the heart of

this system is the Arduino Mega 2560 microcontroller which is also capable of functioning as a micro web server and the interface for all the hardware modules. All communication and controls in this system pass through the microcontroller. The smart home system offers feature such as environmental monitoring using the temperature, humidity, gas and smoke sensors. It also offers switching functionalities to control lighting, fans/air conditioners, and other home appliances connected to the relay system. Another feature of this system is the intrusion detection which it offers using the motion sensor and all these can be controlled from the Android smart phone app or web application.

Working

The basic block diagram of the smart home system is shown in figure. A micro-controller is used to obtain values of physical conditions through sensors connected to it. These integrated sensors such as the temperature sensor read temperature values, the gas sensor detects smoke and cooking gas to avoid fire outbreak. The automatic switching on and off of the light is controlled by the Light Dependent Resistor (LDR) which determines the day light intensity. Also to incorporate security in our design, a motion detector is integrated using Passive Infrared Sensor (PIR) to detect movement in the home when the security system is turned on.

A relay switch is used to send control signals from the micro-controller to the electronic device used to achieve the switching on and off action. A web portal is designed with a one-factor authentication system (username and password) to check authenticity of the home user. It acts as an input device to control the home appliances and

also acts as an output device to read the values of the physical conditions.

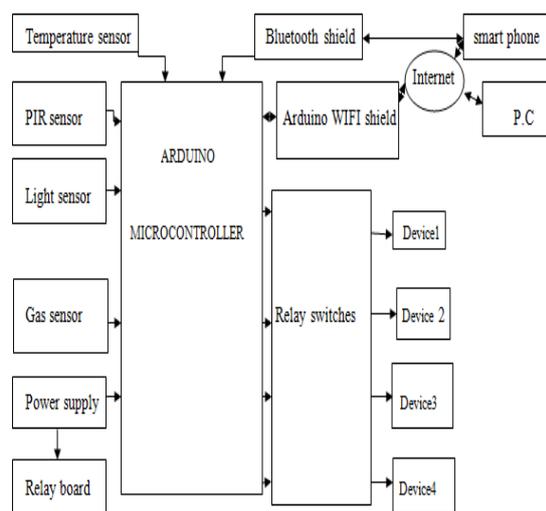


Fig.3. Block Diagram of the Smart Home System

A low cost and efficient smart home system is presented in our design. This system has two main modules: the hardware interface module and the software communication module. At the heart of this system is the Arduino Mega 2560 microcontroller which is also capable of functioning as a micro web server and the interface for all the hardware modules. All communication and controls in this system pass through the microcontroller. As we can see in figure 2, the smart home system offers feature such as environmental monitoring using the temperature, humidity, gas and smoke sensors. It also offers switching functionalities to control lighting, fans/air conditioners, and other home appliances connected to the relay system. Another feature of this system is the intrusion detection which it offers using the motion sensor and all these can be controlled from the Android smart phone app or web application. Arduino can sense the surroundings by receiving input signal from a

variety of sensors and can affect its environment via actuators. An analog temperature sensor is a chip that tells you what the ambient temperature is. The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin and is illustrated in figure 3. It is fairly simple to use, but requires careful timing to grab data.

III. Advantages of Home automation systems:

In recent years, wireless systems like Wi-Fi have become more and more common in home networking. Also in home and building automation systems, the use of wireless technologies gives several advantages that could not be achieved using a wired network only.

- 1) Reduced installation costs: First and foremost, installation costs are significantly reduced since no cabling is necessary. Wired solutions require cabling, where material as well as the professional laying of cables (e.g. into walls) is expensive.
- 2) System scalability and easy extension: Deploying a wireless network is especially advantageous when, due to new or changed requirements, extension of the network is necessary. In contrast to wired installations, in which cabling extension is tedious. This makes wireless installations a seminal investment.
- 3) Aesthetical benefits: Apart from covering a larger area, this attribute helps to full aesthetical requirements as well. Examples include representative buildings with all-glass architecture and historical buildings where design or conservatory reasons do not allow laying of cables.



4) Integration of mobile devices: With wireless networks, associating mobile devices such as PDAs and with the automation system becomes possible everywhere and at any time, as a device's exact physical location is no longer crucial for a connection (as long as the device is in reach of the network).

IV. FUTURE SCOPE

Future scope of the home automation system involves making homes even smarter. Homes can be interfaced with sensors including motion sensors, light sensors and temperature sensors and provide automated toggling of devices based on conditions. More energy can be conserved by ensuring occupation of the house before turning on devices and checking brightness and turning off lights if not necessary. The system can be integrated closely with home security solutions to allow greater control and safety for home owners. The next step would be to extend this system to automate a large scale environment, such as offices and factories. Home Automation offers a global standard for interoperable products. Standardization enables smart homes that can control appliances, lighting, environment, energy management and security as well as the expandability to connect with other networks. Using this system as framework, the system can be expanded to include various other options which could include home security feature like capturing the photo of a person moving around the house and storing it onto the cloud. This will reduce the data storage than using the CCTV camera which will record all the time and stores it. The system can be expanded for energy monitoring, or weather stations. This kind of a system with respective changes can be implemented in the hospitals for

disable people or in industries where human invasion is impossible or dangerous, and it can also be implemented for environmental monitoring.

V. CONCLUSIONS

In this paper, a novel architecture for low cost and flexible home control and monitoring system using Android based Smart phone is proposed and implemented. The proposed architecture utilizes a micro web server and Bluetooth communication as an interoperable application layer for communicating between the remote user and the home devices. Any Android based Smart phone with built in support for Wi-Fi can be used to access and control the devices at home. When a Wi-Fi connection is not available, mobile cellular networks such as 3G or 4G can be used to access the system. The system also uses the Google speech recognition engine thus eliminating the need for an external voice recognition module. Prospective future works include incorporating SMS and call alerts, and reducing the wiring changes for installing the proposed system in pre-existing houses by creating a wireless network within the home environment for controlling and monitoring the smart home environment. The proposed approach design and implementation of an Ethernet-based Smart Home intelligent system for monitoring the electrical energy consumption based upon the real time tracking of the devices at home an intelgalileo 2nd generation development board, which can be used in homes and societies. The proposed system works on real time monitoring and voice control, so that the electrical devices and switches can be remotely controlled and monitored with or without an android based app. It uses various sensors to not only monitor the real time device tracking but also maintain the



security of your house. It is monitored and controlled remotely from an android. Here we have focused on different process of operating or controlling electrical and electronic appliances remotely with the help of Arduino. This method of controlling such applications is referred to as automation. The experimental setup which we designed has its focal point on controlling different home appliances providing 100% efficiency. Due to advancement in technology, Wi-Fi network is easily available in all places like home, Office Building and Industrial Building so proposed wireless network easily controlled using any Wi-Fi network. The wiring cost is reduced. Since less wiring is required for the switches. This also eliminates power consumption inside the building when the loads were in off conditions. This system is also platform independent allowing any web browser in any platform to connect.

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