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Wireless Home Automated System Using Web Application and Remote Control

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ABSTRACT:This study presents the design and implementation of a wireless home automation system based on Arduino Uno microcontroller and ZigBee as the central controller. The system provides the means of managing and supervising the devices by the use of Web Application and remote control in an appropriate way. The system is developed and incorporated with web application by the home gateway for web interoperability. To support the usefulness and effectiveness of the system, Liquide Crystal Display (LCD) screen, remote control, interior controller, the exterior controller is developed and appraised.

KEY WORDS: Home automation,Arduino Uno, ZigBee, home appliances, remote control, webapplication

I. INTRODUCTION

Home appliances are fixed separately in a house and each has a switch which will be used by human to control it. In a house where there are many appliances, it will take humans time before they can manage them. But with a centralised device, the appliances can be controlled within a minute especially in a time of emergency or if there is fire outbreak. The system relief human from moving up and down to manage the appliances, and bridges the gap between being at home and controlling them away from home with the use of the web applications.

Home automation introduces the technology in the home with the aim of improving the standard of living of its residents by supplying the various services such as conservation of energy, telehealth and multi-median amusement. Traditional home automation focusses mainly on managing digital appliances that supply the task such as shading, lighting, door, television and heating, and with the growth in advanced information technology, additional services are required to improve the traditional system [1]. And today, many home, office and organization activities may be mechanized and managed by a remote-control device which may be within or Exterior the office and home. A remote is a wireless device designed to be held in the hand and used for controlling various settings by pressing buttons [2]. With the general increase of purchaser's computing electronic appliances such as mobile phones and media players, the group of people that are adopting the technology in their daily life are increasing in number [3], and this allows people to have a way of controlling home in the areas like communication, power saving, home media, comfort, home media, security and related issues[2].

Arduino Uno is a microcontroller board and is regarded as an open source appliance deployed to develop programs for the boards. It may be deployed to receive input from sensors and produces light as output, it allows the communication between the users and objects to be effective[4]. It is uncostly, flexible, proffers diversity of analogue and digital inputs, serial interface, Pulse Width Modulation and digital outputs. It is linked to the computer through the Universal Serial Bus and interacts deploying conventional serial rules. Arduino Uno is an incorporated circuit comprises of microcontroller, assorted programmable input/output lines, 8-23 bits registers, 30kb flash memory and ATMega328RISK [2].

ZigBee is a standard device for wireless network aimed at supervising, managing and constructing home mechanization [5]. It is developed to connect self-governing actuators and sensors to control sections based upon low energy usage [6]. ZigBee network has been classified into three major components: router, device and coordinator. The router supplies an interaction medium between the appliances, and it supports and may act as receiver/transmitter. The coordinator transmits information and controls the functions which define the network [7].

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At the end of this proposed system, a wireless home automation system will be designed using Arduino, and ZigBee. The system will comprise of three devices; device 1 is a remote control that will be used with LCD screen to control the light. Device 2 controls Exterior light; the light will turn off automatically when sun comes-up and turn on when the sun goes down and it also controls the gate. Device 3 controls lights in four rooms and the light level of the room will be altered using a dimmer

II.STATEMENT OF THE PROBLEM

Many authors have designed and implemented home automation system using ZigBee, Arduino Uno and LCD screen and it was discovered that they can only control the appliances whenever the residents are at home, once they are away from the house, they don't have control over the house appliances again. A study [2] tried in 2014 by incorporating an Android application into a home automation system which can be used as a remote to control home appliances but it was not successful.

There may be an emergency that will come up and the resident will not be able to put the appliances in order before leaving the house or the residents may decide to switch **'OFF'** the appliances during the daytime and **'ON'** them in the night when they are away from the house. With this web application incorporated in the wireless home automation system to be used as a remote control, appliances can be controlled anywhere and anytime all over the world. In the light of the above need, a wireless home automation system using microcontroller boards and the ZigBee with a remote control to control the interior and Exterior light, the gate through the servo, and web application arebeen design and implemented. It can be used to control other home appliances such as such as fan, heater, and freezer.

III. RELATED WORKS

Several research involving wireless home automated system using Arduino Uno, ZigBee, LCD and Bluetooth have been conducted in the past. This section presents a review of someof these works.

Agbo et al [8] developeda smart home controller that uses an Android device through the Bluetooth to manage the operation of security door system automatically. The system uses an Android phone to send a command to the security module installed on the door, as the security module received it, module passes the command to the microcontroller that closes and opens the door.

Another home automated system that uses Arduino Uno was designed with different relevant modules that permit the remote control of fan or light using sensor data for the changes made [9]. The system is expandable, inexpensive, bringing convenience, energy efficiency and accessibility

In another study [2] a home automated system was developed using Arduino, ZigBee and android application. The system has a remote control used with LCD screen that controls interior and exterior home electrical gadget that combines android phone application. Interior controller controls four rooms light and the light level of room four can be altered using a dimmer switch. From outside, servo gate opens automatically when it senses a shadow, and the gate closes if it does not sense a shadow. Then automatically, the exterior light turns "OFF" when the sun comes up and turn "ON" when the sun goes down.

Samuel et al in [10] developed a home security alert system that used ZigBee, Microcontroller, resistance temperature to detect the temperature, a smoke sensor to detect smoke, and a vibration sensor to detects forced entry through the windows and the doors. At the point of entering the password, the microcontroller deactivates the security feature, activates the alarm and sends the image of the burglary through the ZigBee to the person in charge as well as sending a message to the resident when fire/smoke is detected.

Lartigue et al. [11] developed a wireless home security system based on ZigBee standard. The system uses ZigBee modules, Arduino Microcontroller, passive infrared sensor, a magnetic contact sensor, automated door lock and android application. The house doors are remotely locked and unlocked; Graphics User Interface is developed for the user to interact with the home security system and the android application is integrated which enable the residents to receive the update messages concerning the security situation of the house when they are not at home.

Fang et al. [12] present a LED lights intelligent control system based on ZigBee technology. The system utilized the CC2430 chip, Arduino, photosensitive and passive infrared sensors are deployed to discover the presence of difference or change from within the environment, and network, router, terminal equipment and coordinator are used to perceive wireless clever control of LED lights

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In another study [13] a wireless real-time home automation system was developed using Arduino Uno microcontroller. The system uses cellular phone, appliances and sensors. Two operational modes are developed; manual-automated by which device is accessed and supervised through cellular phone and self-automated mode.
Nayan et al. [7] developed ZigBee communication technology that acts as interaction medium for the sensors and hardware in a mechanized house system for the smart home. The LCD (Liquid Crystal Display) screen is deployed to show the system's result on a receiver and microcontroller manages the results and sensors of the system. The sensors are used to send signals to the microcontroller when they sense any difference or change within the home.

IV. DESIGN AND METHOD

The core of this wireless home automation system was grouped into two major designs: hardware and software designs. The hardware design was arranged into units which comprising of Remote and Interior Control Unit and Exterior Control Unit and Software design including Arduino integrated developer kits Environment with C++ programming language, web-server with PHP support, processing IDE, and the home gateway. Figure 1 demonstrates the proposed home automation system architecture

HARDWARE DESIGN:

Remote and Interior Control Unit

The main function of this unit is to control the interior light of four rooms and the fourth room light used a dimmer receives a message whenever the outer light is on/off and displayed the state of the light on the LCD screen. This unit was built using Arduino Uno controller board, ZigBee, a remote, break board, LCD screen and infrared sensor. ZigBee series 2 was recommended for designing this work because it enabled easy and simple interaction between point to point and microcontrollers, and point to multipoint interaction. A remote communicates to interior control through the infrared sensors to either switch on/off the interior light respectively. The LCD screen was placed on break board, and connected to Arduino board using the following pins; RS pin was connected to digital pin 12, Enable pin was connected to digital pin 11, D4 pin was connected to digital pin 5, D5 pin was connected to digital pin 4, D6 pin was connected to digital pin 3, D7 pin was connected to digital pin 2 and also connected to 5V and GND. The broken board also connected four LEDs' positive legs to pin A2, 8, 9, and 13 respectively for digital read and the four negative legs are connected through the 220Ω resistor to the ground respectively. Figure 2 showed Remote and Interior Control Circuit

Exterior Control Unit

The main function of this control unit performs is to inform the interior control unit whenever the outer light was on/off at sunrise or sunset respectively. The Arduino, ZigBee, break the board, LED, Servo and photo resistor were used. The positive leg of LED was connected to pin 11 on Arduino board and negative leg was connected to GND. The positive leg of Photo resistor was connected to 5V and negative leg through the 220Ω resistor to GND connected for both outer light and servo gate. The servo signal wire was connected to pin 13 on Arduino board and to the 5v and GND on break board and it was used to automatically open the gate whenever the photo-resistor sensed a shadow and closed it when there was no shadow. Figure 3 showed Exterior Control Circuit

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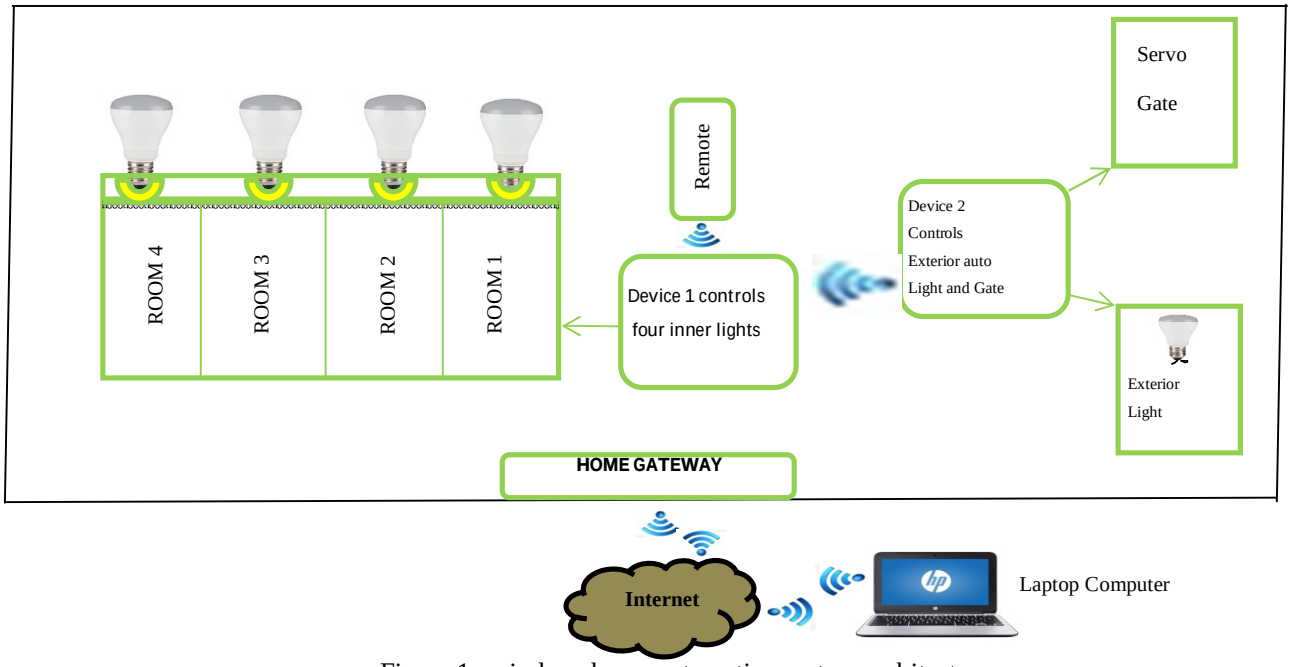

Figure 1: wireless home automation system architecture

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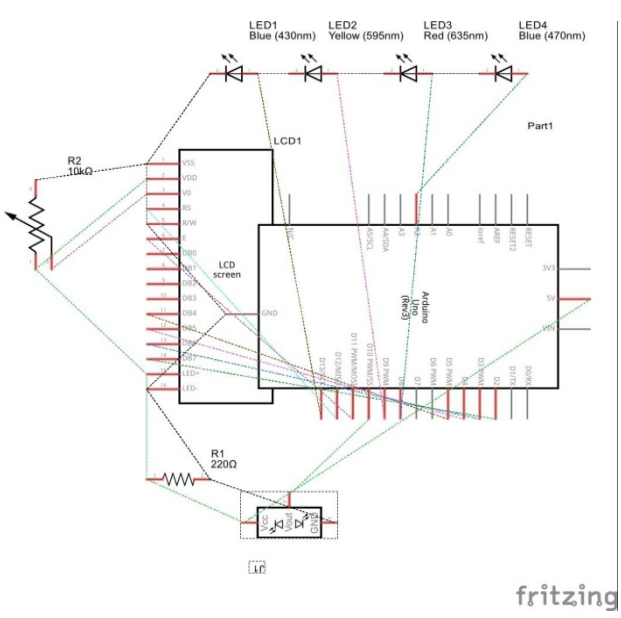

Figure 2 Remote and Interior Control Circuit

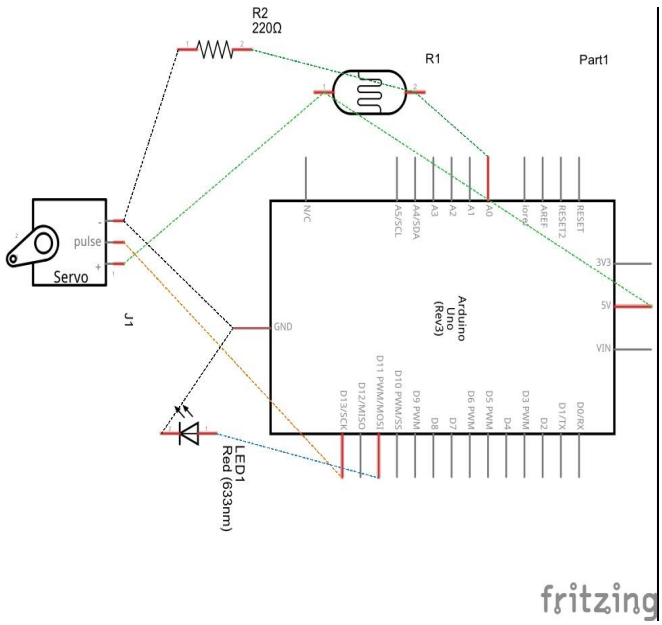

Figure 3 Exterior Control Circuit

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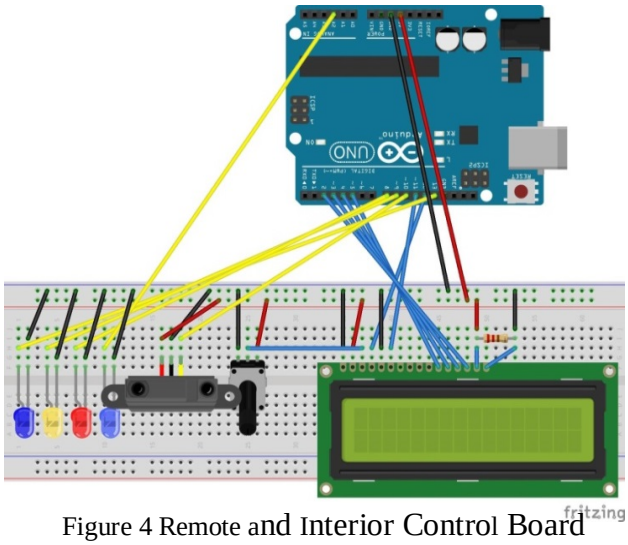

Figure 4 Remote and Interior Control Board

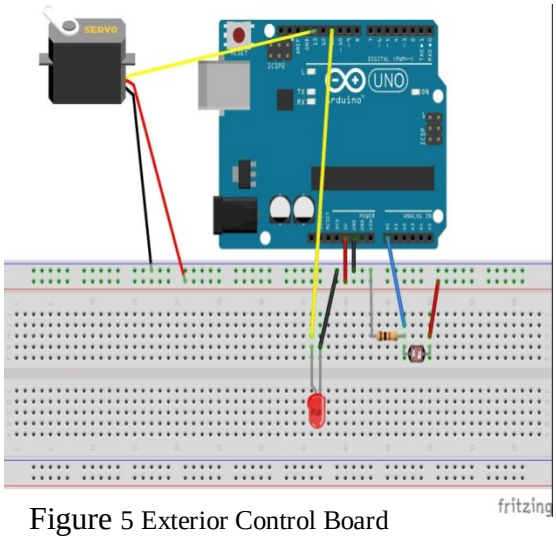

Figure 5 Exterior Control Board

SOFTWARE DESIGN

The X-CTU software supply by Digi International was used for the configuration and testing of the two ZigBee. Before the software communicates with the ZigBee, the baud rate has to be configured. The information may be communicated and shown by the ZigBee module. Arduino integrated development kits environment was used to design the software Because, it permits the compilation, writing and uploading of code to the board. C++ programming language, web server with PHP support were used.

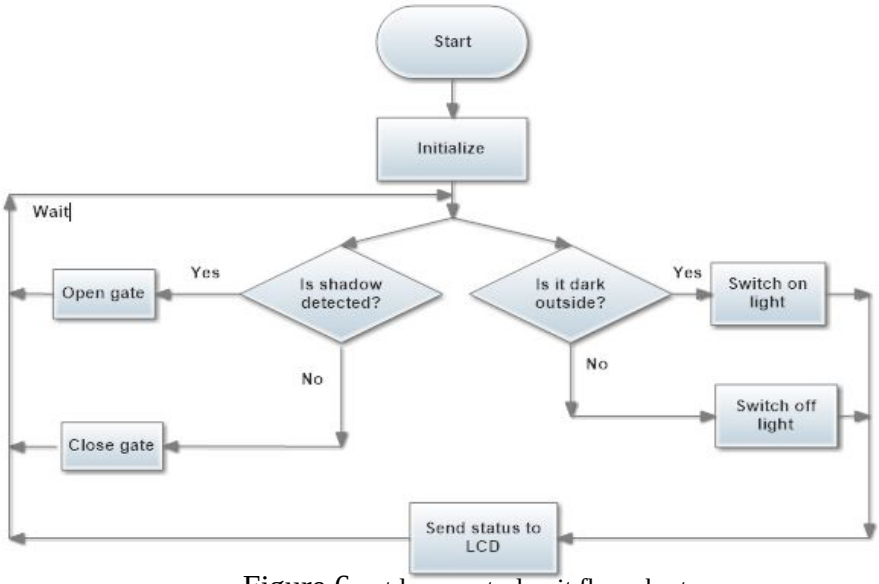

Figure 6 outdoor control unit flow chart

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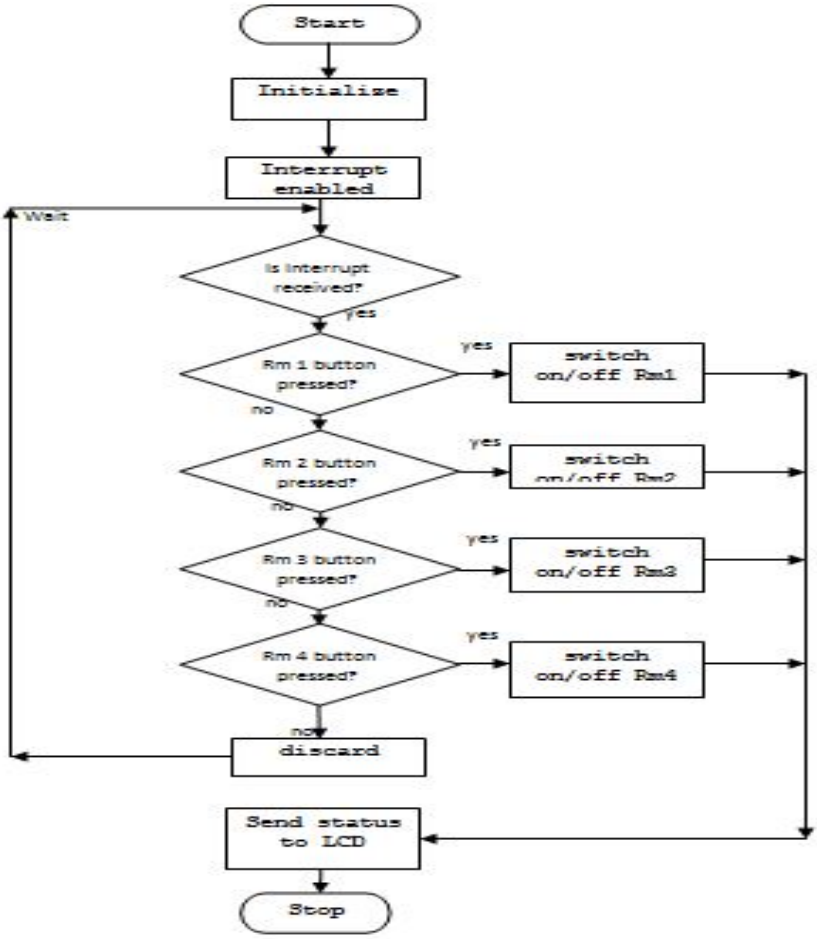

Figure 7: Remote control Flow Chat

V. IMPLEMENTATION

Three programs were developed, two for device 1 and 2 and one for a web application: the first is a program uploaded in device 1which enabled the remote to instruct the interior system to switch “ON” or “OFF” the lights of four rooms respectively and display the action performs on the LCD screen. It enables the interior system to receive the instruction from the remote and perform the task. Second is a program uploaded in device 2 which enabled the Exterior control system to automatically switch “ON” or “OFF” the light whenever there is sunset or sunrise respectively and to open the servo gate when photoresistor senses a shadow and close it when there is no shadow. It enables the Exterior system to inform interior system anytime that there is a state.

The functionality of three devices was successfully implemented and incorporated in two devices, and communication between the two devices was successfully implemented. But it was observed that the response of the devices are slow and output of the state change of Exterior light does not display sometimes in accordance with what is required.

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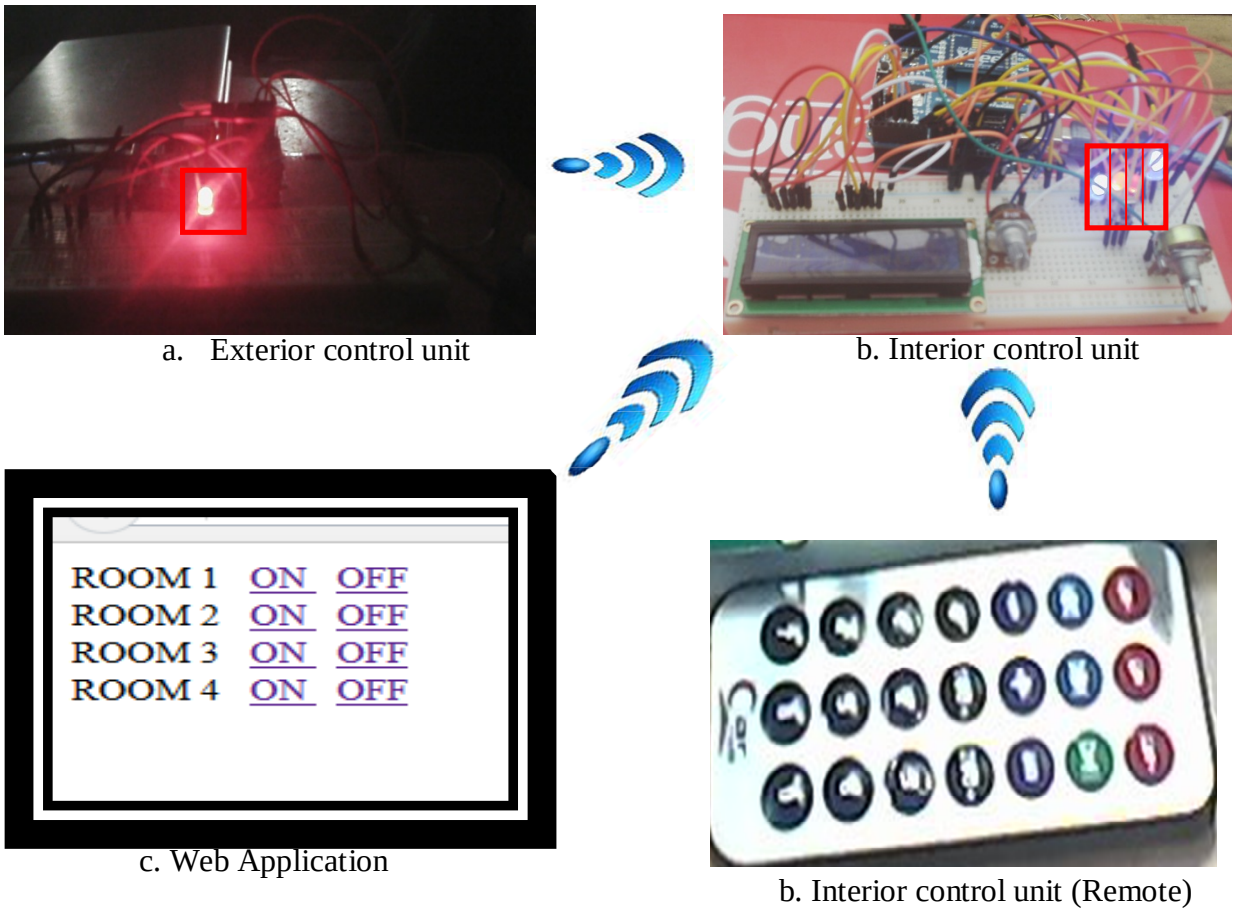

a. Exterior control unit

b. Interior control unit

c. Web Application

b. Interior control unit (Remote)

Figure 8 Hardware Implementation of the Proposed System

Consider figure 7, the proposed system operated in two modes, firstly, the interior control unit used manually automated mode; the lights are monitored and controlled manually by using a remote control and web application. The flow chat indicates the process in figure 6. In this mode, the light detection status is carried out by the Arduino Uno. The resident may select the required light by using a remote-control key or web application button and the selected light will on/off based on the resident's desire.

The second one is self-automated mode; the Exterior controller monitors and controls the devices automatically by switching "ON" or "OFF" the light at sunrise/sunset respectively. It opens the servo gate when the photo-resistor senses the shadow and closes it when there is no shadow. The residents can only monitor the action.

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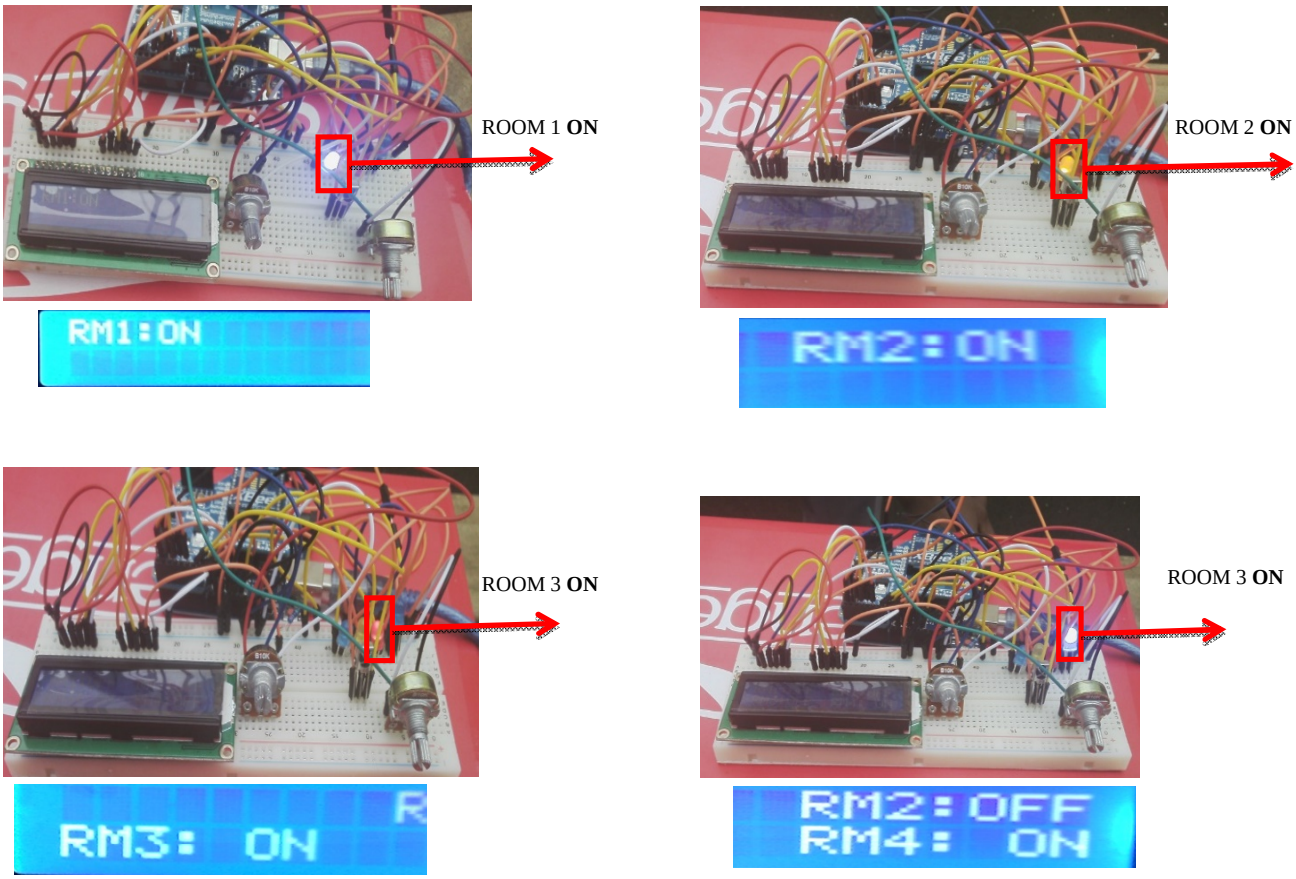

Figure 9: The Light State of Interior Unit

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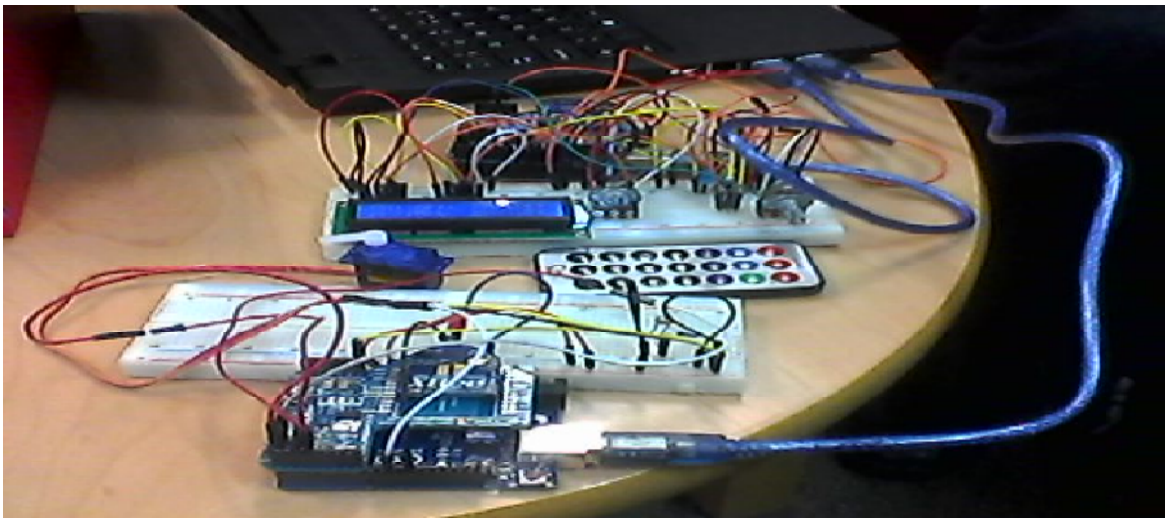

Figure 10: The Exterior and Interior devices with change state of lights on LCD screen

VI. HOW IT WORKS

This section explains how the system works to achieve the aim of this research work. The remote control is used by humans to instruct the interior controller through the infrared sensor to switch on/off the light of four rooms respectively and the key press from remote determine the state of the lights which displays on Liquid Crystal Display (LCD) Screen. Automatically, the Exterior controller switches off the Exterior light at sunrise and switches off the light at sunset, and servo opens when the photoresistor senses a shadow and closes when there is no shadow.
The Exterior controller informs the interior controller when the servo gate opens/closes and when the Exterior light is on/off and the state of Exterior light is displayed on the LCD screen. Humans use the web application to control and monitor the interior and appliances through the internet anywhere all over the world as they use the remote control to manage house appliances when they are in the house.

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VII. RESULTS AND DISCUSSION

The system has been designed, implemented and evaluated. To prove and demonstrate the effectiveness and practicality of the system; two devices and web application were developed. The first is a remote control with LCD and interior control system linked to four lights in different rooms; the second is Exterior control system linked to Exterior light and servo gate and the third is a web application which serves as an online remote control that enables the control of home automation system anywhere all-over the world. All the devices were subjected to testing rigorously and some errors and delays have been noticed between the remote-control button press and interior light response, and sometimes device 1 (interior) received a wrong message from device 2. The system functions as required.
Due to limited time, three devices were incorporated into two devices and as a result of that, the interior and Exterior control system could not inform the remote control when there is a state change in either Exterior light, servo gate or interior lights respectively

VIII. CONCLUSION

As technology advance in this present time, people are more interested in using wireless devices and web application as a means of controlling home appliances such as lights, fans, doors, gates, freezers etc. An integrating web application to manage home appliances anywhere makes it a convenient for man and to have full control over house appliances even when he is away from the house. The wireless home automation developed in this research work; remote control, interior device and exterior device communicate with each other, except for the exterior device that could not inform the remote control when there is a change in either Exterior light, servo gate or interior lights. Web application communicate perfectly with the two devices.

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