Development of Wireless Light Control System Based on Arduino and CC1101

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Abstract—**The Internet of Things (IoT) drives the enhancement within Information and communication technology (ICT). It has been used to improve productivity, safety and quality of life. In recent years, smart home application has been applying the concept of IoT so that the users can remotely monitor their properties through internet network. In this paper, we designed and implemented a light controlling system via wireless sensor network using Arduino board and CC1101-chip, which supports the smart home application security systems. In order to solve the interconnection problem between wireless sensor network and the internet, a small solution for wireless light control system embedded with web server has been designed. The system should be able to convert user's command into radio frequency and send to specific device linked to wireless sensor network. Overall, the design framework of the system was introduced and analyzed, which include the hardware design and software implementation. The hardware used in this paper includes the Arduino Uno R3, Arduino UNO R3, Arduino Nano, Arduino Ethernet Shield, CC1101-chip of Texas Instruments (TI) and relay. The software implemented is developed based on C++. Test results of this system showed that lights on the end device or node that connect to the wireless sensor network can be controlled by any web browser within local area network (LAN).**

Index Terms—**Wireless Light Control; CC1101; Arduino; WSN.**

I. INTRODUCTION

With the emergence of internet of things (IOT), the principles that gave rise to the internet are now leading to new kind of network of everyday devices, an "Internet-0" [1]. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It is a physical computing platform based on a simple microcontroller board, and able to programme software for the board through Integrated Development Environment (IDE). Arduino has its own software editor, debugger and compiling tools for user to write the coding and upload it to the board. In addition, Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motor, and other physical outputs [2]. In this paper, wireless light control system was developed via Arduino Uno R3, Radio Frequency (RF) and other related components so that users are able to control the light through a tiny web server.

The critical hardware structure is the base station and node. Base station should be able to host a tiny web server that allows system to host the web site for user to control light via Local Area Network (LAN). Arduino microcontroller was chosen as the main component to build the low-power consumption web server. However, a single Arduino microcontroller board only can handle Ethernet shield or wireless communication module. Inter-Integrated Circuit (I2C) bus protocol technology is used to solve the problem connection or communication between two Arduino boards.

The radio frequency communication module CC1101 is a very low power Radio Frequency (RF) communication component that combines the excellent performance of a leading RF transceiver with an industry-standard enhanced microcontroller base on 8051(MCU 8051). Besides, the component is also equipped with in-system programmable flash memory, 8-KB RAM, and many other powerful features. The CC1101 is highly suitable for systems where ultra-low power consumption is required [3]. Wake-on Radio is also one of the reasons that CC1101 is being used for the wireless communication module between base station and node.

This paper showed that the user is able to control the light via any kind of browser that runs on personal computer, mobile phone or tablet. Besides, this system is able to run on cross platform. The user is able to access the base station through any operating system, which includes windows, Mac OS, iOS, Linux and etc.

II. METHODOLOGY

Figure 1 shows the system framework applied in Arduino wireless light control network. The user is able to send their command to the base station via any web browser, which includes the personal computer, notebook, mobile phone or tablet that is ready to be connected to the same Local Area Network (LAN) with the base station.

CC1101-chip of Texas Instruments (TI) is used in wireless communication between the base station and the node. The base station is responsible to manage the whole wireless sensor network and the communication with the user.

The base station and the node used C++ programming languange. Each node will behave its unique id and address. The node will receive the command from the base station and switch on or off the light as per user's request. User can control the system through internet browser. Base station is designed to host a simple web site that allows user to communicate with it.
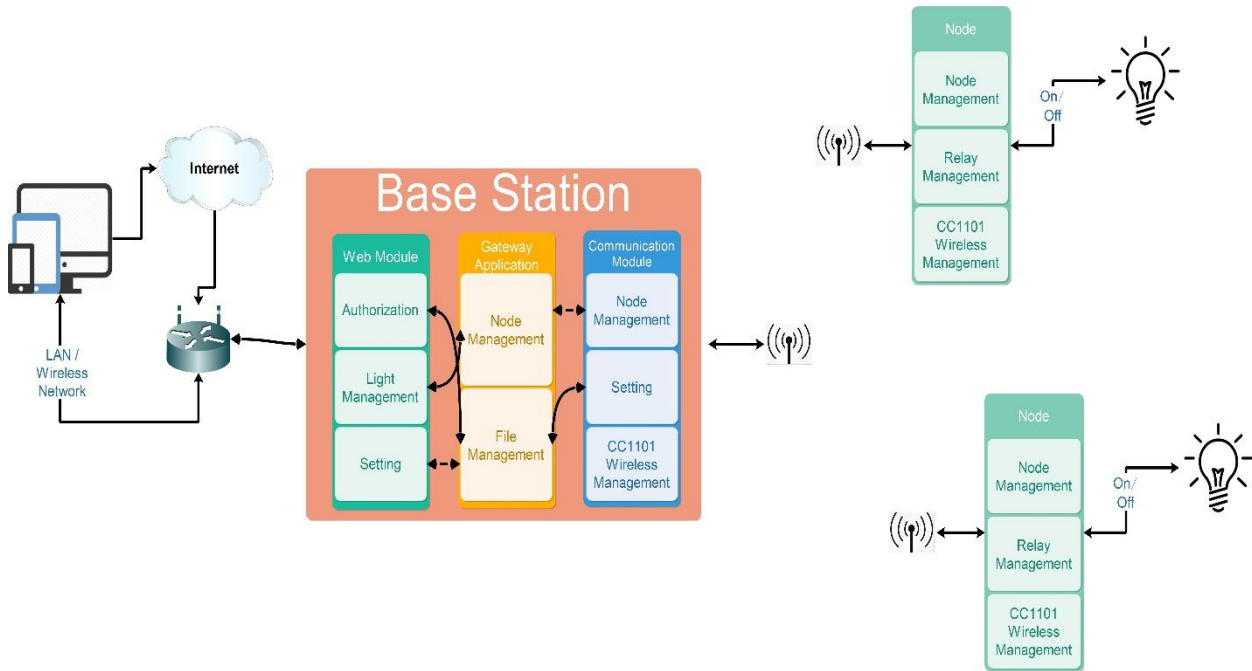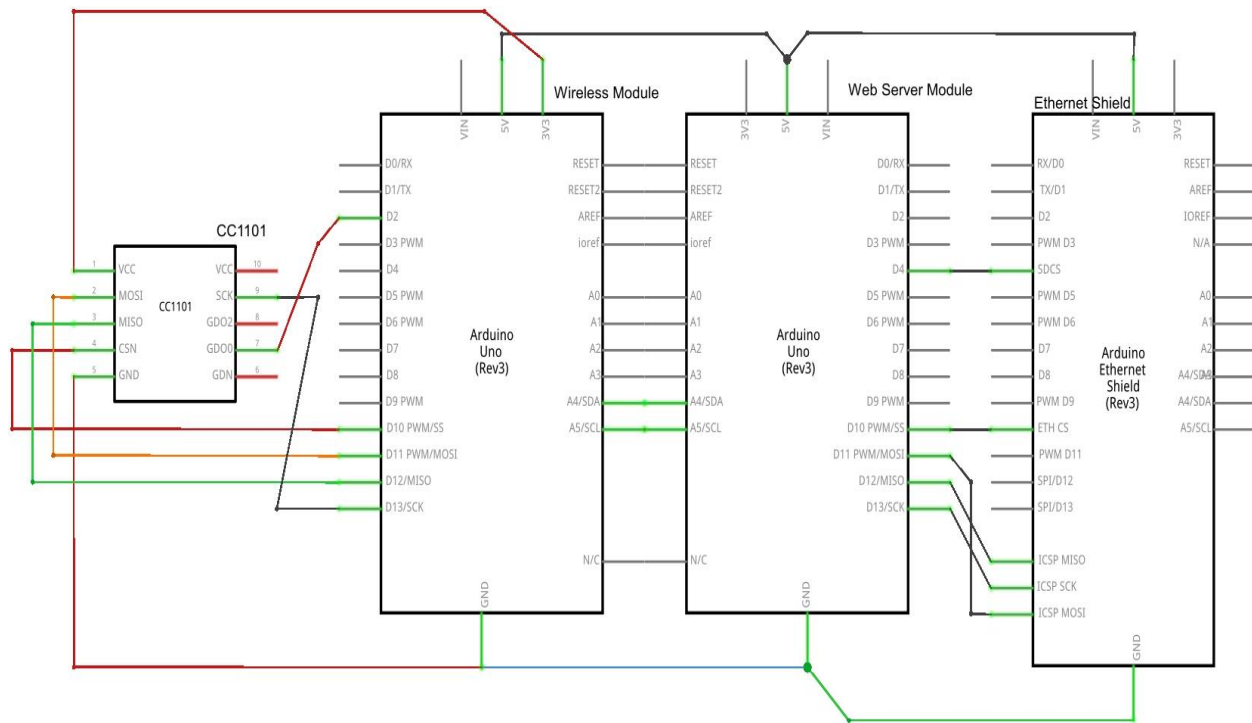
Figure 1: System Framework

Figure 2: Hardware Design for Base Station

A. Hardware Structure

Figure 2 shows the base station hardware design. In this paper, the base station uses 3 Arduino boards, which is an Arduino Uno R3, Arduino UNO R3 board and Arduino Ethernet shield. The connection between Arduino Uno R3 and Arduino Ethernet shield is through 5v, GND, pin 4, pin 10 to pin 13. The integrated cuircuit (I2C) bus protocol, also known as the two wire interface is a simple serial communication protocol that uses just two pins of a microcontroller namely SCL (serial clock) and SDA (serial data) [4].

For this paper, Arduino Uno R3 and Arduino UNO R3 request to connect the 5v, GND, pin A4 (SCL) and pin A5 (SDA) for exchange data purpose. Arduino Uno R3 is connected to Web server module through the ethernet connections. The web server module is meant to host the website that allows user to browse and send command to the base station. The base station will then execute the command. The advantage of using website is to allow user to connect base station using any devices that can connect to the internet.

Arduino UNO R3 that connects to the CC1101-chip, named as Wireless module is the critical modules which allow the base station to communicate with the node through radio frequency of 433 MHz. Figure 3 and Figure 4 show the base station and node respectively.

Figure 3: Base Station Design

Figure 4: Node Design

B. Software Structure

The software structure contains web site and communication development using ATmega328. Besides that, wireless sensors network and communication between base station and node are also being developed.

Arduino code basically uses C/C++ programming language. Arduino uses a set of standard libraries to hide some of the functionalities behind the curtain [5]. The C++ becomes the primary programming language in developing the main core and the wireless communication.

HTML, java script and XML were used to develop the website that is hosted at the Ethernet shield. The web site is stored in micro-SD card and pluged into Ethernet shield, so that the user can browse it anytime.

Figure 5 shows the flow chart that describes the control algorithm on the base station. The base station controls Arduino Uno R3 and Arduino UNO R3 board. It is mainly functioned to set the input and output serial port that have already been defined in the setup. After that, it will initialize the Ethernet shield which establishes the connection with LAN. This process fixes the IP address from the router and defines the MAC address for the Ethernet shield so that the router can identify it. This process will loop until it gets the IP address from router before starting the web server. When the IP address is assigned by the router, the system will turn in a standby mode until the user makes a connection request to the web server through any internet browser. User can control the light (i.e. to switch on or off) via web server through the XML script. When the user's commands are captured by the web server module, it will transfer the command to wireless module.

Wireless module will analyse the user's command, and will transmit the command to the specify node to switch on or off the light. If the command is successful transmitted, the wireless module will wait for further updates response from the node. The base station will then be in idle mode and wait for user next command.
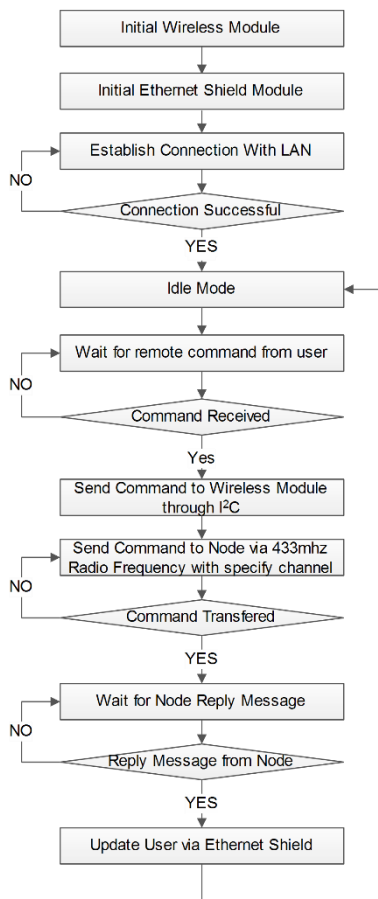

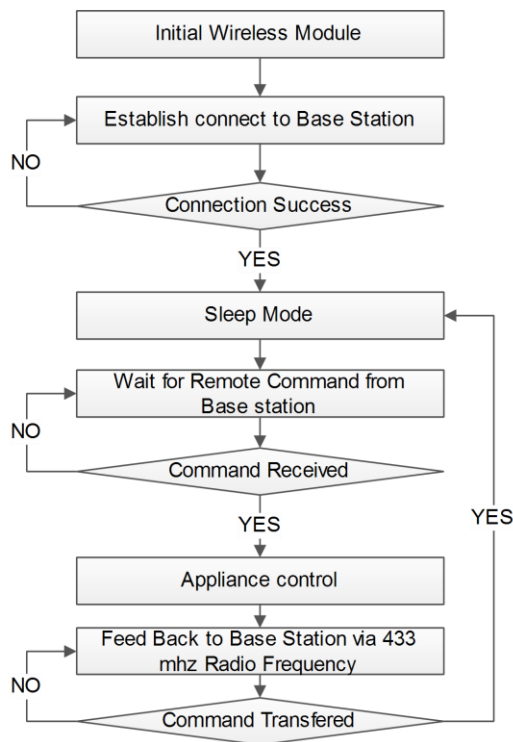Figure 5: The flow chart that describe control algorithm on the base station

Figure 6: The flow chart that describe control algorithm on the node

C. Installation Node Station Diagram

Figure 7 shows that the electrical diagram after the installation of the node station. Its usage may need to connect the Live (L) wire into the node station so that user can remotely control the light via this system.
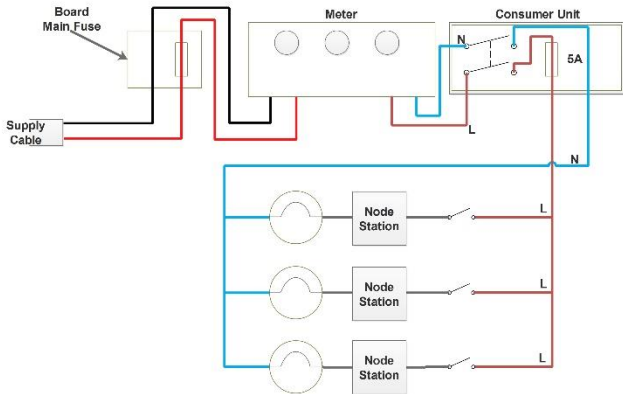

Figure 7: Electrical diagram

III. RESULTS AND DISCUSSIONS

Testing is the critical process to prove the system design is a success or fail. This paper applies black-box testing methodology, which is a method of software testing that examines the functionality of an application without peering into its internal structures or workings [6]. When user browses the web from any device, the base station will then generate instructions to the specific node that is connected to the base station.

Figure 8(a), Figure 8(b), and Figure 8(c) show that user is able to switch on or off the light through laptop and smart phone The devices are running on different operating system, which are Windows, Android, and iOS via build in browser.

(a)

(b)

(c)

Figure 8, (a) Test Result on Window, (b) Test Result on Android, (c) Test Result on iOS

User is able to control each of the light that is installed with the wireless node. This in turn increases the home security systems. By having to control specific lights remotely, the amount of electrical energy used can be reduced also.

IV. CONCLUSION

In this research, the Arduino Uno R3, Arduino UNO R3 and Arduino Nano microcontroller were used as the basic controller. The CC1101-chip wireless communication module was used to control the wireless light system. The test result showed that the system has successfully embedded web server into the wireless light control system. It allows the user to manage the light control through LAN or any other remote divices such as such as smart phone of laptop. This system is suitable not only for smart home application, but it can also be used by industries or street light control.

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