Improvement of Model Automatic Tracker Strength Signal Antenna Based On Azimuth and Elevation Control Approach

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Abstract. The model of tracking the automatic signal strength of the system through the receiver antenna is one way to minimize the attenuation of the receiving signal through automatic antenna movement techniques based on information data input the value of the azimuth and elevation angle between the satellite and receiving antenna. The purpose of this research is to ensure the existence of satellite orbit trajectories, and the signal strength emitted will always be stable in each orbit position. While the method used in this research is field observation and design system with position of satellites as target objects tracking of the signal strength to designed device which located as a receiving antenna and tracker device. Analysis and measurements results showed that all satellite targets tracked resulting in a minimum to maximum angle of azimuth and elevation have percentage errors 0.52% - 4.02% and 0.25% - 3.99% when detecting NSS6 while when detecting Palapa D the value minimum to maximum percentage errors were 0.6% and 4.67% with a tolerance of directing angle to satellite < 2° according ITU-R recommendations. The conclusion is that satellite objects can be tracked the position of the orbit by looking the level of strong consistence of the received signal quite well based on the results of small angle error detection.

1. Introduction
Development of an antenna signal strength tracker system in long distance communication is increasing especially to determine the target position of a satellite according to its orbit. The positioning of these satellites certainly requires an increase gain of antenna so that the effect can reduce the beam width antenna. Therefore this system is needed to controlling automatically position of the antenna. To increase the accuracy, a design method is needed by taking the parameters of the antenna's orbital position such as azimuth angle and satellite elevation as the target by receiver antenna.

Previous research has been describe of signal amplifier tracking system using azimuth angle as references value indoor with Wi-Fi access points [1],[2],[3]. The results of previous other research [4] told related to concept of automatic signal strength tracking specifically for satellite communication through using a closed loop algorithm approach that produces miss position loss of 1 dB from totality tracking results. While the results of research in [5],[6] looking for an auto tracking design model using microcontroller device, GPS, sat finder and digital compass for the azimuth and elevation synchronization estimation process for the Cakrawarta-2 satellite. In this research, an automatic tracking device was designed that was able to direct the Cakrawarta-2 satellite at angle of 107.35 BT S-band frequency 2520 MHz - 2670 MHz. Weaknesses in this research have actually been improved by [6],[8] which proposes the need for additional pointing controller systems that are able to produce accuracy and a minimum average error of 11.3º (azimuth) and 1.2º (elevation) although the fact of azimuth angle have percentage of fault tolerance is still below the standards according to ITU-R recommendation is equal 2º from the peak pointing.
Therefore in this research we will design a development model for signal strength automatic tracking devices using a type of parabolic antenna to control and obtain azimuth and elevation angle variations as indicators to obtain strength signal level with azimuth angle $\leq 2^\circ$ and elevation $\leq 2^\circ$ for the purpose of minimizing impact transmission losses on the deviated position of the satellite being tracked. Based on the information data from the results of previous studies, the main objective of this research is to develop a system for automating the search for satellite signals through detection through receiver antennas parabolic the hope that the satellite orbit can be monitored properly.

2. Research Method

The system development model is shown through the design flow and diagram blocks as illustrated in (see Figure 1).

![Flowchart of Signal Strength Tracking System](a)

![Flowchart of Signal Strength Tracking System](b)

**Figure 1.** Signal Strength Tracking System Automatic Flowchart through Azimuth and Elevation Angles

The method approach used in this research is field observations and quantitative descriptive technique through system design will starting with determining first type of satellite as tracker target and its frequency allocation. In its implementation, the parabolic receiving antenna is used as a tracking antenna to obtain azimuth and elevation angle values of several types of satellites as indicators of received signal strength.
From the Figure 1 stage can be illustrated as a schematic design block system shown in Figure 2.

![Diagram Block of Automatic System for Strength Signal Trackers Based on Azimuth and Elevation Angles Value](image)

Changes in the value of azimuth and elevation angles are related to changes in signal strength received by the antenna in tracking position of the satellite where the magnitude can be determined using equations 1 and 2 [7], [8], [9].

\[
A' = \tan^{-1}\left(\frac{(\text{ls-le})}{\sin\text{Le}}\right)
\]

(1)

Azimuth changes depend on latitude (Le), longitude of the receiving antenna (le) and satellite (ls).

\[
E = \tan^{-1}\left(\frac{(6.6107345-\cos\gamma)}{\sin\gamma}\right)
\]

3. Results and Discussion

The model developed need testing so that the system is designed according to specifications and produces a good device. The testing stages using comparison methods is calculation and measurement techniques for several satellite objects including NSS6 and Palapa D. The result of testing and measurement of Palapa D Satellite can be seen in (see Table 1).
Table 1. Results of Testing and Measurement of Palapa D Satellite (113° BT)

| Calculate Result | Monitoring Position | Margin Error |
|------------------|----------------------|--------------|
|                  | Indoor   | Outdoor   | Indoor   | Outdoor |
| $A'$  | $E$   | $A'$  | $E$   | $A'$  | $E$   | $A'$  | $E$   |
| 38.17 | 79.72 | 40.52 | 83.13 | 39.58 | 77.97 | 2.35 | 3.41 | 1.41 | 1.75 |
| 38.17 | 79.72 | 41.62 | 80.13 | 41.37 | 77.59 | 3.45 | 0.41 | 3.20 | 2.13 |
| 38.17 | 79.72 | 35.26 | 76.58 | 40.56 | 80.54 | 2.91 | 3.14 | 2.39 | 0.82 |
| 38.17 | 79.72 | 34.88 | 80.22 | 42.57 | 79.58 | 3.29 | 0.50 | 4.4  | 0.14 |
| 38.17 | 79.72 | 37.57 | 77.29 | 40.82 | 81.92 | 0.60 | 2.43 | 2.65 | 2.20 |
| 38.17 | 79.72 | 40.55 | 78.31 | 37.32 | 79.59 | 2.38 | 1.41 | 0.85 | 0.13 |
| 38.17 | 79.72 | 41.04 | 75.55 | 35.26 | 80.96 | 2.87 | 4.17 | 2.91 | 1.24 |
| 38.17 | 79.72 | 37.32 | 78.48 | 33.5  | 78.55 | 0.85 | 1.24 | 4.67 | 1.17 |
| 38.17 | 79.72 | 43.6  | 80.13 | 41.00 | 79.70 | 5.43 | 0.41 | 2.83 | 0.02 |
| 38.17 | 79.72 | 40.43 | 81.44 | 37.57 | 78.45 | 2.26 | 1.72 | 0.60 | 1.27 |

Comparison of Test Results of Azimuth Palapa D Satellite can be seen in (see Figure 3):

![Figure 3. Comparison of Test Results of Azimuth Angle Palapa D Satellite](image)

The results of testing the azimuth and elevation angles as a function of signal amplification indicates that the change intensity of fluctuation strength signal occurs when measurements are carried out indoors for 10 test number. This happens because there are many room barriers that cause the signal's angle and strength signal level change rapidly compared to outdoor conditions.

The result of Testing Measurement of NSS 6 D Satellite (95° BT) can be seen in (see Table 2):
**Tabel 2. Results of Testing and Measurement of NSS 6 D Satellite (95° BT)**

| Calculate Result | Monitoring Position | Margin Error (%) |
|------------------|---------------------|------------------|
|                 | Indoor | Outdoor | Indoor | Outdoor |
| $A'$ | $E$ | $A'$ | $E$ | $A'$ | $E$ | $A'$ | $E$ |
| 298.17 | 73.14 | 296.28 | 71.19 | 294.52 | 74.95 | 1.89 | 1.95 | 1.89 | 1.81 |
| 298.17 | 73.14 | 294.15 | 70.19 | 296.18 | 71.92 | 4.02 | 2.95 | 4.02 | 1.22 |
| 298.17 | 73.14 | 300.43 | 75.40 | 297.88 | 72.89 | 2.26 | 2.26 | 2.26 | 0.25 |
| 298.17 | 73.14 | 300.37 | 71.74 | 297.99 | 73.64 | 2.20 | 1.40 | 2.20 | 0.50 |
| 298.17 | 73.14 | 300.14 | 69.15 | 295.80 | 72.51 | 1.97 | 3.99 | 1.97 | 0.63 |
| 298.17 | 73.14 | 298.69 | 74.14 | 296.10 | 74.54 | 0.52 | 1.00 | 0.52 | 1.40 |
| 298.17 | 73.14 | 300.53 | 71.57 | 299.49 | 75.44 | 2.36 | 1.57 | 2.36 | 2.30 |
| 298.17 | 73.14 | 299.38 | 70.13 | 297.45 | 72.84 | 1.21 | 3.01 | 1.21 | 0.30 |
| 298.17 | 73.14 | 295.16 | 71.35 | 298.27 | 72.18 | 3.01 | 1.79 | 3.01 | 0.96 |
| 298.17 | 73.14 | 295.23 | 70.02 | 297.43 | 74.42 | 2.94 | 3.12 | 2.94 | 1.28 |

Comparison of testing results of Azimuth Angle NSS 6 Satellite can be seen in (see Figure 4):

**Figure 4.** Comparison of testing results of Azimuth Angle NSS 6 Satellite

Changes of azimuth and elevation angles at the NSS 6 satellite tracking position is greater and the intensity varies when the elevation angle is detected. Comparing with figure 3, the position of degree $^0$BT is able to produce a strength signal level when the angle $^0$BT is smaller. The results of this analysis by previous researchers [10, 8] illustrates that changes in satellite strength signal always changes result in the azimuth and elevation values every time. While accuracy determined by the movement angle of the tracking system with the position angle of the object being tracked [9, 10].

**4. Conclusion**

Based on the results of design and testing shows that the system has the ability to work well with an average margin error < 20 according with purpose of research although there are some results greater than the value of 20. The measure of success is seen when this automation tracking device captures the azimuth and
elevation angle variations accordingly the condition of the surrounding environment with a minimum range margin of error 0.52% (azimuth) and a maximum of 4.67% (elevation).

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