Design and implementation of prototype smart plug at home automation based on bluetooth using Arduino Uno

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Abstract. Home automation is one of the simplify daily activities at home. Automation of the stop contact system, can make the switch operation be shortening. Arduino Uno is used as the main controller in a smart plug system. Server systems made wide the device. Bluetooth module HC-05 is used as a wireless transmission medium. The result tests got a maximum range of 17 meters with barrier and 20 meters in open space. Delay occurs with a time of 400ms. by conditioning on or off to take a trigger of contactor in a home.

1. Introduction
A lot of innovations have been made to make a process simplifier and get benefits in human life. Humans are being depend on technological developments including property areas.

Home automation system is use of information technologies and control system to reduce the human labor [1]. The main characteristic of home automation system is remote monitoring and access of home appliances and systems [2]. Research for home automation will increase revenue and global development within 2015-2020 [3]. One of the innovations is Home Automation (HA). It is created to make variety of processes more simplifier. It covers, such as Smart Plug systems that can be connected and off itself. SmartPlug is a plug that can be used as a tool for measuring electrical energy and also can be used as a remote control using an internet connection [4]. It is a sub-systems HA which can facilitate it is user either in turning on or disconnecting to the contact, based on command. Usually, plugging or un plugging has been done manually in each house, so is took times much. Bluetooth is one of the wireless technology used in stop contact control of the house.

Bluetooth is one of the different wireless technology alternatives to Wi-Fi. Bluetooth is widely used on smartphones, and many devices require a connection between two devices. The Bluetooth module will be paired to the Arduino Uno board in order to send and receive Bluetooth signals. The Bluetooth module is very easy to use with a microcontroller to create wireless applications [5]. Arduino Uno is used as a manager and a logical organizer on or off that converts digital signal commands to analog to control the electrical outlet. The electrical control system still uses a manual power outlet, that is unplug and plug in. It is placed in a hidden and hard to reach. So, Bluetooth is needed to overcome this problem. Electrical outlet is the basic of all household electrical appliances, this prototype is designed to be able on electronic devices in general.
2. Method
In this research, the steps are taken to obtain the intended results in Prototype Smart Plug at Home Automation Based on Bluetooth using Arduino Uno that made in the form of a flowchart as shown in Figure 1, below.

![Flowchart research method](Image)

Can be seen on figure 1, literature review, identification of problem, and analysis needs which has been done in this research. The last, the problem will be found and it must be solved by this system, to be analyzed.

2.1. Smart home
The lighting, security, temperature, ventilation, and entertainment system is a system that is common in a conventional home in which it can stand alone. One of them could be controlled individually by using remote control, switch, etc. People must be adapting to all system, such as lighting levels, temperature and security protections at night, individually [6].

2.2. Arduino uno
Arduino Uno is a board microcontroller based board on ATmega328. Arduino is a widely used open-source microcontroller board based on simple input-output pins, which could be analog or digital and equipped with ability of functional expansions [7]. It has 14 digital input/output pin (6 pins are used as PWM output), 6 analog inputs, 16 MHz crystal oscillator, USB connection, electrical jack reset button. This system uses only one board by downloading serially to a PC [8].

2.3. Bluetooth
Bluetooth is a technology that allows two devices compatible, such as smartphones and PCS used a wireless and visible channel connections. We can see before, where the keyboard is connected to the computer. Now, bluetooth improves the use of cable technology which is complicated.

Bluetooth has the same function nearly with wireless local area network (WLAN) which uses IEEE 802.11 standard radio frequency, the services and transferring data are still shorter but it needs lower power. Compared with LTE and Wi-Fi technologies, Bluetooth consumes less energy while communicating with other terminals [9]. Since Bluetooth employs a frequency hopping technology, it has a relatively higher resistance to interference in data transmission than other technologies [9].

Bluetooth HC-05 is a wireless communication module on the 2.4Ghz frequency with a choice of connections can be as a slave or a master. The effective range is 10 meters, although it can reach more than 10 meters, but the quality of the connection decreases. It is very easy to use with a microcontroller to create wireless applications. The interfaces used are serial RXD, TXD, VCC and GND [10].

3. Results and discussion
3.1. Design
Making a transmission process data to relay is part of design prototype. The data could be taken from Arduino device which has been installed by special application in order to transmit data via bluetooth, as shown in figure 2 below.
Android has been chosen, because it is commonly used, easy to operate and applicable. Interface of this android is very simple. It consists of the ON and OFF commands as well as the option to pair against bluetooth, as in figure 3 below.

![Android Bluetooth 1
HC-05
Board 1   
Arduino Uno
Board 2   
Arduino Uno
Bluetooth 2 
HC-05
Bluetooth 3 
HC-05
Board 3   
Arduino UnoRelay
Plug-in](image2)

**Figure 2.** Flowchart design.

**Figure 3.** User interface android application.

Arduino as a medium input/output controller in which different coding must be given based on their function. There are 3 boards which use different coding. All the boards which can continue data from smartphone to the relay have been uploaded by code. Repetition program used delay 100 ms, as data reading which has received. It makes power efficiency, so there is no request repeatedly.

3.2. Implementation

Assembling board Arduino based on prototype specification is one of the implementation. They must be connected to USB 5 voltage, laptop, power bank or adaptor. The next, press ON or OFF if android device paired to module bluetooth 1, as in Figure 4 below.

![Implementation board module 1 & 2.](image3)

**Figure 4.** Implementation board module 1 & 2.

Relay which is used 5 voltages and connected to the power of house as plug in, it could be seen from output pin 13 on the 3 board.
The results of prototype will be taken as the whole result of this research. Distance optimization in each module bluetooth in which could be done or not. Should the lamp ON or OFF on android. It could be seen of table 1.

| Distance | Condition |
|----------|-----------|
| 1 meter  | Connected |
| 2 meter  | Connected |
| 3 meter  | Connected |
| 4 meter  | Connected |
| 5 meter  | Connected |
| 6 meter  | Connected |
| 7 meter  | Connected |
| 8 meter  | Connected |
| 9 meter  | Unstable  |
| > 10 meter | Unstable |

Measuring of module bluetooth 1 to android. The distance between 1 – 9 meters, the data could be well transmitted. It could be seen on monitor serial. But, the bluetooth has not connected again on 9 meters more. It is said that the smart plug prototype can be used in a medium house or not too big.

The second test, using the wall as a signal barrier bluetooth transmission. It has taken, that the distancing of change got in 1 meter. The wall can obstruct bluetooth signal beam from smartphone to module server. Shown as table 2.

| Distance | Condition |
|----------|-----------|
| 1 meter  | Connected |
| 2 meter  | Connected |
| 3 meter  | Connected |
| 4 meter  | Connected |
| 5 meter  | Connected |
| 6 meter  | Connected |
| 7 meter  | Connected |
| 8 meter  | Unstable  |
| 9 meter  | Unstable  |
| > 10 meter | Unstable |
4. Conclusion
All the systems work very well. The first board received android data. The second board continued the first data board using bluetooth transmission. The third board which is received bluetooth data. Continued to the relay and connected to the plug which used 220 voltages (Indonesia standard).

The data has been taken from parameters. The output which is such as a lamp that is plugging into the smart plug prototype. It could be ON or OFF, according to the command of user.

The next data is the distancing that could be reached by bluetooth radius. So, there is no cable everywhere. This prototype is very satisfactory, maximal 8 meters with the wall barrier, and 9 meters without wall it could reach the house, generally.

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