CHAPTER 3
METHODS

In the process of comparing the performance of an audio signal at different distance, a proper planning is important to achieve the goal of this project research. The flow of this project has been discussed in this chapter.

3.1. Project Plan

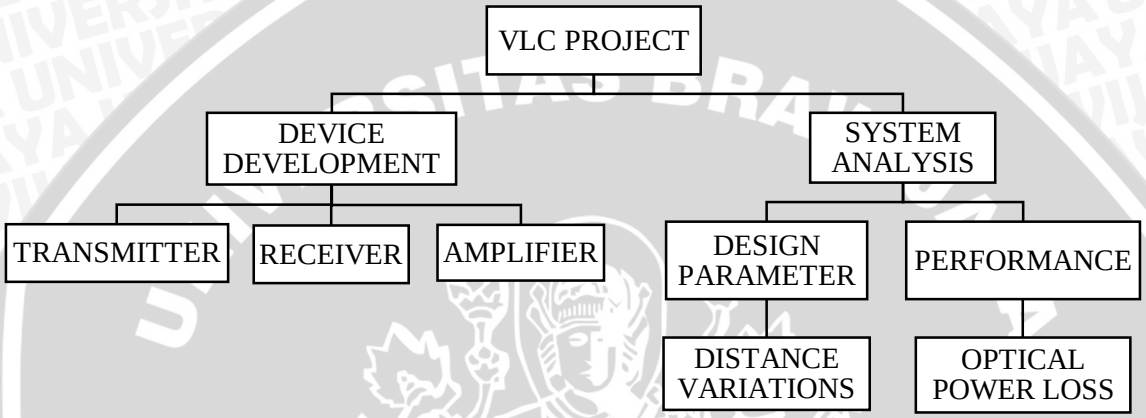

Figure 3.1 Project plan

Figure 3.1 shows the project plan of the project. According to objective of the project which has been discussed in Chapter 1, this project are focus on designing the VLC system for audio transmission. We need to develop the VLC system consist of transmitter, receiver, and amplifier. Moreover, the system performance are analyzed based on the voltage, current, power, and optical power loss.

3.2. The Method of Device Development

In order to implement voice transmission using visible light communication, first we need to design the VLC transmitter and receiver based on the project plan which have been shown on subsection 3.2. Based on the project plan, we will generate a system that contains of VLC transmitter system, VLC receiver system, implementation of the amplifier at the transmitter and receiver.

Figure 3.2 shows the basic transmission system of visible light communication and Figure 3.3 shows VLC system that has been successfully developed for this project. Based on the block diagram this system consist of two main part; transmitter and receiver. At transmitter system, we can see that the system consist of laptop for data source, audio

jack cable for transfering audio signal from the laptop to amplifier, amplifier for amplify the audio signal from the laptop, and LED to transmit the audio signal by light. The signal has been transmitted wirelessly at a certain distance. At the receiver, the system consist of photodetector to capture light from LED and converts the optical power to electric power, amplifier to amplify the output power from photodetector, and speaker to converts electrical energy to sound energy.

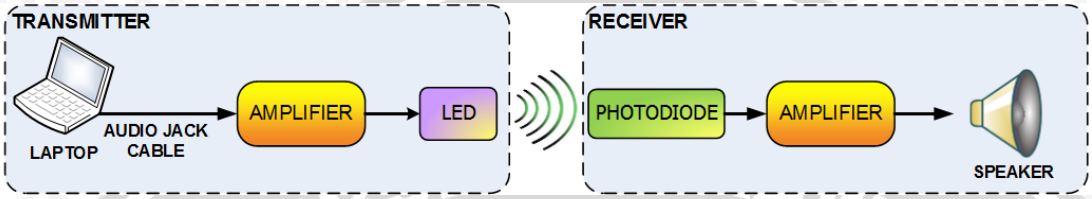

Figure 3.2 Visible light communication block diagram

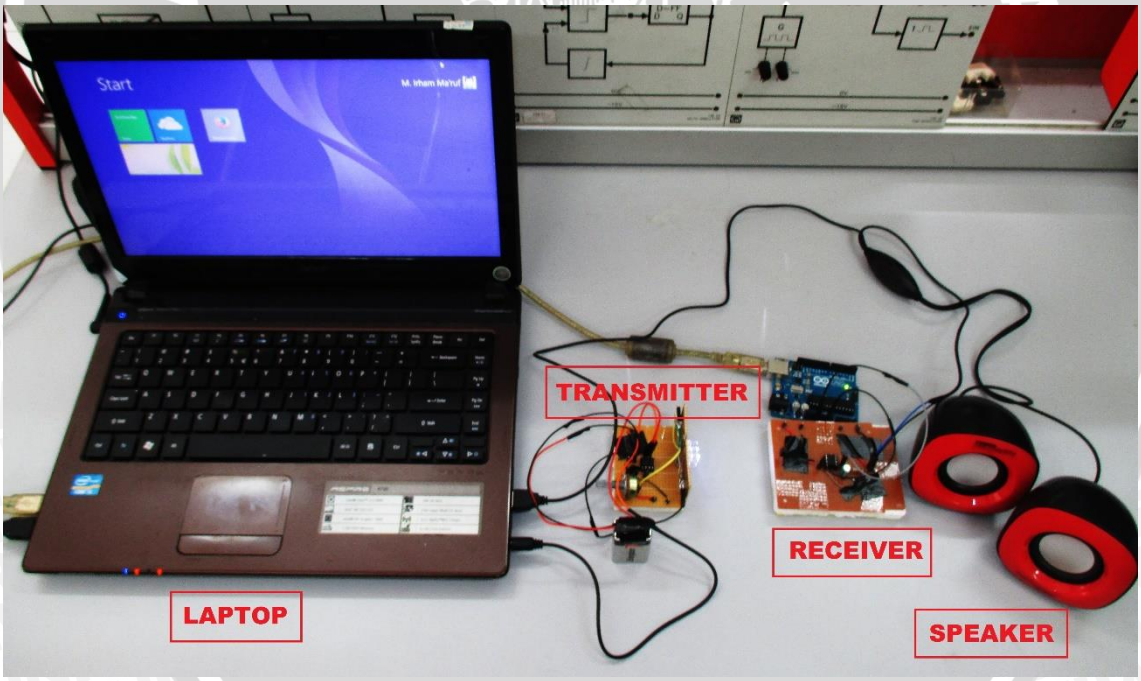

Figure 3.3 Visible light communication system overview

3.2.1. VLC Transmitter System

In order to transmit audio signal through visible light, the intensity of the light emitted from white LED at transmitter must be modulated according to the audio signal. The audio signal can be obtained from the computer through a 3.5 mm audio jack cable as shown in Figure 3.4.

Figure 3.4 3.5 mm audio jack cable
(Source: Anonymous, 2015)

After that the audio signal from the audio jack is transmitted through the LED as light source. However the voltage from audio jack is very small (from 0.4 mV to 3 mV). The power is not enough to turn on the LED. Therefore in the transmitter system, amplifier circuit is needed to amplify the audio signal from audio jack. So the output from audio jack will be the input on pin 2 and 3 LM386 amplifier as shown in Figure 3.6.

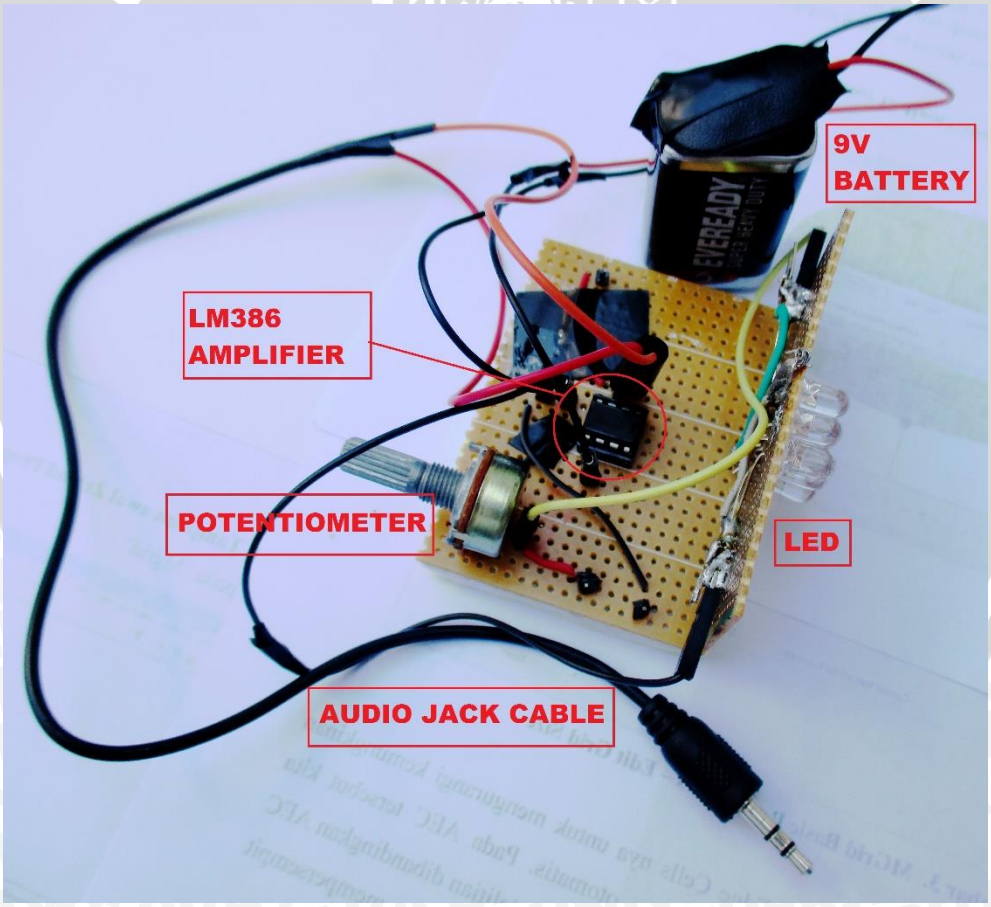

Figure 3.5 Transmitter system overview

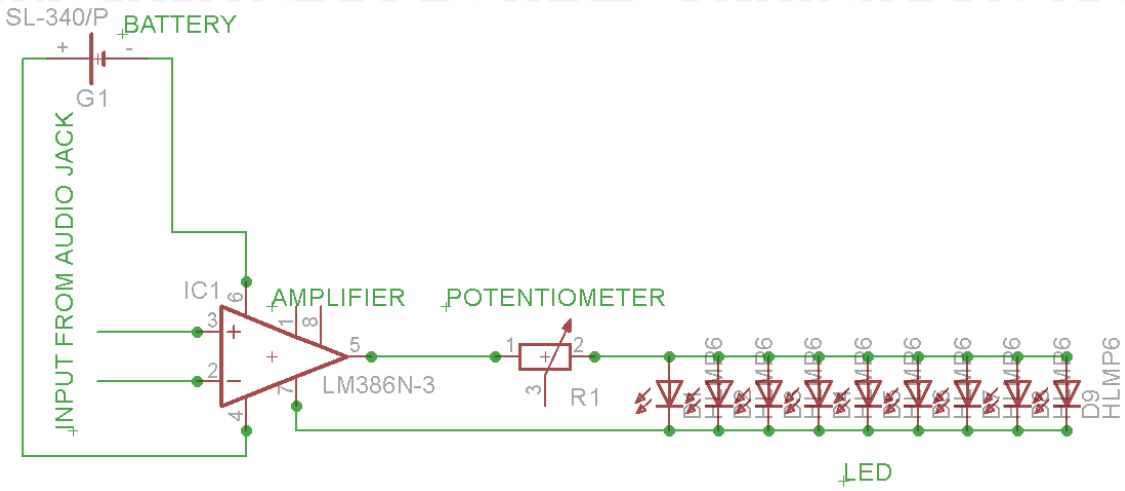

Figure 3.6 Schematic of VLC transmitter system

According to Figure 3.5 and Figure 3.6, transmitter circuit contains LM386N as amplifier, 9V battery, potentiometer, and LED.

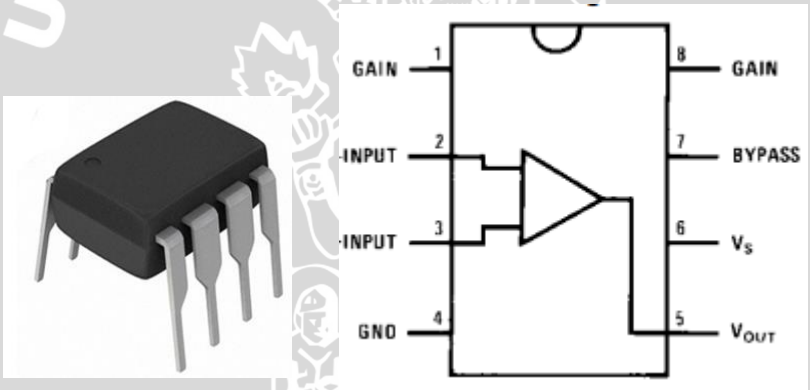

Figure 3.7 LM386N amplifier
(Source: Anonymous, 2014)

The LM386N as shown in Figure 3.7 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value up to 200.

Figure 3.8 9 V Battery
(Source: Anonymous, 2014)

In order to get the supply voltage to 9 V, we need to use 9 V battery. The battery will become the input voltage in pin 6 of LM386 amplifier. The audio from laptop will be transfered by audio jack and will become the input of LM386N in pin input 2 and 3. The voltage source from 9 V battery which has been constant become 5 V from voltage regulator, will become the voltage source of LM386N in pin 6 as positive voltage and pin 4 as ground. So the output voltage from audio jack will increase and enough to turn on the LED. At the transmitter, 9 units of 5 mm super bright white LED has been used as the light source as shown in Figure 3.9.

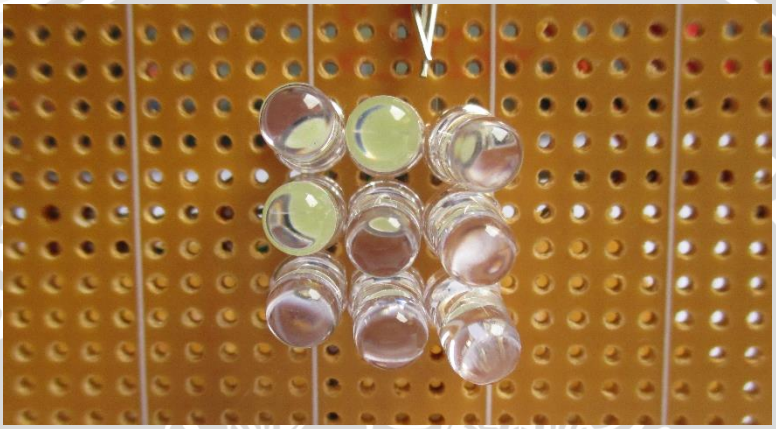

Figure 3.9 5 mm Super bright white LED

The intensity of LED light can be adjusted with variable resistor 10 kΩ as shown in Figure 3.10. Besides of that, the function of the variable resistor is to limit the value of current flow through the LED and also to avoid destroying the device.

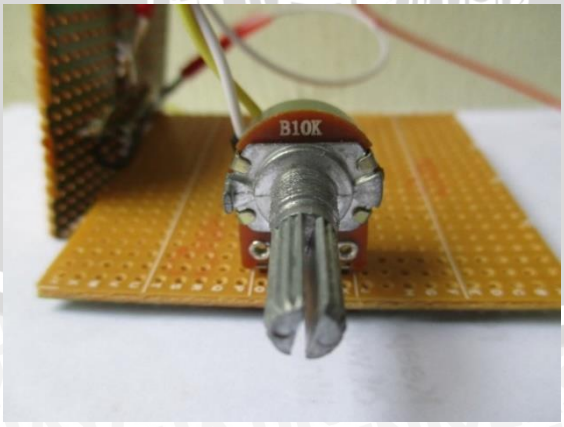

Figure 3.10 Variable resistor 10 kΩ

3.2.2. VLC Receiver System

The receiver system as shown in Figure 3.10 and 3.11 consist of a photodiode, LM386 Amplifier, power source from arduino UNO, and speaker.

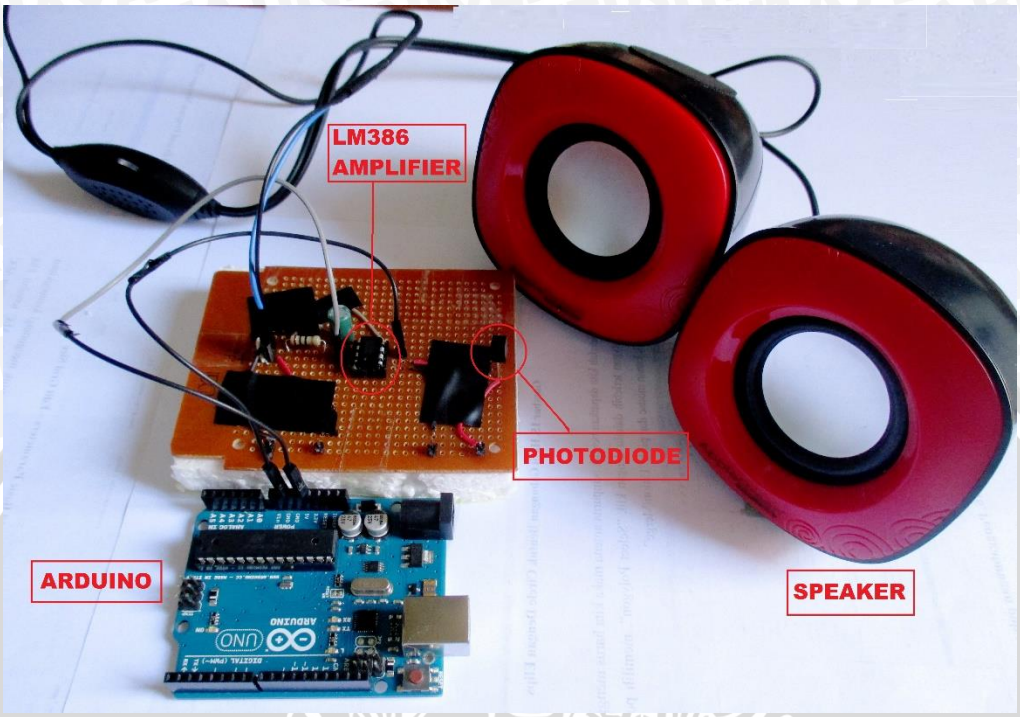

Figure 3.11 VLC receiver system overview

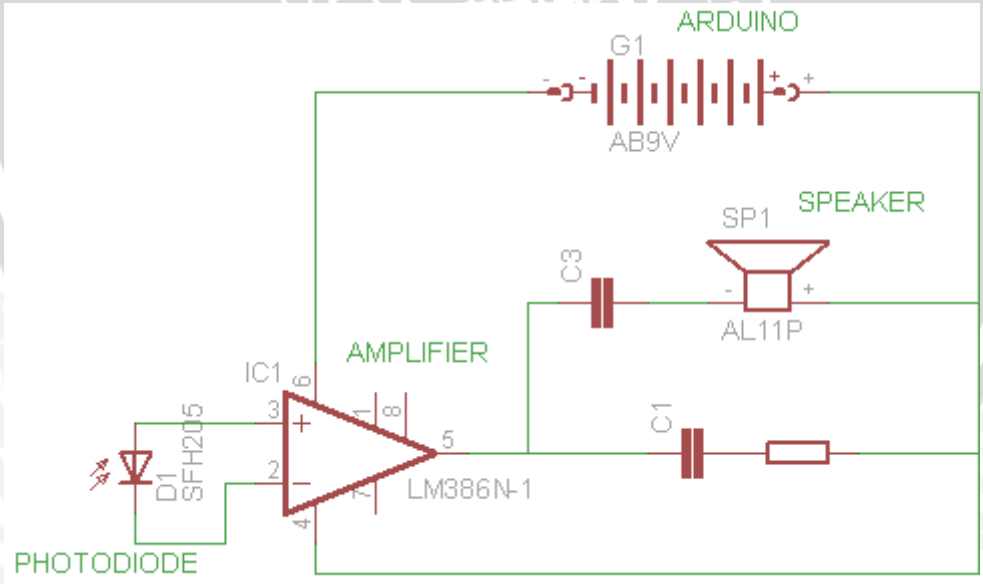

Figure 3.12 Schematic of VLC receiver system

The light from LED will be received by Vishay BPW41N photodiode. The function of the photodetector is to convert the emitted photon energy into electrical

energy. BPW41N is a PIN photodiode with high speed and high radiant sensitivity as shown in Figure 3.12.

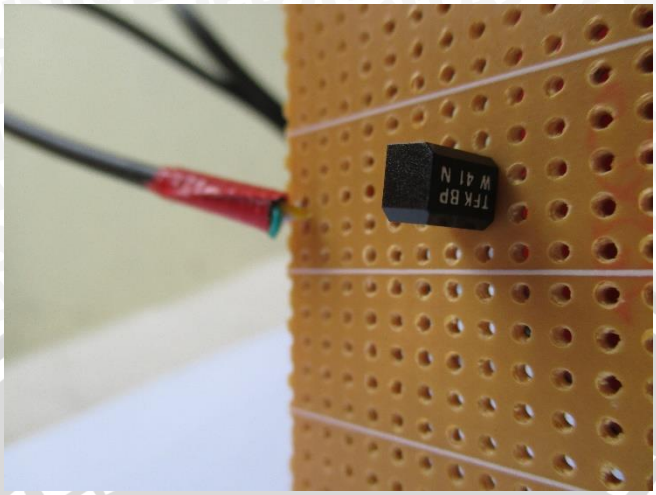

Figure 3.13 Vishay BPW41N photodiode

Because the voltage from photodiode is very small, it cause the audio can't be heard in the speaker. Therefore in the receiver, system amplifier circuit is needed to amplify the audio signal that has been received by the photodetector.

Figure 3.14 Arduino UNO rev 3
(Source: Anonymous, 2015)

According to Figure 3.11, the output from photodiode will be the input for amplifier LM386 in pin 2 and 3. Arduino UNO rev 3 have been used as power source at amplifier, which have been applied in pin 6 in LM386 amplifier. Therefore the voltage from the photodiode will be increased and the audio can be heard in the speaker. The Apple Green SP-158 is used as the speaker in receiver end as shown in Figure 3.13.

Figure 3.15 Apple green SP-158 speaker

3.3. Analysis Method

To analyze the system performance of VLC system, there are some method which has been used in this thesis.

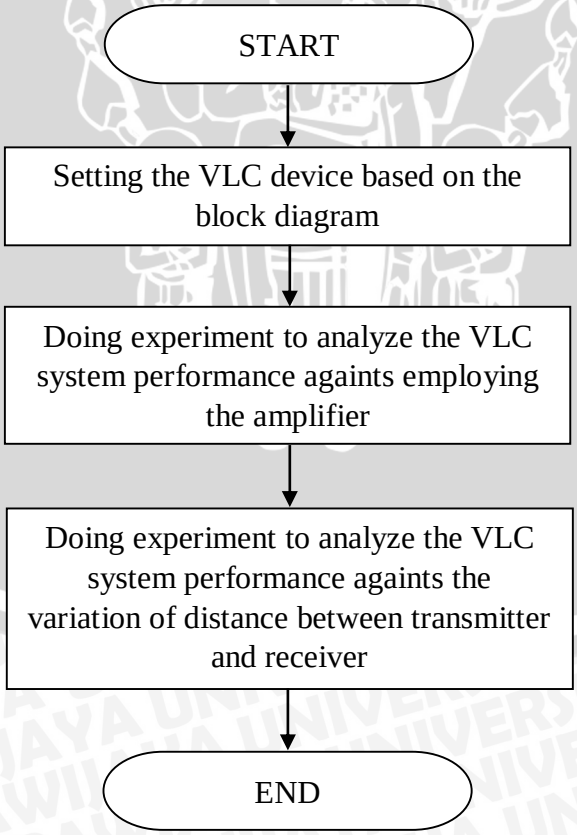

Figure 3.16 Steps to doing the experiment

Figure 3.16 shows the step by step to doing experiment in this thesis. First step is setting the VLC device before experiment, then doing experiment to analyze the performance of VLC system againts employing the amplifier. And the next is doing experiment to analyze the performance of VLC system againts the variation of distance between transmitter and receiver.

3.3.1. Amplifier Effect to VLC System

To analyze the VLC system performance againts employing the amplifier, there are some step by step to doing experiment as shown in Figure 3.17.

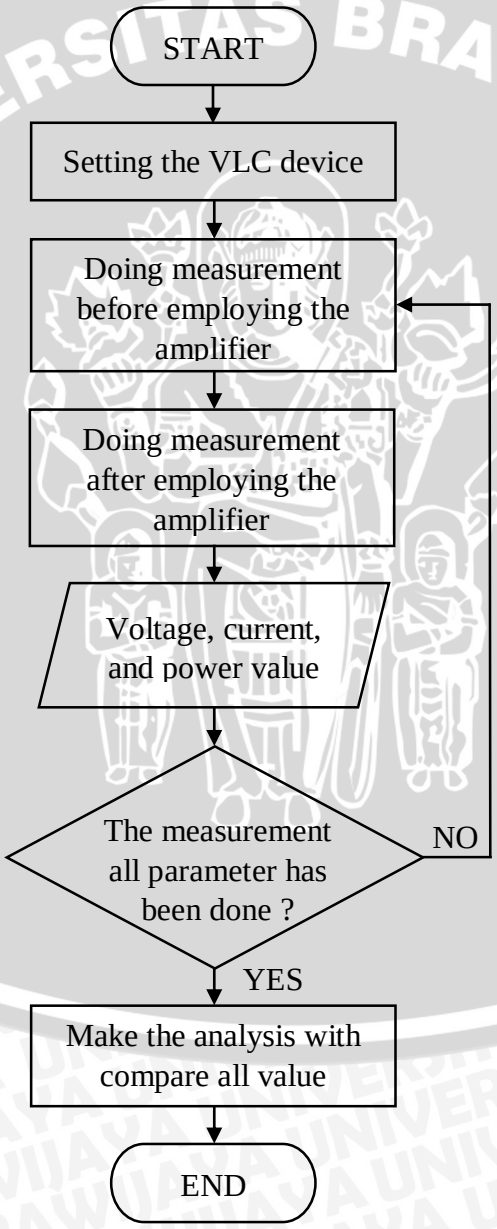

Figure 3.17 Steps to doing the experiment

From the Figure 3.17, in order to analyze the system performance againts employing the amplifier, first step is setting the VLC device. Then doing measurement for this system with some parameters are voltage, current, and power. If this section has been done, the next is doing measurement to VLC system after employing the amplifier. If all parameter has been measured, so the final step is make analysis with comparing the result for both condition.

3.3.2. Distance Effect to VLC System

To analyze the VLC system performance againts the variation of distance between transmitter and receiver, there are some step by step to doing experiment as shown in Figure 3.18.

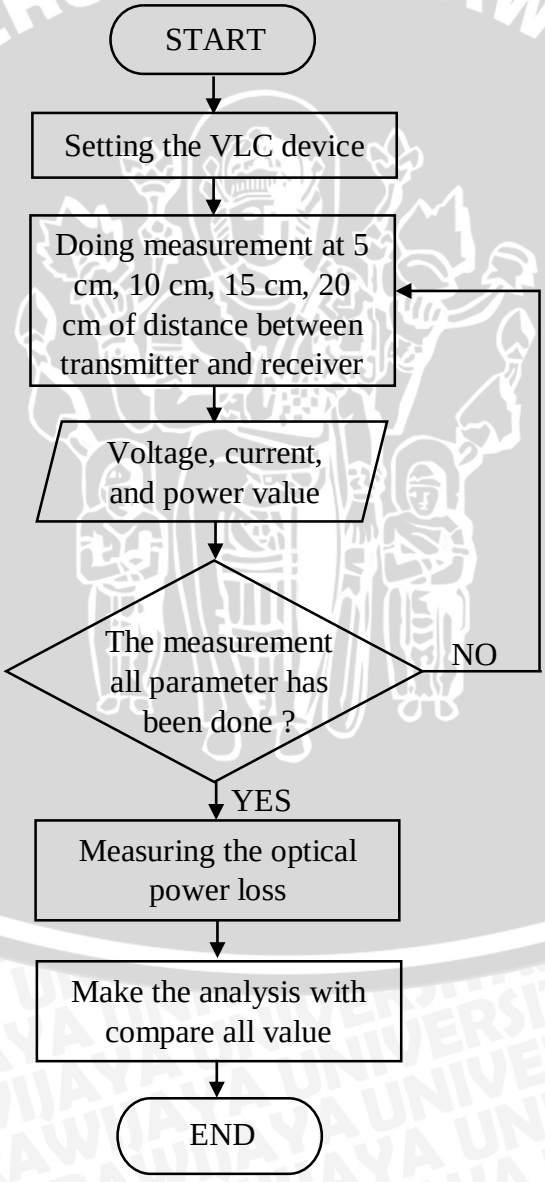

Figure 3.18 Flow chart of the distance effect to VLC system

From the Figure 3.18, to analyze the system performance againts the variation of distance between transmitter and receiver, first step is setting the VLC device. Then doing measurement at 5 cm, 10 cm, 15 cm, 20 cm of distance between transmitter and receiver with some parameters are voltage, current, and power. If this section has been done, the next is measuring the optical power loss. If all parameter has been measured, so the final step is make analysis with comparing the result.

3.4. Summary

The methodology which have been used in this project are consist the method of hardware development and system analysis. For hardware development we have been developed the hardware of VLC system consist transmitter, receiver, and amplifier circuit at the transmitter and receiver. At tr ansmitter system consist laptop, audio jack, amplifier, and LED. At receiver system consist photodetector, amplifier, and speaker.

On system analysis, the performance parameter such as voltage, current and power have been observed and measured at the transmitter and receiver. The optical power loss has been calculated with using parameter which have been designed such as variation of distance between the transmitter and receiver of the VLC system and the amplifier usage.