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11-Element Yagi Antenna for 1800 MHz Frequency

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Abstract- The need for internet connection is very important because everything is connected to each other with the internet, but due to limitations on access points, many areas are still experiencing difficulties in accessing the internet, one of which is the suburban area. Suburban areas that are indicated to be still difficult to reach due to obstacles from buildings, and the influence of weather. In order for the signal to be reached in this area, an 11-element Yagi antenna with a working frequency of 1800 MHz is needed, which is expected to produce a high gain so that the antenna beam is maximized. This final project aims to design an 11-element Yagi antenna at a working frequency of 1800 MHz, and analyze antenna parameters such as return loss, VSWR, bandwidth, gain, and polaradiation. The design of the yagi antenna uses CST Studio Suite 2019 software. After the simulation results are as desired, the fabrication or manufacture of the antenna is carried out. The simulation results after optimization are -26.00 dB, VSWR 1.10, and gain 12.32 dB. After the simulation is carried out, the next fabrication or manufacture of the 11-element Yagi antenna, the measurement obtained a return loss value of -11.29 dB, and VSWR 1.74, although the measurement results are far from the simulation but the results of this measurement have met the requirements of the antenna specifications.

Keywords- Yagi Antenna, Reflector, Driven, Director, *Return Loss*, VSWR, Polaradiation.

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I. INTRODUCTION

Suburban areas, also known *as* city *suburbs*, are areas of land that are inside a city's periphery or that are somewhat outside of it but can still be divided. Pinggiran kota is a concept of "urban" or "suburban," which is frequently interpreted as "suburbs." [18] Specifically, a suburban or cityscape is a combination of a rural area with a city (urban). In regional terms, a suburban is a region that is divided into or encompasses both rural and urban areas (urban fringe or country side).

In suburban areas, there are still certain areas with relatively unstable and uneven network quality. A few factors that affect the quality of life in suburban areas are as follows: (1) Physical impairment, such as building defects and trees can reduce the quality of signals. Hard building structures or building materials like concrete and wood can weaken soil and reduce the strength of soil that is eroded by erosion. (2) Although suburban areas often have a lower population density than larger cities, the quality of signals may suffer if the number of people using cell phones in a particular region increases. Thin-layer networks can lead to signal density that is more robust and can negatively impact the network's overall performance. (3) In addition, caffeine also lowers the quality of sleep in this area.

In order to resolve this issue, an antenna tuned to 1800 MHz frequency should be used. One type of antenna that is used for long-distance communication is the yagi antenna. Yagi antennas are frequently used in areas where the quality of the antenna's network is unstable because they are versatile.at The maximum frequency of up to 30 GHz and the maximum signal radiation radius of up to 30 km from the base transceiver station. [5]

A few of the studies on Yagi antennas that have already been conducted are based on research conducted by [6] and involve the construction of a 5-element antenna as a 4G signaling antenna at a frequency of 1800 MHz. This type of antenna is used in 4G Telkomsel networks to produce better results in terms of parameters such as return loss, where the return loss of -2.570 dB is reduced to -10.151 dB. This results in a change in which the two return losses are more closely spaced apart and meet the standard for antenna return loss.

The optimal level is at or below -10 dB. Additionally, [15] employed a Yagi 7 Antenna planning elements at a frequency of 915 MHz, resulting in a gain of around 11.45 dB, a bandwidth of -65.9 MHz, and a return loss of 10 dB. In the last test, [13] scanned five antenna elements for 4G LTE repeaters at a 1.8 GHz frequency. The results showed a -28.39 dB return loss, a bandwidth of 280 MHz, and a gain of 10.451 dBi.

II. METHOD

In this study, we will design a patch-shaped microstrip antenna. Before starting the design process, we need to understand the specifications of the antenna to be designed and perform the calculation of the dimensions of the patch antenna.

A. Research Flow

There are a few steps that will be explained in the final task. A few steps in the antenna design process are shown in the diagram, including those that address the antenna's dimensions, gain, VSWR, frequency of operation, and mathematical return loss. The two layers include the ground plate diameter, the patch length, and the width count. Finally, during the first and second phases, the antenna dimensions are carried out using the software CST 2019.

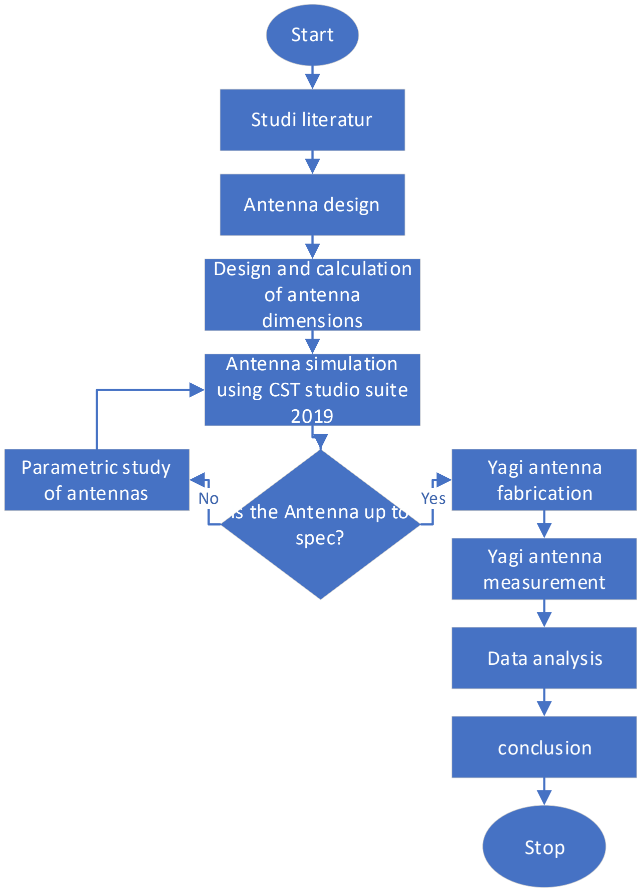

Fig.1 Research Flow

B. Antenna Dimensions

TABLE I
ANTENNA DIMENSIONS

No.	Element Type	Element Length (mm)
1.	Reflector	79.325
2.	Driven	76.82
3.	Director 1	73.48
4.	Director 2	73.48
5.	Director 3	73.48
6.	Director 4	73.48
7.	Director 5	73.48
8.	Director 6	73.48
9.	Director 7	73.48
10.	Director 8	73.48
11.	Director 9	73.48
12.	Reflector to driven spacing	41.75
13.	Spaces driven to directory 1	51.77
14.	Space between directories	51.77
15.	Aluminum diameter	2
16.	Boom diameter	4

After doing the calculations to measure the length of the reflector, driven, and director, the space between the antenna elements determines the dimensions of the antenna patch can be seen in the table above. After obtaining the dimensions of the Yagi antenna, proceed with designing the Yagi antenna design using CST Studio Suite 2019 software.

C. Antenna Design

In this study, a Yagi antenna with 11 elements will be designed. Before designing the antenna, we must first know the specifications of the antenna to be designed and the dimensional calculations of the Yagi antenna.

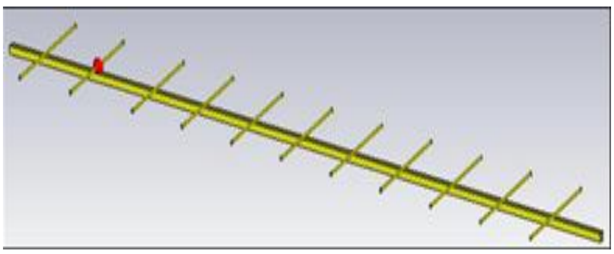

Fig.2 Design of 11-Element Yagi Antenna

After making some size changes to the dimensions of the antenna so that the desired simulation results can be obtained. In the modified antenna, the length of the element and boom is changed according to the previously determined element.

III. RESULT AND DISCUSSION

A. *Parametric Study*

The following are the results of antenna calculations after a parametric study or optimization so as to obtain optimal results where the size will be different from the size in the theoretical calculations obtained and this size will be used for fabrication, can be seen in Table II. The following are the simulation results of the 11-element Yagi antenna parameters that have been carried out parametric studies.

TABLE II
CALCULATION RESULTS OF YAGI ANTENNA ELEMENTS AFTER OPTIMIZATION

No.	Element Type	Element Length (mm)
1.	Reflektor	95.00
2.	Driven	77.00
3.	Direktor 1 - 9	67.00
4.	Spasi driven ke direktor 1	25.00

The following are the results of simulation of the parameters of the 11-element yagi antenna that have been carried out parametric studies.

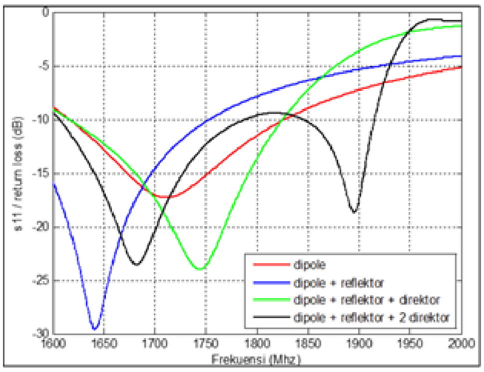

Fig. 3 Return Loss Director 1 than Director 2

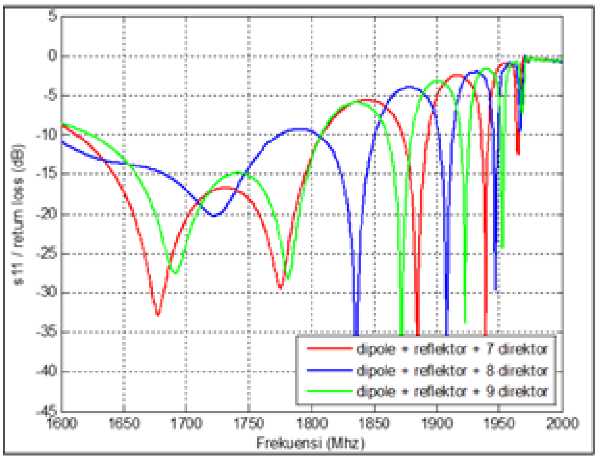

Fig. 4 Return Loss of Director 3, Director 4, Director 5, and Director 6

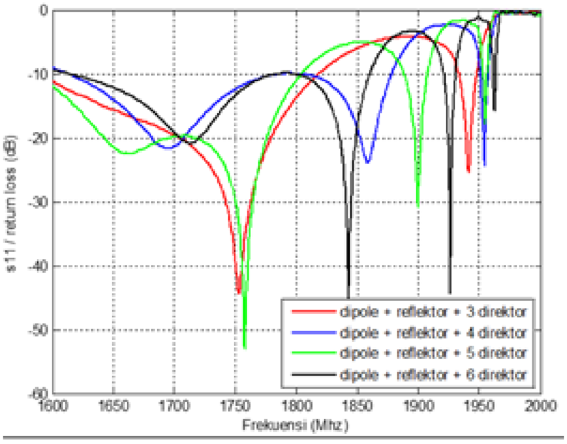

Fig. 5 Return Loss of Director 7, Director 8, and Director 9

Polaradiation Phi (Azimuth) = 0 on an 11-element yagi antenna at 1800 MHz working frequency.

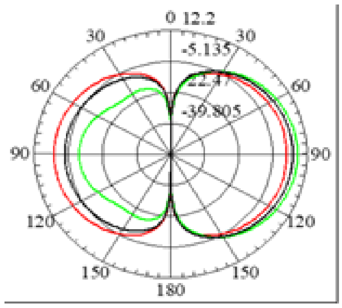

Fig. 6 Phi Polaradiation of Director 1 and Director 2

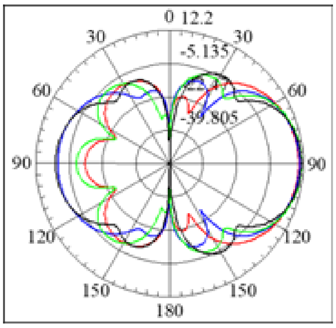

Fig. 7 Phi Polaradiation of Director 3, Director 4, Director 5 and Director 6

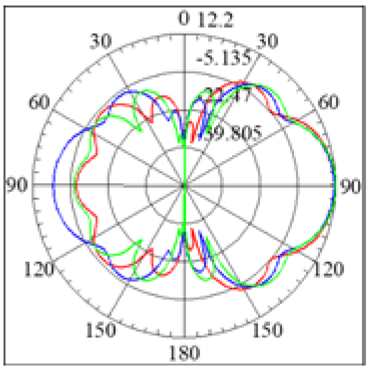

Fig. 8 Phi Polaradiation of Director 7, Director 8, and Director 9

Polaradiation Phi (Azimuth) = 90 on an 11-element yagi antenna at 1800 MHz working frequency.

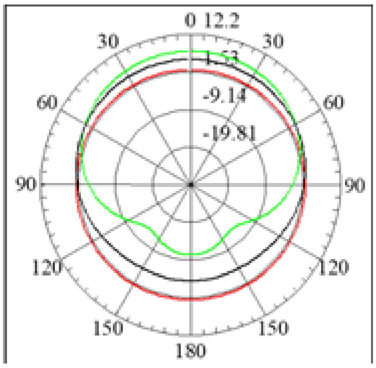

Fig. 9 Theta Polaradiation of Directors 1 and 2

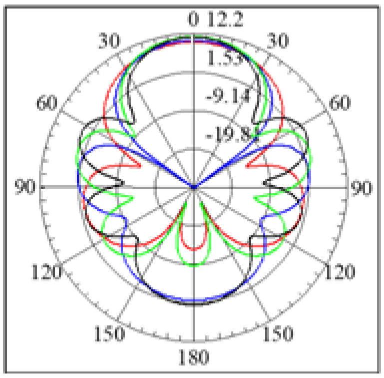

Fig. 10 Theta Polaradiation of Director 3, Director 4, Director 5, and Director 6

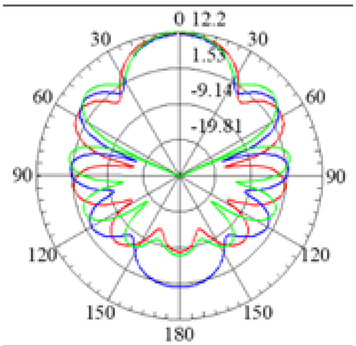

Fig. 11 Theta Polaradiation of Director 7, Director 8, Director 9

B. *Fabricated Antenna*

Fig. 12 Antenna Fabrication

After completing the antenna design, the antenna design is obtained. From the design, fabrication and measurement are carried out to obtain the value of antenna parameters, such as working frequency, return loss, VSWR, gain, bandwidth and radiation pattern shape. In the simulation results that have been carried out, the modified antenna will be compared with the antenna fabricated in this final project to determine the best return loss and VSWR values in the 1800 MHz frequency range.

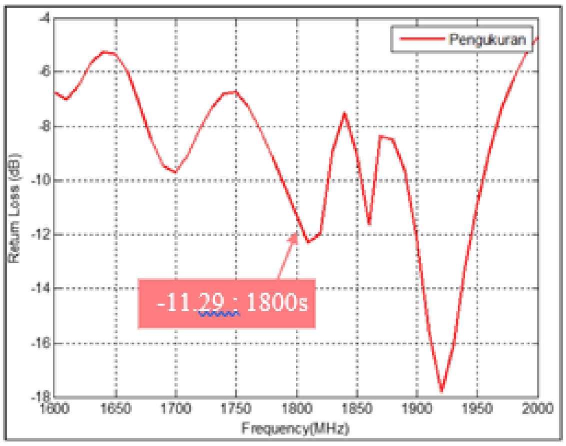

Fig. 13 Return Loss

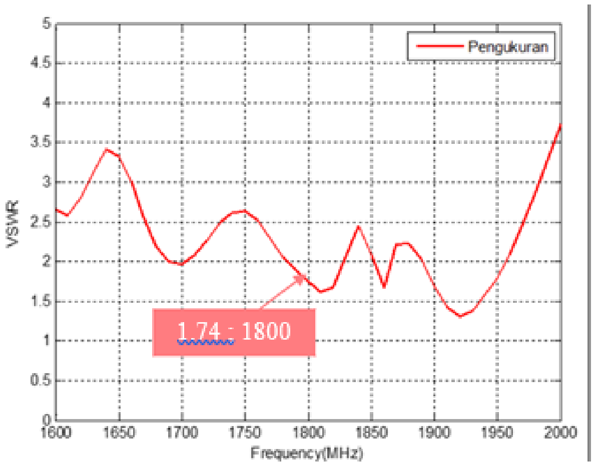

Fig. 14 VSWR

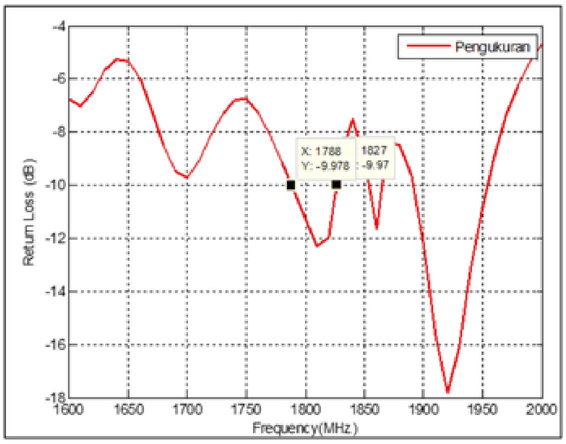

Fig. 15 Bandhwith

TABLE II
COMPARISON OF SIMULATION AND FABRICATION RESULTS

No.	Parameter Antena	Simulation Antenna Results	Fabrication Antenna Results
1.	Frekuensi (MHz)	1800	1800
2.	*Return Loss* (dB)	-26.00	-11.29
3.	VSWR	1.10	1.74
4.	*Bandwidth*	182	39

From Fig 13 the return loss value of the measurement results is -11.29 dB which is still in accordance with the return loss parameter reference which is ≤ -10 and for the VSWR value in Fig 14 is at 1.74 which is still in accordance with the VSWR parameter reference which is 1 ≤ VSWR ≤ 2. The frequency obtained is also in accordance with the working frequency at 1800 MHz. As for the bandwidth in Fig 15, the results obtained are 39 MHz. However, for the results of the return loss and VSWR parameters, the Yagi antenna fabrication can still be said to be as desired.

IV. CONCLUSION

Antenna for working frequency at 1800 MHz, where the return loss value is -26.00, VSWR value 1.10, bandwidth 182 MHz, gain 12.31 dBi, and the radiation pattern formed is unidirectional.

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