

Domotics – A Cost Effective Smart Home Automation System Using Wifi as Network Infrastructure

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Abstract

This paper describes an investigation into the potential for remote controlled operation of home automation (also called as Domotics) systems. It considers problems with their implementation, discusses possible solutions through various network technologies and indicates how to optimize the use of such systems. This paper emphasizes on the design and prototype implementation of new home automation system that uses WiFi technology as a network infrastructure connecting its parts. The proposed can be viewed on two fold; the first part is the software (web server), which presents system core that manages, controls, and monitors users' home. Users and system administrator can locally (LAN) or remotely (internet) manage the system code. Second part is hardware interface module, which provides appropriate interface to sensors and actuator of home automation system. Unlike most of available home automation system in the market the proposed system is scalable that one server can manage many hardware interface modules as long as it exists on WiFi network coverage.

Index terms-Domotics, Home automation, Networking, WiFi

I. INTRODUCTION

Home automation refers to the use of computer and information technology to control home appliances and features (such as windows or lighting). Home networking is the core in the implementation of an automation system for a smart home. Automated system has less manual operation, so that the flexibility, reliabilities are high and accurate [1]. Hence every field prefers automated control systems Most of the smart home applications are adopted with wireless networking methods, such as Zigbee, Wi-Fi, or 433 MHz radio frequency (RF) wireless communication [4]. There are various solutions available in the market for enabling smart home environment. Cameras, sensors like temperature, motion detection, light are used for data acquisition which is further processed by a microcontroller for decision making. The microcontroller not only processes the data to interpret the behavior of the surroundings where it is being installed but also controls the power outlets of the surroundings.

Home automation can also provide a remote interface to home appliances or the automation system itself, to provide control and monitoring on a smartphone or web browser. An example of remote monitoring in home automation could be triggered when a smoke detector detects a fire or smoke

condition, causing all lights in the house to blink to alert any occupants of the house in case of emergency. If the house is equipped with a home theatre, a home automation system can shut down all audio and video components to avoid distractions, or to make an audible announcement. The system could also call the home owner on their mobile phone to alert them, or call the fire department or alarm monitoring company

II. OBJECTIVES OF THE PAPER

The primary objective of a home automation system is to create Centralization of Control and Power and Ubiquitous access to the home network.

The objectives of the project include:

1. To design a robust, cost efficient and compact architecture for Home Automation System.
2. To implement the design using minimal and dependable Hardware components and Software's.
3. To demonstrate the possibility of a ubiquitous access to the home network using network technologies.
4. To propose a standardized remote-controlled HASs architecture.
5. To provide a user friendly graphical interfaces development.

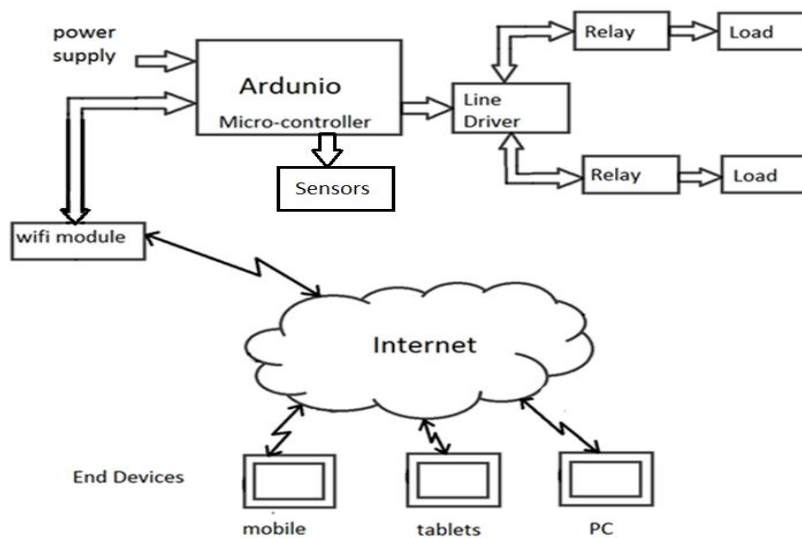


Figure 1: Block Diagram

III. ARCHITECTURAL OVERVIEW

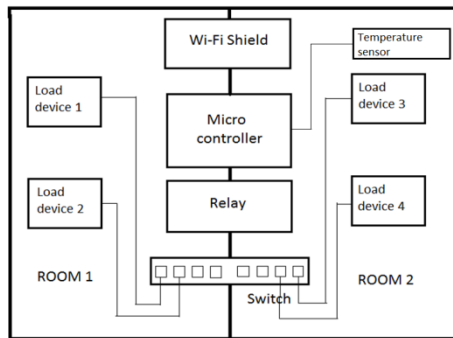


Figure 2: Layout Diagram

3.1 DESCRIPTION

The layout of the project is designed for two rooms as a prototype. The microcontroller board is the central console of the layout. It is integrated in between the two rooms to provide easy connectivity. The Wi-Fi Shield is mounted on the Arduino microcontroller board. The relay which drives the load devices are connected to the respective pins on the microcontroller board. The switches are controlled by the relay action. The load devices such as light bulbs, fans etc. are connected to the different switches provided in each room. The temperature sensor which is placed in one of the rooms is directly connected to the analog pin on the Arduino microcontroller board. This measures the live temperature of the room.

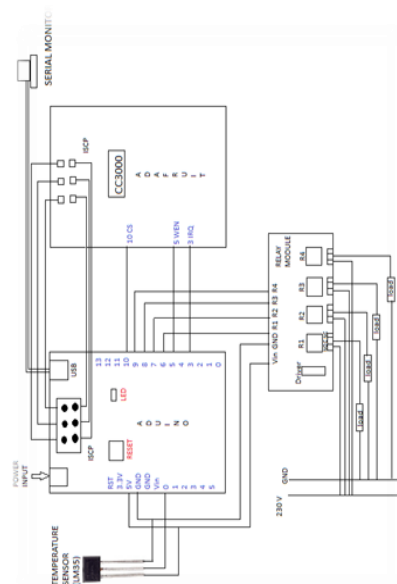


Figure 3: Circuit Diagram

IV. HARDWARE IMPLEMENTATION

The 4 channel 5V Relay module is used to connect the loads to the microcontroller. The Digital I/O pins numbered 6, 7, 8 & 9 on the Arduino board are used to connect the 4 relays [5]. The pins are set to OUTPUT mode and HIGH or LOW voltage is sent to the relay depending on the operation to be performed. The operations may be turn ON or OFF a device. The load devices such as bulbs, fans etc are connected to the relay. The relay has two more pins connected to the Arduino: Voltage and GND pins.

A temperature sensor is directly connected to the Arduino board which is implemented to note the current temperature of a room. An LM35 temperature sensor gives an analog voltage reading, which can be

converted to Celsius using the formula

$$\text{temp} = (5 * \text{val} * 100 / 1024) [7]$$

where "val" is the analog reading from the LM35 gives a centigrade temperature reading. The LM35 has 3 pins: Voltage IN, Voltage OUT and GND. The temperature sensor is powered with 5V DC from the Arduino board and the voltage is read through analog pin 0.

A serial monitor, which can be a computer, is connected to the USB port to monitor the events serially. All the serial communications and serial I/O can be monitored through the serial window.

The circuit illustrates the wired connections in the prototype model. The Arduino Uno microcontroller board is the central unit of the project which runs a code to control a Relay board according to the input and also serves a web page through which respective output to the relay board can be controlled. The software code is written into the Atmel ATmega328P microcontroller integrated in the Arduino Uno board using the Arduino IDE software. Arduino provide an Integrated Development Environment (IDE) which supports C/C++ Language for programming [4]. Arduino microcontroller board hosts an USB port through which serial communications can be executed which includes downloading the code and monitoring the serial output. The Arduino can be powered through the input power supply port or USB port. The Arduino Uno consists of on board LED indicator lights and a RESET button.

The Adafruit CC3000 is the Wi-Fi shield used in the project to wirelessly connect the microcontroller to an available network [5]. Adafruit shield is made for the Arduino board and it can be mounted on the Arduino board. The integration of the Wi-Fi shield to the Arduino is through few pins on the Arduino

V. SOFTWARE IMPLEMENTATION

This chapter elaborates the software development with the help of a flowchart describing the events that occur. It also includes a detailed approach to the execution of the code and the intermediate test output.

5.1: DESCRIPTION

The Arduino IDE is the software used for designing the code to handle the load and perform specific actions. A code including all the header files and functions needed is written in C Language to provide the solution to the defined problem. The structure of the code is primarily divided into 2 parts-setup() and loop(). The setup function includes I/O pin mode declaration, Serial Communication initialization, Server and Client initialization and other variable and function declarations. The loop function includes the main code which describes the solution for the stated problem. A function to scan for

the available SSIDs is run and the Wi-Fi connects to the preferred network, if available. An IP address is assigned to the Wi-Fi shield using the DHCP (Dynamic Host Configuration Protocol). In this project a client is initialized under the server and checked for its availability and connectivity. The webpage is the client in this project. The HTML (Hyper Text Markup Language) code is written such that the server waits for the instructions from the client (user). Based on the user's input from the web browser, the http server hosted on arduino signals the relay system to perform corresponding operations given by the arduino microcontroller

5.2 FLOWCHART

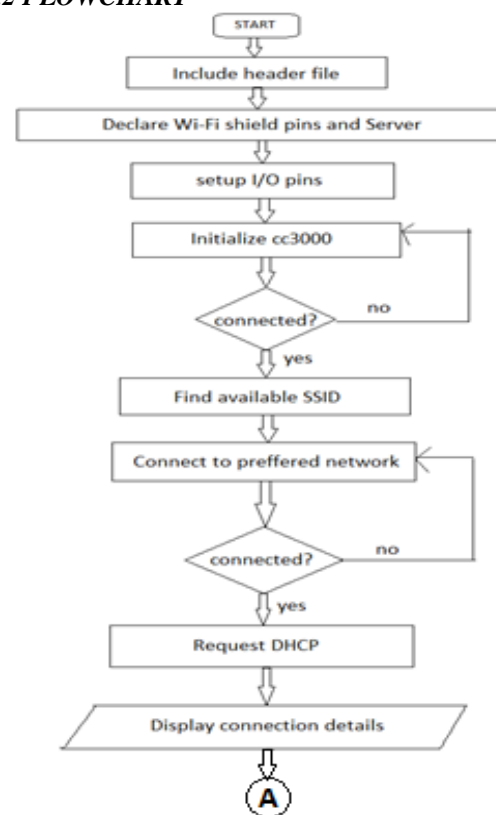


Figure 4: Flowchart for the arduino code

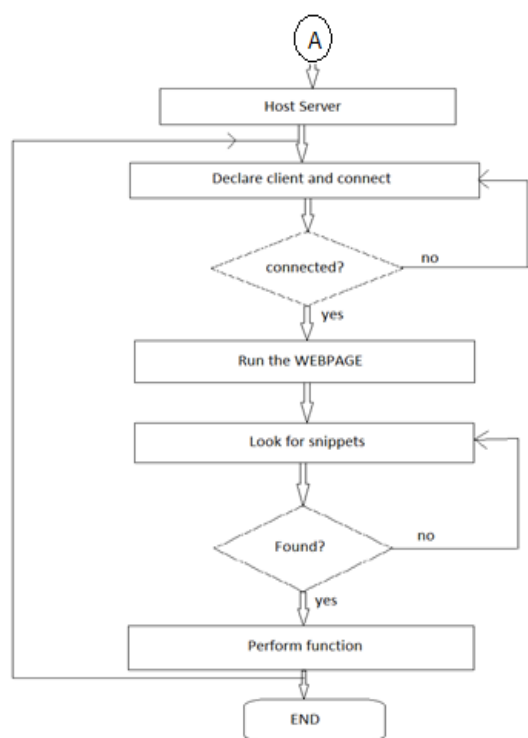


Figure 5:Flowchart Continued.

VI. APPLICATIONS

Using the home automation system, we can check up on the babysitter while at work, or your home while on vacation, through an internet connected video camera. Furthermore, it can adjust the thermostat while you lie in bed, or from a cell phone on your way home from work, heat the hot tub or turn on the oven on the way home from work through cell phone. Home automation system can also eliminate the need to walk around the house turning off lights before exiting the home or going to sleep, turn off all house lights with the touch of a single button. It can control all scheduled tasks, such as watering the lawn and outdoor lighting, with a simple computer program and most importantly it can organize and control every component of the home entertainment system—television, DVD, VCR and whole-house audio—with a single touch-screen remote from anywhere in the home

VII. COMPARISON OF DIFFERENT TECHNOLOGIES

In this section, we compare our WiFi method of realizing home automation with other methods of Home Automation to bring out the advantages of this technology over the others. From the Table, we can notice two important things. That is its range is very high and it is the most cost effective of all the methods available until now.

	RF	BLUETOOTH [3]	ZIGBEE [2]	WIFI
NETWORK	PAN	PAN	LAN	LAN/WAN
TOPOLOGY	P2P	STAR	MESH, STAR, TREE	STAR
POWER	LOW	VERY HIGH	MEDIUM	LOW
SPEED	400Kbps	700Kbps	250Kbps	11-100 Mbps
RANGE	< 3m	< 30m	10-200m	Not restricted
COST	MEDIUM	HIGH	MEDIUM	LOW

Table 1: Comparison Of Different Technologies

VIII. CONCLUSION

This project proposes a low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution. The approach discussed here is a novel and has achieved the target to control home appliances remotely using the Wi-Fi technology to connect devices and satisfy user needs and requirements. Wi-Fi technology has proved to provide remote control, home security and is cost-effective as compared to the previously existing systems. Hence we can conclude that the required goals and objectives of home automation system have been achieved.

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