Analysis of the Effect of Antenna Type on RTL-SDR Radio Transmit Power

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Abstract. RTL-SDR is an electronic hardware device in the form of a USB dongle with a central component in the form of a microchip manufactured by Realtek Semiconductor Corp, Taiwan. SDR itself stands for Software Defined Radio. RTL-SDR is widely used by hobbyists, educators, and learners to conduct radio signal experiments. However, many RTL-SDR users need to pay more attention to the importance of the type of antenna used in signal reception. The selection of a suitable antenna can significantly affect signal reception quality. The purpose of this research is to determine the quality of various types of antennas as receiver antennas for SDR radio signals. The tested antennas include the yagi, monopole, and circular loop. The indicator used for comparison is power (dB). The power measurement process is performed using supporting software called GNU Radio. Data collection is conducted under unobstructed conditions. The frequencies used are 125.1 MHz, 130.1 MHz, and 135.1 MHz. The distances between the transmitting and receiving antennas are 1m, 3m, 5m, and 6m. The results of the antenna quality testing show that the monopole antenna obtained an average power value of -15.6dB, the circular loop antenna -16.5dB, the yagi flash antenna -17.1dB, and the yagi VDR antenna -18.1dB.

Keywords: RTL-SDR, yagi antenna, monopole antenna, circular loop antenna, GNU Radio.

1 Introduction

Analysis of the Effect of Antenna Type on RTL-SDR Radio Transmit Power is a study conducted to determine the effect of antenna type on radio signal transmit power on RTL-SDR (Realtek Software Defined Radio) devices[1]. Realtek here refers to the chipset used, namely Realtek RTL2832U[2]. This chipset is modified by the user and developer community to be used as a radio receiver with software-defined radio (SDR) technology[3].

The RTL-SDR device is a radio receiver that is relatively cheap and can be operated via a computer or laptop using specific software. The reason for using RTL-SDR devices in this study is because RTL-SDR devices are relatively more affordable in terms of price[4]. Second, RTL-SDR devices can work with various radio signal processing software, such as GNU Radio, SDR#, HDSDR, and others.

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Thirdly, RTL-SDR devices can be paired with external antennas, thus increasing the sensitivity and catchability of radio signals[5]–[7]. The last reason is that using RTL-SDR is relatively easy to operate, so it does not require special knowledge to learn it.

In use, RTL-SDR devices require an antenna as a radio signal receiver. The antenna used in this device can be either a built-in antenna or an additional antenna mounted on the SMA connector available on the device[8].

2 Method

2.1 Research Design

Based on the research method that has been carried out, the block diagram of the overall research design of the device is shown in the figure below.

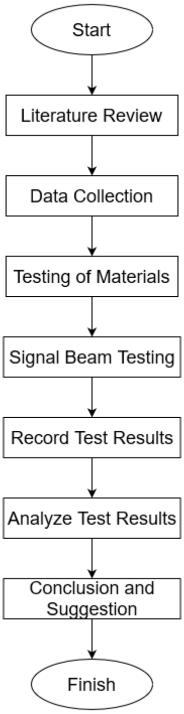

Fig. 1. Research Flowchart

2.2 Research Variable

Research variables in this study are independent and dependent variables, which are included in the independent variables: the type of antenna, the frequency used, and the distance between the receiving and sending antennas. The dependent variable is the quality instrument of the antenna beam, namely the power value (dB) received by the receiver antenna[9].

2.3 Testing

The test steps that will be carried out are as follows:

1) Prepare supporting software and hardware in antenna types, RTL-SDR, and GNURADIO software.
2) Connecting the antenna with RTL- SDR.
3) Connecting RTL-SDR to GNU RADIO software
4) Measuring the transmit power the receive antenna receives at each frequency and distance determined.
5) Make a graph to present the results of transmitting power measurements for each combination of antenna, frequency, and distance.

3 Results

3.1 GNU Radio Transmitter Block Diagram

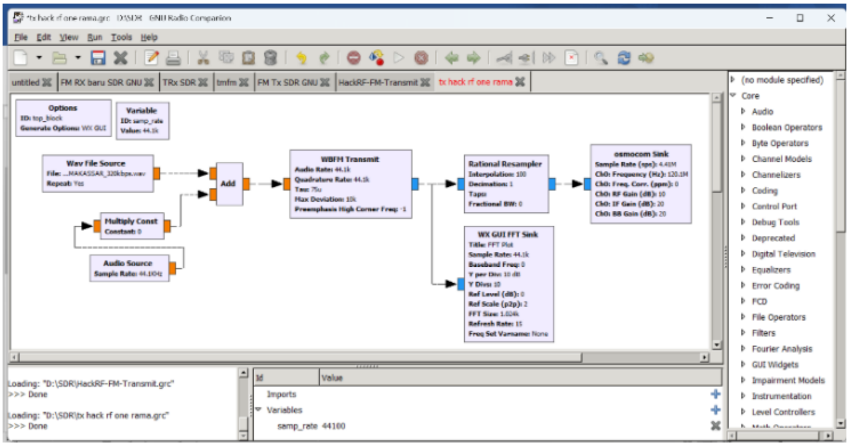

Fig. 2. GNU Radio Transmitter Block Diagram

The GNU Radio transmitter block diagram is a diagram that describes the signal processing flow in the transmitter system developed using GNU Radio software[10].

3.2 GNU Radio Receiver Block Diagram

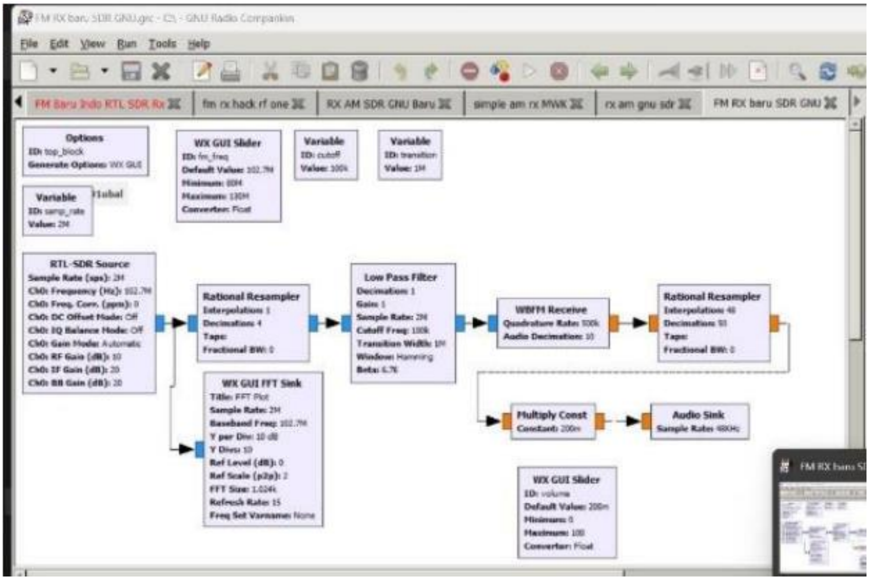

Fig. 3. GNU Radio Receiver Block Diagram

The receiver block diagram in GNU Radio is a component that receives and processes signals from hardware or external signal sources using software-defined radio (SDR)[10].

3.3 Monopole Antenna Testing

Tests were conducted on the transmitting power of RTL-SDR with working frequencies of 125.1 MHz, 130.1 MHz, and 135.1 MHz using monopole antenna at distances of 1 meter, 3 meters, 5 meters, and 6 meters.

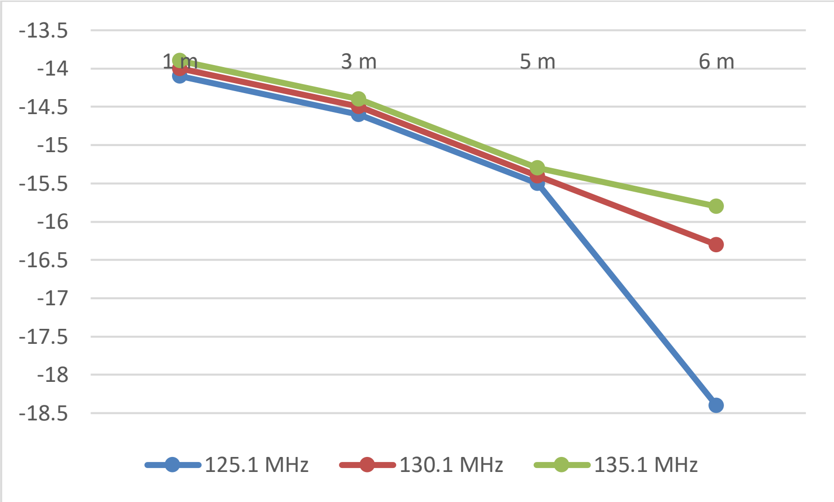

Fig. 4. Monopole Antenna Testing

Based on the test results, it is known that at a working frequency of 125.1 MHz, the received transmit power is -14.1 dB at a distance of 1 meter, -14.6 dB at a distance of 3 meters, -15.5 dB at a distance of 5 meters, and -18.4 dB at a distance of 6 meters. At the frequency of 130.1 MHz, the received transmit power is -14 dB at a distance of 1 meter, -14.5 dB at a distance of 3 meters, -15.4 dB at a distance of 5 meters, and -16.3 dB at a distance of 6 meters. While at frequency 135.1 MHz, the received transmit power is -13.9 dB at a distance of 1 meter, -14.4 dB at a distance of 3 meters, -15.3 dB at a distance of 5 meters, and -15.8 dB at a distance of 6 meters.

3.4 Circular Loop Antenna Testing

Tests were conducted on the transmitting power of RTL-SDR with working frequencies of 125.1 MHz, 130.1 MHz, and 135.1 MHz using circular loop antenna at distances of 1 meter, 3 meters, 5 meters, and 6 meters.

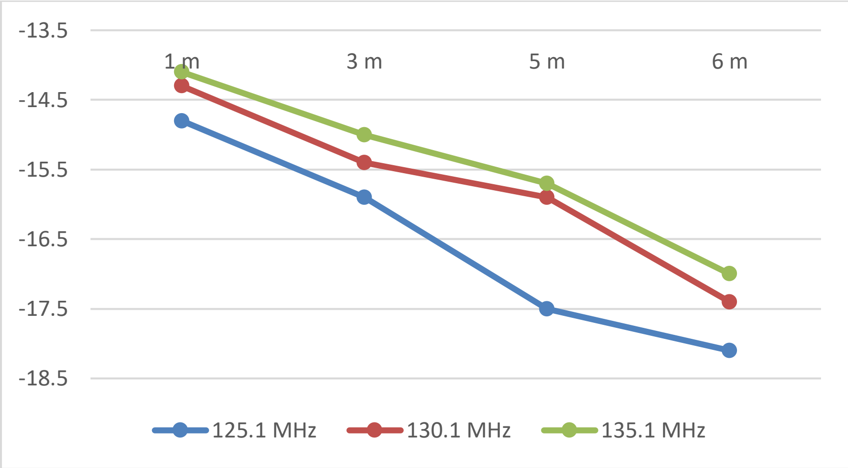

Fig. 5. Circular Loop Antenna Testing

Based on the test results, it is known that at a working frequency of 125.1 MHz, the received transmit power is -14.8 dB at a distance of 1 meter, -15.9 dB at a distance of 3 meters, -17.5 dB at a distance of 5 meters, and -18.1 dB at a distance of 6 meters. At the frequency of 130.1 MHz, the received transmit power is -14.3 dB at a distance of 1 meter, -15.4 dB at a distance of 3 meters, -15.9 dB at a distance of 5 meters, and -17.4 dB at a distance of 6 meters. While at frequency 135.1 MHz, the received transmit power is -14.1 dB at a distance of 1 meter, -15 dB at a distance of 3 meters, -15.7 dB at a distance of 5 meters, and -17 dB at a distance of 6 meters.

3.5 Yagi Flash Antenna Testing

Tests were conducted on the transmitting power of RTL-SDR with working frequencies of 125.1 MHz, 130.1 MHz, and 135.1 MHz using yagi flash antenna at distances of 1 meter, 3 meters, 5 meters, and 6 meters.

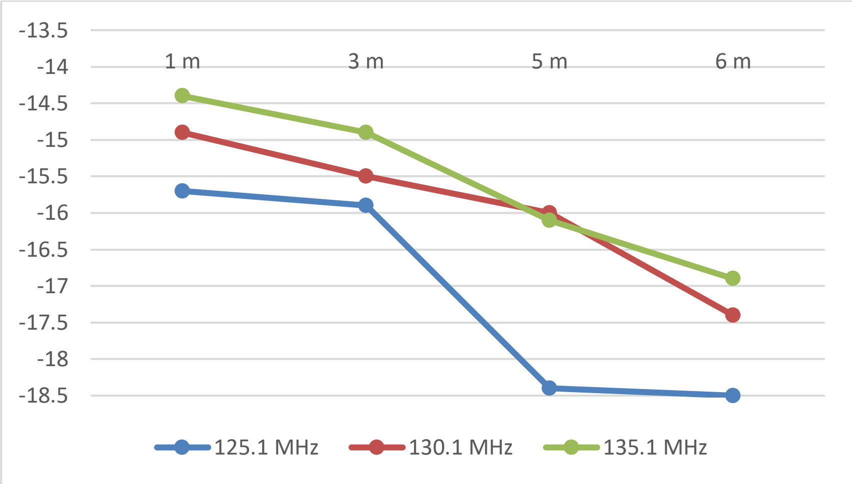

Fig. 6. Yagi Flash Antenna Testing

Based on the test results, it is known that at a working frequency of 125.1 MHz, the received transmit power is -15.7 dB at a distance of 1 meter, -15.9 dB at a distance of 3 meters, -18.4 dB at a distance of 5 meters, and -18.5 dB at a distance of 6 meters. At the frequency of 130.1 MHz, the received transmit power is -14.9 dB at a distance of 1 meter, -15.5 dB at a distance of 3 meters, -16 dB at a distance of 5 meters, and -17.4 dB at a distance of 6 meters. While at frequency 135.1 MHz, the received transmit power is -14.4 dB at a distance of 1 meter, -14.9 dB at a distance of 3 meters, -16.1 dB at a distance of 5 meters, and -16.9 dB at a distance of 6 meters.

3.6 Yagi VDR Antenna Testing

Tests were conducted on the transmitting power of RTL-SDR with working frequencies of 125.1 MHz, 130.1 MHz, and 135.1 MHz using Yagi VDR antenna at distances of 1 meter, 3 meters, 5 meters, and 6 meters.

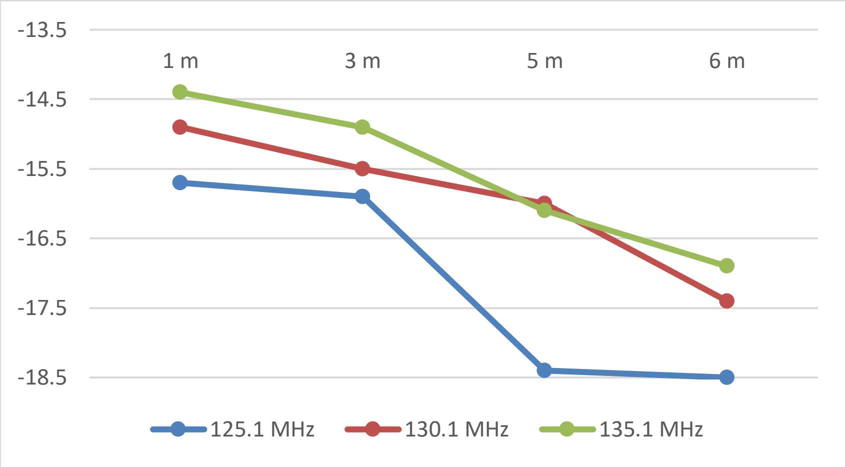

Fig. 7. Yagi VDR Antenna Testing

Based on the test results, it is known that at a working frequency of 125.1 MHz, the received transmit power is -15.7 dB at a distance of 1 meter, -15.9 dB at a distance of 3 meters, -18.4 dB at a distance of 5 meters, and -18.5 dB at a distance of 6 meters. At the frequency of 130.1 MHz, the received transmit power is -14.9 dB at a distance of 1 meter, -15.5 dB at a distance of 3 meters, -16 dB at a distance of 5 meters, and -17.4 dB at a distance of 6 meters. While at frequency 135.1 MHz, the received transmit power is -14.4 dB at a distance of 1 meter, -14.9 dB at a distance of 3 meters, -16.1 dB at a distance of 5 meters, and -16.9 dB at a distance of 6 meters.

Based on the test results in the graph above, it can be proven that the type of antenna, frequency, and distance can affect the quality of the RTL-SDR radio[11], [12]. The test results show that the antenna power value decreases as the antenna distance increases. In addition to distance, frequency also affects the power value (dB) produced. The frequency used in this study uses FM frequencies that do not overlap with the frequency of existing radio stations[13], [14]. In addition to disturbing other users, this can also be dangerous if the frequency interferes with frequencies used by flight navigation or state security. The test results above show that the higher the frequency, the more the power (dB) value increases. This frequency is related to the type of antenna used. The characteristics of the antenna used can influence the difference in frequency results[15]. Monopole antennas, circular loop antennas, and yagi antennas have different characteristics, with monopole antennas showing the best-transmitting power, followed by circular loop antennas and yagi antennas.

Overall, the average calculation results of the four antennas show that the Monopole antenna gets the best power (dB) value for RTL-SDR radio transmissions based on distance and frequency, so the monopole antenna is suitable for implementation on RTL-SDR radio devices.

4 Conclusion

Based on the test results above, the following conclusions can be drawn:

a. The type of antenna used influences the transmitting power of the RTL-SDR radio, where the increasing distance, the power results will decrease.
b. The most suitable antenna to be implemented in RTL-SDR is the Monopole antenna. It is based on the average test results that the Monopole antenna gets a result of -15.6dB, the Circular Loop antenna of -16.5dB, the Yagi Flash antenna of -17.1Db, and the Yagi VDR antenna of -18.1dB.

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