

Performance of 2.4 GHz Xbee for Digital Image Transmission

By Lilik Anifah

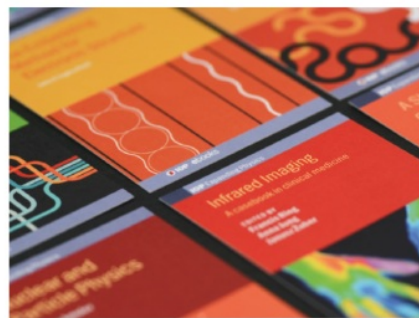
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Performance of 2.4 GHz Xbee for Digital Image Transmission with Yagi Antenna

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Abstract. The use of xbee modules is generally used for sending sensor data. In wireless communication today not only sensor data is sent, but also images that have a higher level of complexity. This study is used to determine the performance of xbee based on the IEEE 802.15.4 protocol for sending image data. Yagi antennas are used to strengthen or support XBee performance when shipping. The stages of the simulation were carried out with the 2016 CST software. The VNA preameter test produced yagi antenna parameters with a working frequency of 2.4 Ghz return loss = -12.27 dB, VSWR = 1.545. The results of sending a vertical image resolution of 160 x 120 obtain an average delivery time of 4.05 seconds, a speed of 678.28 bytes / second and data loss of 29% with the furthest distance of 250 meters. The results of sending vertical images of resolution 320 x 240 obtained an average delivery time of 11.24 seconds, speed of 779.28 bytes / second and data loss of 20% with the furthest distance of 200 meters. The results of sending a horizontal image resolution of 160 x 120 obtain an average delivery time of 4.03 seconds, a speed of 727.15 bytes / second and data loss of 20% with the furthest distance of 450 meters. The result of sending a horizontal image resolution of 160 x 120 obtained an average sending time of 11.19 seconds, a speed of 735.52 bytes / second and data loss of 23.8% with the furthest distance of 400 meters.

Keyword: antenna, VSWR, return loss, delivery speed

1. Introduction

Xbee is a communication device based on 802.15.4 technology and is now widely used in wireless networks [1-2]. The Zigbee or IEEE 802.15.4 protocol is typically used to connect sensor networks specifically designed for low-level communication with low complexity, low power consumption and low data rates [3-6]. The IEEE 802.15.4 specification describes wireless and media access protocols for private area network devices [7-8]. In terms of network capability, the ZigBee protocol supports three types of communication topologies such as point-to-point, point-to-multipoint and mesh topologies with one device as a coordinator [9-10]. The main device (PAN coordinator) in IEEE 802.15.4 determines the node cycle in the topology [11]. In its use a lot of combined with antennas



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that have high specifications. The quality of data communication is influenced by the antenna where the selection of the right antenna, good design and the factors that cause weakening of the signal from diffraction, refraction, reflection, and dispersion depend on the type of environment in which this communication is used [12-13]. Antenna design with Yagi-uda is able to change radiation patterns while maintaining antenna operating frequencies [14-15]. The antenna radiation patterns as a mathematical function or graphical representation of the radiation properties of the antenna as a function of space coordinates [16]. The yagi antenna consists of 3 elements which are driven, the director placed in front plus the reflector placed behind [17-19]. To increase the gain, usually by adding the number of directors as well as by optimizing the distance between directors [20-21]. Based on some previous papers, we will conduct further research to analyze more deeply the work performance of the Yagi antenna. This paper aims to analyze the Xbee 2.4 GHz performance for sending digital images with the Yagi Antenna. With this research, we will know the extent to which the results of sending data when viewed from the quality of data and speed of data transmission.

2. Method

Block diagram of the system is shown in Figure 1. Based on Figure 1 some requirements used are CV0706 camera, XBee, Arduino, Antenna, and Laptop. CV0706 camera, used to take pictures that will be sent later. Microcontroller, which is used is Mega Aduino function to control the camera and the transmission flow. XBee used for communication or as a picture sender. Laptop 1 is used to display images that have been sent or monitoring data that has been sent. Antenna used to convert electrical signals into electromagnetic signals. Laptop 2 is used to process and display data to be converted into images.

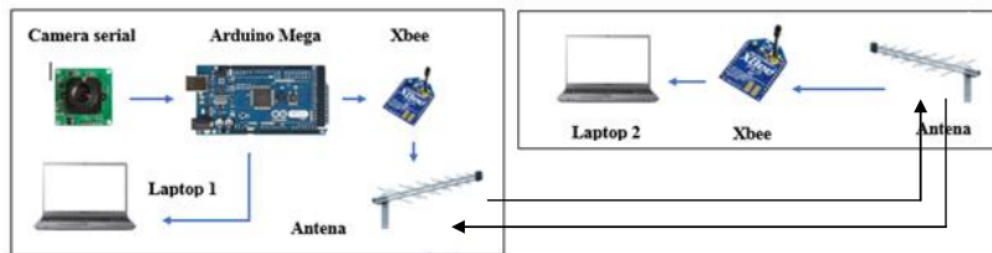


Figure 1. Block diagram of the system.

There are several important yagi antenna components: reflector, driven and director. Yagi antennas are symmetrical antennas and therefore there must be a balun (balance to unbalance) so that the antenna can function optimally. Image transmission process the components used include vc0706 cameras, xbee, xbee adapters and arduino mega. For schematic circuits in the drawings and hardware is shown in Figure 4 and Figure 5. For Image Transmission System

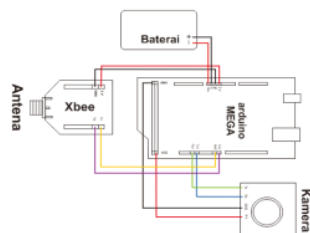


Figure 1. Circuit schematic.



Figure 2. Image transmission system.

3. Results and Discussion

The testing phase is done by first testing the antenna parameters. With this test you will be able to find out how the actual antenna specifications. Tests are carried out with a VNA (Vector Network Analyzer) tool. The parameters tested are return loss, VSWR and impedance. Image testing is done with 2 different tests and 2 different image resolutions.

Yagi Antena Testing

3.1. Return Loss Testing and VSWR Testing

From Figure 6 and Figure 7 it can be seen that the yagi antenna works quite well by producing a return loss of -12.27 dB at a frequency of 2.4 Ghz. This result is quite good considering the limit of its provisions is -10 dB although it is still very close.

The result of measuring VSWR parameters using VNA and the results obtained at a frequency value of 2.4 Ghz with a value of 1.545. These results are already good considering the provisions limit is <2 .

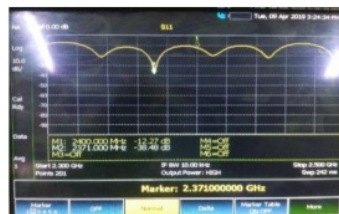


Figure 6. Return loss

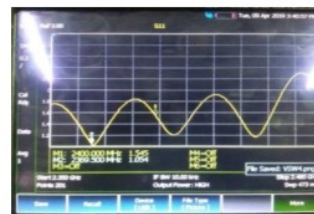


Figure 7. VSWR

Image testing is carried out with several stages, namely horizontal testing and vertical testing. Each test uses a different image resolution of 160 x 120 and 320 x 240. Testing is carried out 10 times at each distance point with the addition of a distance of 50 meters until the image can not be sent. The speed of transmission is obtained by dividing the number of bytes of the image sent by the sending time. Missing data is a comparison between the bytes received and the bytes of the image sent

Horizontal Image transmission

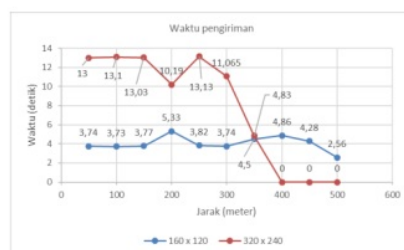


Figure 8. Comparison transmission time in horizontal test



Figure 9. Comparison of transmission speed in horizontal test

The results of sending images in the vertical test for the percentage of 100% transmission, while the average transmission time takes approximately 3 seconds and the transmission speed is around 950 bytes /second.

The results of transmission images in the vertical test, for the transmission percentage is 100%, the average transmission time requires approximately 13 seconds and the transmission speed is around 950 bytes/second. For the distance of 200, 300 and 350 meters the results are unfavorable where a lot of data is lost so the percentage of transmission decreases.

Figure 8. shows that the results of sending time between 160 x 120 resolution and 320 x 240 differ quite significantly due to the number of bytes sent because the resolution is greater, the number of bytes sent more and the sending time is also getting longer. Average delivery for 160 x 120 resolution is 3.8 seconds and 320 x 240 resolution is 13 seconds. If there is more value than that, it can be ascertained that the data sent has problems. Constraints such as sending speed decreases so that the time required is higher or the connection time is lost so that the recorded time is lower.

For the transmission speed the average value is almost the same between the resolution of 160 x 120 and 320 x 240. This similarity is due to different bytes and different transmission times.

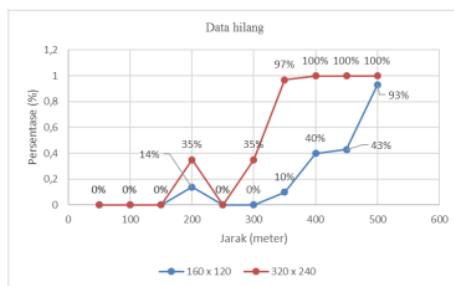


Figure 10. Comparison of data is lost on the horizontal test



Figure 11. Comparison of transmission percentage on a horizontal test

The greater percentage of lost data occurs at a large resolution of 320 x 240 although the difference is not too high but at 320 x 240 resolution only reaches a maximum distance of 250 meters.

The percentage of delivery results is better at a small resolution of 160 x 120, in this dimension the delivery distance reaches 450 meters. While images that have a resolution of 320 x 240 can only reach a distance of 300 meters.

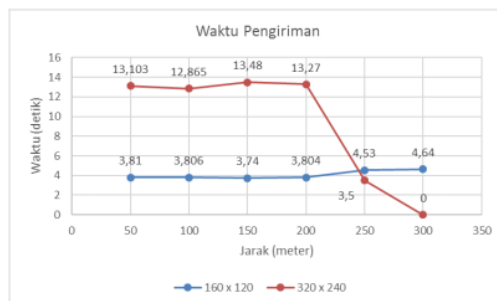


Figure 12. Comparison of transmission times on vertical test

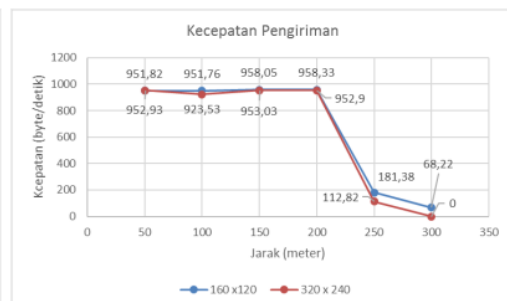


Figure 13. Comparison of transmission speed on vertical test

The results of sending images in the vertical test. Based on these data, it is known that the percentage of shipments is 100%. The average sending time requires is 13 seconds and the sending speed is around 950 bytes / second. For the distance of 100 and 250 meters, the results obtained are not good where a lot of data is lost, so the percentage of transmission decreases.

It is shown that the results of sending time between 160 x 120 resolution with 320 x 240 differ quite far. This is because the number of bytes sent, the greater the resolution the more number of bytes sent and the longer the sending time. The average delivery for 160 x 120 resolution is 3.8 seconds and 320 x 240 resolution is 13 seconds. If there is more value than that, it can be ascertained that the data sent has problems. Some constraints such as sending speed decreases so that more time is needed or connection time is lost so that the recorded time is not high.

For transmission speed the value is the same between the resolution 160 x 120 and 320 x 240. This equation is due to different bytes and different delivery times so that the speed is the same.

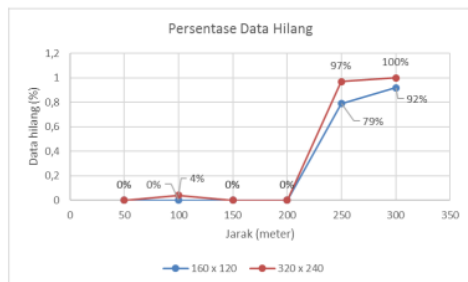


Figure 14. Comparison of data lost on vertical test

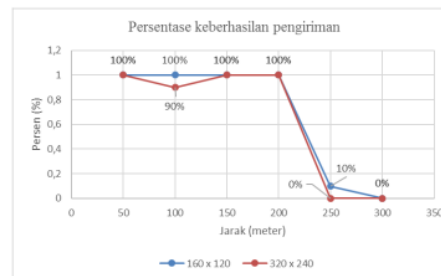


Figure 15. Comparison of transmission percentage on vertical test

The results of transmission images on the vertical test. Based on the table the transmission percentage is 100%. The average delivery time is around 3.8 seconds and transmission speed approximately 950 bytes/ second. For the distance of 250 and 300 meters, the results obtained are not good where a lot of data is lost so the percentage of transmission decreases.

The greater percentage of lost data occurs at a large resolution that is 320 x 240 although the difference is not too much but at a resolution of 320 x 240 can only reach a distance of 250 meters.

The results of transmission percentage is better at a small resolution of 160 x 120 which can reach distances of 250 meters. At a distance of 50 to 200 meters get a transmission percentage 100%.

4. Conclusion

The yagi antenna with a working frequency of 2.4 Ghz and has a return loss specification - 12.27 dB, at VSWR value 1.545 has been implemented. This system is completed with an image transmission system with xbee transmission and receiver modules and visual studio GUI. The results of transmission vertical image resolution of 160 x 120 obtain an average transmission time of 4.05 seconds, transmission speed of 678.28 bytes/second and data loss of 29% with the furthest distance of 250 meters. Vertical images transmission with a resolution of 320 x 240 obtains an average transmission time of 11.24 seconds, transmission speed 779.28 bytes/second and data loss of 20% with the furthest distance of 200 meters. Horizontal image sending resolution of 160 x 120 obtains an average transmission time of 4.03 seconds, transmission speed of 727.15 bytes/ second and data loss of 20% with the furthest distance of 450 meters. While the results of transmission on horizontal image resolution 160 x 120 obtain an average transmission time 11.19 seconds, with transmission speed 735.52 bytes/second and data loss of 23.8% with the furthest distance of 400 meters.

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