Smarthome Using Android Smartphone, Arduino uno Microcontroller and Relay Module

Nanang Sadikin$^1$
Marliana Sari$^2$
Busye Sanjaya$^3$

$^{1,3}$Universitas Islam Attahiriyah. Jalan Kampung Melayu Kecil III No. 15 Jakarta.
$^2$Politeknik Negeri Medan. Jalan Almamater No 1 USU, Medan.
nanang_sadikin@yahoo.com

Abstract. Today life become easy and simple because of technology. Internet become the key for enables remote anything from anywhere. One of this application is smarthome system. Smarthome system able to control electric and electronic equipment from remote. This system able to control electric and electronic equipment such as television, air conditioner, microwave, lamps, fan, etc using smartphone from the Internet. Power off and on all devices can be done remotely. Steps in design of smarthome systems are using waterfall methods that is problem identification and data collection in planning process, requirement analysis, hardware and software integration design, application design, and testing. This system build using Arduino uno microcontroller, android smartphone, relay module, web server and ethernet module.

1. Introduction
Technology widely used today in our life. There is no barrier anymore such as time and distance. Computer is used in every aspect of life that make process become more effective and efficient. Not only standalone, computer used in network for user collaboration. Internet is global computer network in the world, which can be used anytime and anywhere. Internet provide function and feature as sophisticated communication and information media, thus provide efficiency. With Internet, now everything in home is undercontrol. We can remote devices such as lights, fan, television, refrigerator by online. As long as Internet connection available, we can turn on or off devices from anywhere and anytime.

Microcontroller
Microcontroller control function of electronic board. Microcontroller integrated circuit consist of CPU, memory, timer, serial and pararel port, input/output port, analog to digital converter (ADC), etc. History of microcontroller begin with history of microprocessor in the 1971, Intel 4004 is the first microprocessor, and in 1972, TMS 1000 is the first microcontroller created by Gary Boone from Texas Instrument. In 1974, some of IC factory offering microprocessor and controller using microprocessor such as Intel 8080, 8085, Motorola 6800, Signetics 6502, Zilog Z80, and Texas instruments 9900. In 1976, Intel build first microcontroller Intel 8048, and next in 1980 Intel 8051 or widely known as MCS51. In 1996 Atmel AVR microcontroller launch by Atmel. Atmel AVR widely used until today. AVR is a RISC (Reduce Instruction Set Computing) microcontroller. AVR is stand for Advance Versatile RISC.[5]
Smartphone
Smartphone is an intelligent phone which has the capability of a computer. Smartphone categorizes as a high-end mobile phone equipped with mobile computing capability. With mobile computing capability, smartphone has a higher performance than ordinary phones. The first smartphone is a combination between personal digital assistant (PDA) and mobile phones or phone with camera. Today's, smartphone also have capability as a portable media player, low-end digital compact camera, pocket video camera and GPS. Smartphone modern also equipped with high resolution touch screen, browser with full web access like PC, also wifi and broadband access.[3]

Android
Android is a software for mobile devices which include operating system, middleware and core application. Android is completed with Android SDK (Software Development Kit) that provides tools and support API (Application Programming Interface) for developing applications in the Android platform using Java programming language.
Android application written using Java programming language, that is Java code compiled along with data and resource file needed by application connected by Android Asset Packaging Tool (AAPT) becomes an Android package, a file with extension .apk. This file is distributed as an application and installed in mobile devices.[3][4]

Arduino
Arduino is an open-source electronic board which main component is a microcontroller chip. Microcontroller is a chip or IC (integrated circuit) that can be programmed using a computer. Program is recorded in the order of electronic circuit that can read input, process and generate output in accordance with the expected result. Output can be signal, amount of voltage, light, voices, vibration, motion, etc. There are many microcontrollers around us, such as in mobile phones, MP3 players, DVD players, TVs, air conditioners, through car and motorbike electricity systems. Microcontroller also use as a driver for robots from toys until factory robots.[2][6][7].

Wireless Sensor Network
Wireless Sensor Network is a type of distributed wireless network, which uses Embedded System technology and sensor node devices, doing censoring, monitoring, sending data, and deliver information to the user by internet. There are many types of sensors, such as humidity, radiation, temperature, pressure, mechanic, motion, vibration, position, etc. Every type of sensor has its own software (application, operating system) and hardware, integrated to the Wireless Sensor Network system.[1]
In Wireless Sensor Network there are some of sensor node. There are three components in sensor node: Sensor, Actuator and Transducer.
Sensor is a hardware or devices which perform scanning such as temperature, humidity, radiation, etc. Sensor performs input function for all stimuli in their environment. For the output we need to know about the actuator.
Actuator define as a device or computer hardware which perform output function from input that they receive from sensor, also control external devices. Then completed function from a system called Wireless Sensor Network.

Transducer define as a something, which can be in form of physical such as devices or virtual, which performing to help the energy conversion from one form to another, due to works which perform by sensor in the environment scanning and Actuator which control devices. In Transducer need to know what is become input (sensor) and what become output (Actuator). Transducer can in form of thermal, speed, voice, etc.
1. If transducer is heat, then sensor in form of input devices (thermostat, thermistor, thermocouple, resistive temperature detector) and Actuator in form of output device (heater, fan).
2. If transducer is voice, then sensor in form of input device (carbon microphone, piezo electric crystal) and Actuator in form of output device (loudspeaker, bell, buzzer).
3. If transducer is speed, then sensor in form of input device (doppler effect sensor, tacho generator, slotted opto coupler) and Actuator in form of output device (brake, stepper, AC DC motor)
4. If transducer is pressure, then sensor in form of input device (strain gauge, pressure switch, load cells) and Actuator in form of output device (vibration, electromagnet, lift and jack).
5. In Wireless Sensor Network implementation, there is autonomous Computer act as a sensor and sensing board act as a actuator. Both of them joint become sensor node, act as a transducer.

**Relay**

Relay is a switch which operate by electrical and is a Electromechanical component consist of two main parts : electromagnet (coil) and mechanical switch. Relay use electromagnetic principle to move switch with low power voltage to conduct high voltage electric. For example, Relay that use 5V and 50ma can be move Armature Relay as a switch to conduct electric 220V 2A[10].

![Figure 1. Relay](image)

**Blynk**

Blynk is new platform which enable you for fast build interface untuk mengendalikan dan monitor your hardware project from iOS and Android. After download Blynk application, you can create project dashboard and set button, skidder, graphic, and other widget to the screen. Using widget, you can activate pin and turn off or show censor data.

Hardware is easy to build since there are many tutorial available, but software interface more difficult. But Blynk makes create software interface is easy than hardware. Blynk perfect for building projects likes temperature monitoring or turn on/off light from remote.

Blynk support Arduino, Raspberry Pi, and many others microcontroller board. Also support ESP8266, Ethernet Shield, or direct from USB computer.[8]

2. **System Analysis and Design**

There are many appliances in the home used for day to day activity, such as lights, television, radio, air conditioner, microwave, refrigerator, fan, etc. To turn on or off that devices, it is use switch on available in the wall, or by using remote control, or plug the devices to the electricity source on the wall. All the way for turn on or off that devices is still manual works, it must be some doing it from home.[9].

The minus of this manual work is, if the owner not in home, all of devices can not be control from remote or automatic. Smarthome system designed for controlling all of devices in the home, even the person is not in the location. This smarthome system connected to the Internet and all devices can be controlled using android smartphone brings by person.

For example, a person forget to turn of light when he leaves and he just remember when he not in the location, then using this smarthome systems, lights can be shutdown from remote.
### System Requirement Analysis

In the system requirement analysis, the system will be built determined from how users easily perform its roles. Usability is the capability of human functional terms to be used easily and effectively by the specified range of users, given specific training and user support, to fulfill the specified range of tasks, within the specified range of environment scenario.[4]

System requirement analysis used in order to know what we need in smarthome systems. Device that is used as smarthome systems are:

1. Microcontroller Arduino Uno.
2. Android smartphone.
3. Relay module.

Microcontroller Arduino Uno is used as controller device that controls the relay module which controls lamps and other appliances in the smarthome systems. This microcontroller Arduino Uno is connected to the Internet, where Android smartphone via Blynk server on the cloud control microcontroller Arduino Uno.

### System Design

System design is the next step after system analysis cycle, define from functional requirements, engineering implementation preparation describe how a system is build. Build system can be illustration, description, and draft design or alignment from separate elements into integrating system, including configuration from hardware and software components of systems.

![System Design](image1)

**Figure 2. System Design**

The above figure explains about smarthome systems that work to control appliances in the home. Blynk App on the Android Smartphone connected to the Blynk Server on the cloud and Blynk server will control the Arduino Uno boards that connect to the Internet. Arduino Uno drives the relay module connected to the appliance.

#### 2.1. Hardware Design

Figure below shows hardware design for smarthome systems:

![Hardware Design](image2)

**Figure 3. Hardware Design**
Hardware design for smarthome system consist of two block. The first block is Arduino uno microcontroller boards that connected to the Internet and second block is relay module connected to the appliance.

3. Application Design
Blynk is platform for iOS and Android application for controlling Arduino, Raspberry Pi and other microcontroller board by Internet. This is digital dashboard where graphical interface build for project by using widget. Blynk widely support for board and shield. Blynk support your hardware choices, Arduino or Raspberry Pi. Internet by using Wi-Fi, Ethernet and ESP8266, Blynk can create control by online (Internet Of Things). Blynk APP available on Google play store will be used in Smartphone for creating interface and control system cloud server.

The Flowchart below show step for create application for control Arduino uno in Blynk.

![Flowchart](image)

**Figure 4. Steps of Create Blynk Application**

4. System Testing Result
Testing method for this system is using black box method. Black box testing is testing fundamental aspect of system without considering internal logic structure of software. This method used in order to know if software is running properly. Black box testing is method design testing data based on software specification created.
Table 1 summarize testing result from this smarthome system.

| No | Button pressed | Lamp Status | Expected output | Result | Conclusion |
|----|---------------|-------------|----------------|--------|------------|
| 1  | TV            | Green lights on | Green lights can be turn off | Lights off | Accepted   |
|    | TV            | Green lights off | Green lights can be turn on | Lights on  | Accepted   |
| 2  | Kukas         | Yellow lights on | Yellow lights can be turn off | Lights off | Accepted   |
|    | Kukas         | Yellow lights off | Yellow lights can be turn on | Lights on  | Accepted   |
| 3  | Kipas         | Red lights on   | Red lights can be turn off  | Lights off | Accepted   |
|    | Kipas         | Red lights off  | Red lights can be turn on   | Lights on  | Accepted   |
| 4  | Lampu         | Blue lights on  | Blue lights can be turn off | Lights off | Accepted   |
|    | Lampu         | Blue lights off | Blue lights can be turn on  | Lights on  | Accepted   |
| 5  | All           | All off lights on | All lights on | All lights off | Accepted |
|    | All           | All off lights off | All lights off | All lights off | Accepted |

5. Conclusion
After testing we can conclude that electric equipment can control by remote from anywhere and anytime using this smarthome system, using smartphone, blynk and arduino uno.

References
[1] Pratama, I Putu Agus Eka and Sinung Suakanto, Wireless Sensor Network, Bandung, Indonesia: Penerbit Informatika, 2015.
[2] Ardianto, Heri dan Aan Darmawan, Arduino Belajar Cepat Dan Pemrograman, Bandung, Indonesia: Penerbit Informatika, 2016.
[3] Sahaat, Nazarudin, Android Pemrograman Aplikasi Mobile Smartphone dan Tablet PC Berbasis Android, Bandung, Indonesia: Penerbit Informatika, 2012
[4] Kadir, Abdul, Buku Pintar Pemrograman Arduino, Jakarta, Indonesia: Penerbit Elex Media Komputindo, 2015
[5] Saftari, Firmansyah, Proyek Robotik Keren Dengan Arduino, Jakarta, Indonesia: Penerbit Elex Media Komputindo, 2015
[6] Arduino Boards (2016) on ARDUINO. [Online]. Available: http://arduino.cc/en/Main/ArduinoBoards
[7] Arduino Ethernet Shield (2016) on ARDUINO. [Online]. Available: https://www.arduino.cc/en/Main/ArduinoEthernetShield
[8] Blynk (2015) on BLYNK. [Online]. Available: http://docs.blynk.cc/
[9] Azhar, Alam (2012) on INSTRUMENT CONTROLLING. [Online]. Available: http://instrumentcontrolling.blogspot.co.id/2012/06/pengertian-sistem-kontrol.html
[10] Satriawan Wijaya (2009) on TEKNIK ELEKTRONIKA [Online]. Available: http://teknikelektronika.com/pengertian-relay-fungsi-relay/