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Home Automation System using Arduino

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Abstract: *Automation is the key to the current trends (system) being followed to transform them into a better, faster and reliable technological solutions or systems. Automation refers to technique of making systems control themselves with a view to reduce human effort. With this principle came the idea of our project "Home Automation System". The proposed project controls electrical appliances and components at home to be automatically or remotely controlled by the system or by the user respectively. The backbone of this system is the Arduino UNO microcontroller and Wireless Ethernet shield which provides the interface between the user and the appliances. Via internet (webpage) user can access or operate any connected device from anywhere and system also checks for any device left switched on by user to switch it off. With the use of various sensors (Infrared sensors, temperature sensors) and actuators entire connection is established between Ethernet shield and the device. System would also be able to monitor presence of any person inside the room and using this data, user can manage the operability of any connected devices. Modules can be integrated as and when required for easing the task and effort of human.*

Keywords: *Automation, Arduino UNO, Wireless Ethernet Shield, Infrared.*

I. Introduction

Home automation is a step toward what is referred to as the "Internet of Things," in which everything has an assigned IP address, and can be monitored and accessed remotely. Home Automation is also to be known as "Domotics" or "Domotica" as referred in [1]. It can be considered as extension of building automaton towards residential areas which involves handling or controlling of HVAC systems, security, or various electrical appliances. Conventional systems follow standard structure where switches or sensors are connected to a gateway. A user interface is used to handle the entire system for remote monitoring and can be interacted with any web interface or a static computer machine. Few infrastructure standards of a smart home system are pretty much distributed.

II. Background

As mentioned in [2], Home automation system involves various software and hardware components being intertwined to interconnect different electrical devices. Using buttons present on the user interface, user from any remote location, can manipulate or regulate HVAC system, switching on/off lights or other appliances timely to save energy. Entire system is laid on a wireless network with TCP/IP connections between the interfaces. The use of IP and MAC addresses eases out the identification of any device under consideration. The use of microcontrollers, sensors and actuators help the system to complete its functionality and work efficiently, thus saving electricity and hence money. All put in together working of 3 components in an orderly manner helps user to save his/her valuable time.

III. Related Work

A Home Automation System using Wi-Fi based technology was designed and implemented as mentioned in [3] to control and manage several local home devices. It enabled users to locally (LAN) manage and control home devices. The system consists of two modules namely- Server and Interface module. The Server monitors the devices and the Hardware module provides interface to the sensors. The system enabled user to access the server from any local station in the same LAN only. The device for automation used in this project was Micro-controllers. The data or the signal sent by the user was received by a Wi-Fi module connected to the Micro-controller. The System was better than most due to its scalability and flexibility along with its ability to provide Wireless transfer of data and signal response to the hardware control the devices. But lacked the range of operability and durability due to its static nature.

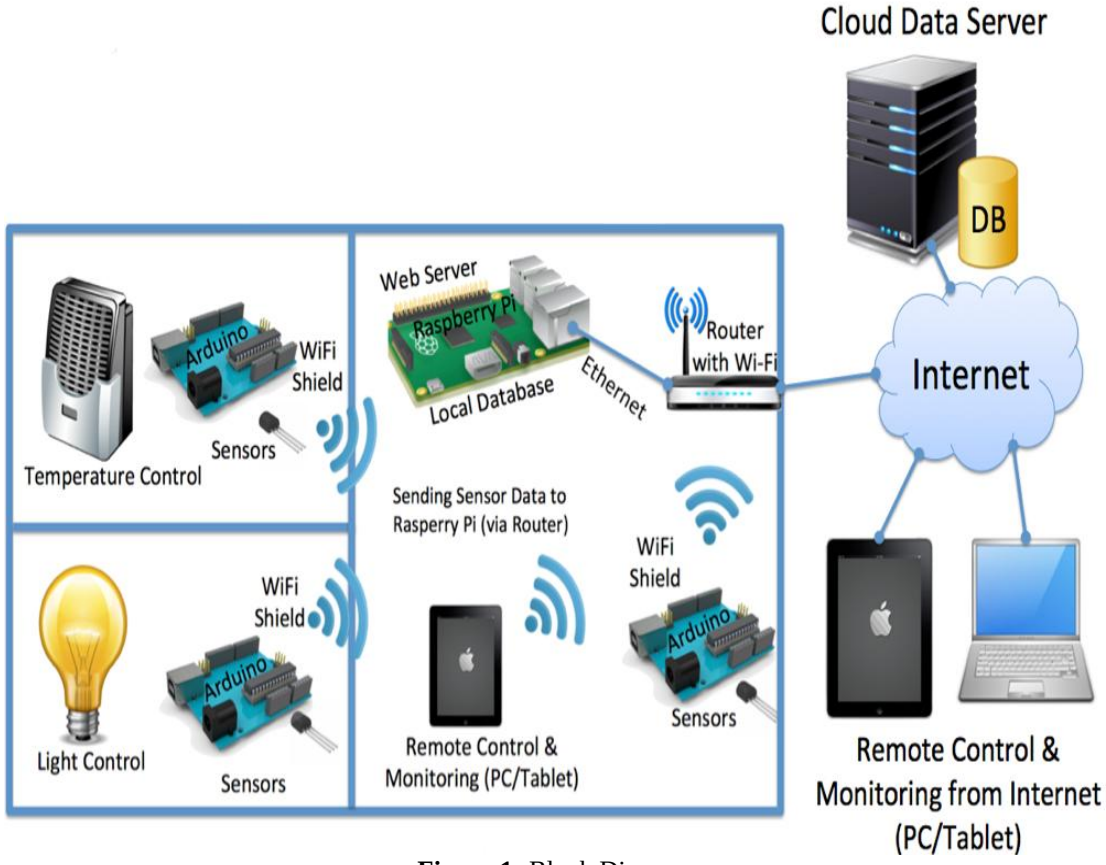

Figure 1: Block Diagram

IV. Proposed System

The proposed system is a Home automation system using internet as a medium to transfer user response for controlling devices. It too consists of two modules – User Communication module and Hardware interface module. The software module transmits the response given by the user via Internet/Server to the Arduino. The Arduino relays a corresponding signal and sends to the meant device. The most important part of the system is a Wireless Ethernet module that is connected to a router. The Ethernet module is also connected to the Arduino. The router after receiving the data sends the signal to the appropriate device using port forwarding. The router generates a Static IP address to make a successful communication with the devices. The Arduino is connected to a Gas sensor and an IR sensor. The System can be accessed from the web browser remotely from any mobile device connected to the Internet. The proposed Home automation System can control the following appliances- Lights On/Off, Air conditioner, Computer On/Off and monitor Gas Leakage at home and motion detection which can activate alarm or adjust temperature of the room accordingly.

The Gas sensor connected to the Arduino senses for the LPG (Butane and Iso-Butane) gas and if detected the Arduino is programmed to send a SMS to the user's Cell phone immediately informing the user of the leakage as in [4]. On the other hand, The IR receiver is used for the Air conditioner. The user sends a signal from the web browser which is further relayed by the router to the Arduino (Web Server) and the Arduino in turn sends the IR response of the particular signal to the Air Conditioner. The IR response depends on the make of the A/C which is programmed in the Arduino as in [5]. In order for operating (switching on/off) computer machine use of WOL (Wake on LAN) technology is used mentioned in [6]. The SMPS has some current being passed through it which can trigger the circuit to be completed and hence switching on the computer system.

Following figure is a flowchart depicting connection establishment & command execution:

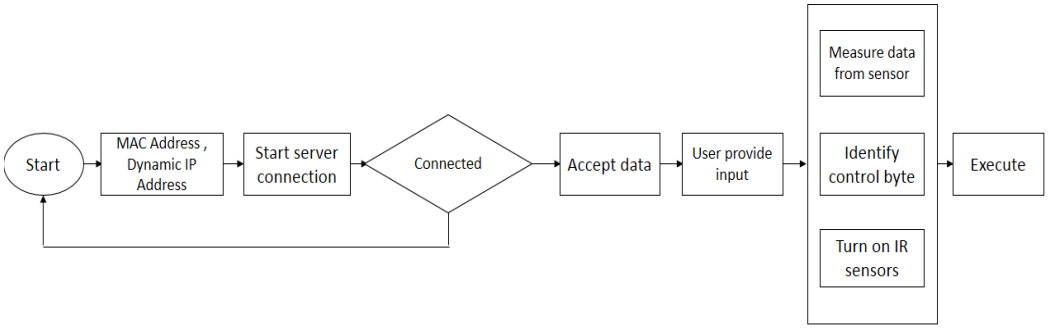

Figure 2: Overall Working

The System consists of three modules:

- USER INTERFACE
- WEB SERVER
- HARDWARE INTERFACE

4.1 USER INTERFACE

The Web browser is the User Interface via which the user communicates and gives signal to the devices. An HTML response is sent to the Arduino UNO as soon as the user sends any data over the Internet. The Web page provides a graphical way to monitor the devices and also control them. The user opens a URL on the Web browser from any Internet connected device and selects an operation for a particular home appliance and submits the response.

4.2 WEB SERVER

The data received from the user Interface or from the Sensors are processed by Arduino UNO micro-controller. The Arduino UNO is a programmable circuit board which has an extensive use in various fields. It is a self-contained board which can be interfaced with a computer/laptop via USB cables etc. It is used as a Web Server and is connected to a Wi-Fi router via Wi-Fi Shield. Using this shield, Arduino is linked with the internet and further provide various built-in libraries which helps in surfacing a web interface on a web browser. Now, the data from the Web page (User Interface) is sent to the router and the Arduino using port-forwarding and Wi-Fi Shield. Arduino is programmed with Embedded C to send corresponding IR signal to the device. This is the main platform using which the user gets the flexibility to monitor several home appliances. Arduino starts the connection whenever an attempt is made to reach the URL from the internet browser. The Wi-Fi Shield initiates the connection using Static IP address. And then after creating a virtual server enables it to run on dynamic address. But to reduce the cost by a significant amount use of ESP8266 serial port Wi-Fi module is used as the shield which has same functionality but with only main features available.

Figure 2: Arduino stacked upon Wi-Fi shield

4.3 HARDWARE INTERFACE

This module consists of actuators and Sensors along with the electrical components to be automated for regulation.

4.3.1 IR SENSORS

With this IR receiver one can obtain the codes for different A/C models. It makes it possible to send IR signal to devices. This is attached to Arduino using add-on module. It can send different IR signals depending upon different operations.

4.3.2 GAS SENSORS

It is used to detect LPG gas in the environment. It can detect leakage and Arduino can be programmed accordingly to immediately notify the user by sending a SMS on his mobile phone whenever the gas above a certain threshold is detected in the environment. MQ-2 and MQ-6 are the generic gas sensors used in the system.

4.3.3 RELAYS

Relays are actually used as a switch to control high powered devices with a tiny signal form Arduino. It allows the devices to be controlled remotely by the relay of signals.

Figure 3: Gas Sensor

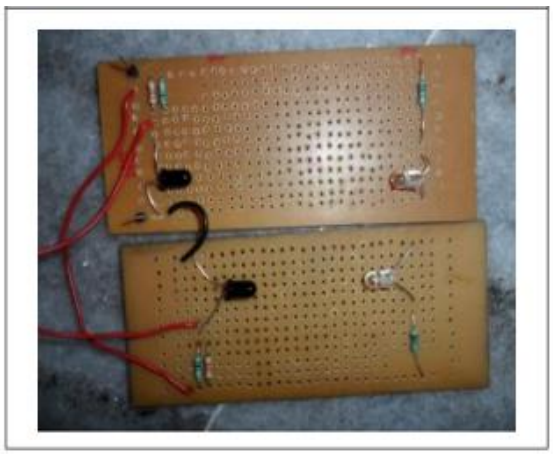

Figure 4: IR Sensor

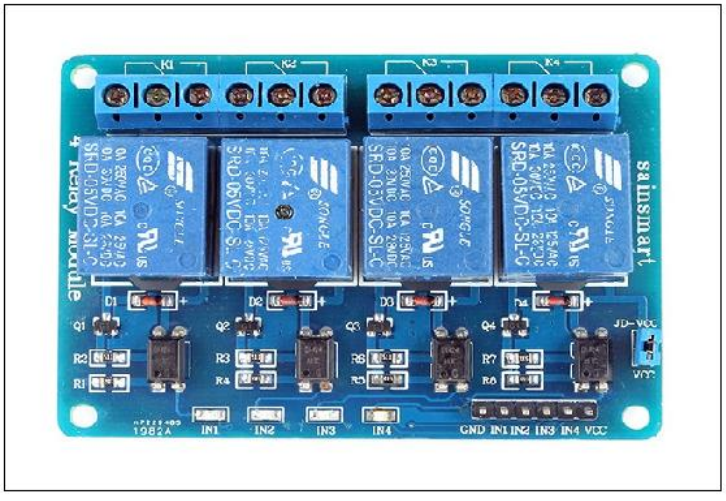

Figure 5: 4 channel relay board

V. Result

System is stable, convenient to use and easily manageable. After partial implementation of the system and research, results were obtained based on the following parameters along with description:

PARAMETER	DESCRIPTION
COST	Significant cost reduction as compared to previous similar projects with the use of ESP8266 Wi-Fi module (4000 RS. cheaper than Arduino shield)
SCALABILITY	New modules can be integrated or added without affecting the functionality of other modules.
RANGE OF OPERABILITY	Increased range of control over devices as the system can be handled over the internet.

VI. Conclusion & Future scope

In the design proposed above we have implemented a Wireless home automation control system using Arduino Uno microcontroller which is very simple and feasible to use. For the web application various web technologies (HTML & CSS) is provided to provide simple reflexive UI. This makes work easier for users by complete automation of necessary various appliances and other components. The safety of user is considered and hence wiring the devices with server is done with utmost care. Further in this current system we can build cross platform system that can be deployed on android, iOS, Windows etc. Limitation to control only necessary devices can be removed by automating all other home appliances. Security feature can also be done by installing cameras, allowing the user to observe activity around a home as in [7]. System can also include motion sensors that will detect any kind of unauthorized, suspicious movement and notify the user immediately. Moreover appliances can be handled using spoken commands and hand gestures.

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