Automatic Antenna Positioning System

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Abstract— There are many problems in manual configuration of dish antennas that are the human errors, misalignment, finding the look angles for every other dish to be installed. This paper aims to present and discuss the development of an automated system for aligning the parabolic reflector antennas for satellite communication. This work automates the steps involved in the manual alignment of an antenna dish. Based on procedures for the manual alignment a satellite dish, was proposed an architecture that employs hardware solutions to this problem. In order to get the exact angle of position of the dish, it needs to be adjusted manually. To overcome the difficulty of manual alignment of antenna, this project helps in aligning the position of the dish using the GPS module. The proposed system will use GPS Module to retrieve the latitude and longitude of the location. Further a formula has been implemented to calculate the elevation and azimuth with respect to the location of the satellite. This solution allows for better placement of the antenna.

Key words: Antenna, Alignment, Azimuth, Elevation, Satellite

I. INTRODUCTION

There are many commercial communications satellites in the geosynchronous orbit. Geostationary satellites are located in orbit directly above the equator and stay in the same place in the sky since they go around the earth at the same angular speed as that of the earth as it rotates. Satellite locations may thus be defined by longitude only. Geo Orbit position is the longitude position around the geostationary orbit. The satellites are all approximately fixed in the sky above the equator.

The most common issue anyone will come across when aligning the dish is aiming at the correct satellite for the broadcasts and receiving they require. Satellite receivers do have details on them regarding the satellites to which they are communicating. They cannot determine whether you are aligned to the correct satellite and rely on the user to align the dish in the correct direction.

The alignment of satellite dishes is currently performed manually wasting many hours to perform this process. Basically, for the manual, we use a spectrum analyzer to monitor the signal during movement of the antenna until the desired satellite is found. Also, to look for the location of a satellite in order to achieve the best reception is an exhaustive process. The manual system has the problem of manual installation which takes more time. Due to manual installation of the system there is possibility of human errors i.e. misalignment of the antenna.

Since each antenna is dedicated to a satellite, it is difficult to point it. So, it is necessary for an automated system in order to achieve the optimum positioning for reception of the signal. The new approach address the steps involved in manually aligning a satellite dish to generate design solutions called Automatic Antenna Positioning.

II. ANTENNA TERMS

The antennas are essential components of all the equipment's used in satellite communication where it is used in transmission and reception of the signals. The antennas are used in various systems such as radio-broadcasting, cell phones, etc. There are following terms related to receiving of the signals in satellite communication specified below. There are various type of antenna related to satellite communication, from those antennas parabolic reflector is used for signal reception purpose. Parabolic antenna uses a parabolic reflector which reflects the signals towards the LNB placed above the center of the dish antenna. The LNB is low noise down-converter block comprises of various functions such as frequency mixer, local oscillator, low noise amplifier and IF amplifier. [8] [3]

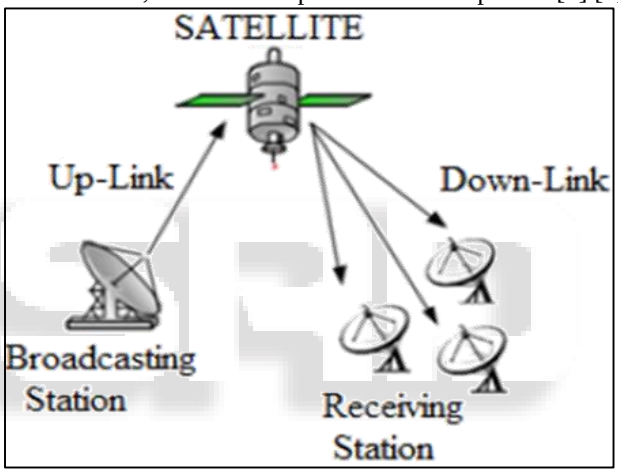

Fig. 1: Satellite communication system

There are some details required in order to successfully align the satellite dish accurately to the correct satellite according to the requirements, these are listed below.

Latitude, which is the angular distance measured in degrees, north or south of the equator and longitude is the angular distance, measured in degrees from the given reference longitudinal line. The coordinates to which an earth station antenna must be pointed to communicate with the satellite are called as look angles. These are most commonly expressed as azimuth (Az) and elevation (El). Azimuth is measured eastward (clockwise) from geographic north to the projection of the satellite path on a horizontal plane at the earth station. Elevation is the angle measured upward from the local horizontal plane at the earth station to the satellite path.

III. TECHNICAL MANUAL ALIGNING

Basically, in the manual maneuvering is necessary: a receiver decoder digital satellite set at a desired frequency, a spectrum analyzer; a C band parabolic antenna, coaxial cable, and RF signal splitter. Two basic instruments are required to both conduct a site survey and aim a dish: An

angle finder or inclinometer and a compass. When a polar mount is installed, these instruments are used to aim the mount towards true south and then to set the polar axis and declination angles. When installing a fixed dish an Az-El mount, adjusting the azimuth and elevation angle can target each satellite. The azimuth is measured in degrees of rotation from true north and the elevation in degrees up from the horizon.

IV. Calculation for the Reference Position

The elevation angle is one that exist in the vertical plane between the satellite and earth station antenna. According to D.L. Hornback (1986), [7] the value of the elevation angle can be obtained.

$$Elevation = \tan^{-1}\left[\frac{\cos Lat \cos L - 0.151}{\sqrt{1 - \cos^2 Lat \cos^2 L}}\right]$$

Where
Lat = Latitude f earth station
L = L_E –L_S =longitude of earth station – longitude of satellite
The azimuth can be defined as,[1]

$$A = \tan^{-1}\left[\frac{\tan L}{\sin Lat}\right]$$

For the southern hemisphere with the earth station west of the satellite:
Azimuth = A
For the southern hemisphere with the station east of the satellite:
Azimuth = 360º – A
For the northern hemisphere with the earth station west of the satellite:
Azimuth =180º – A
For the northern hemisphere with the earth station east of the satellite;
Azimuth =180º + A

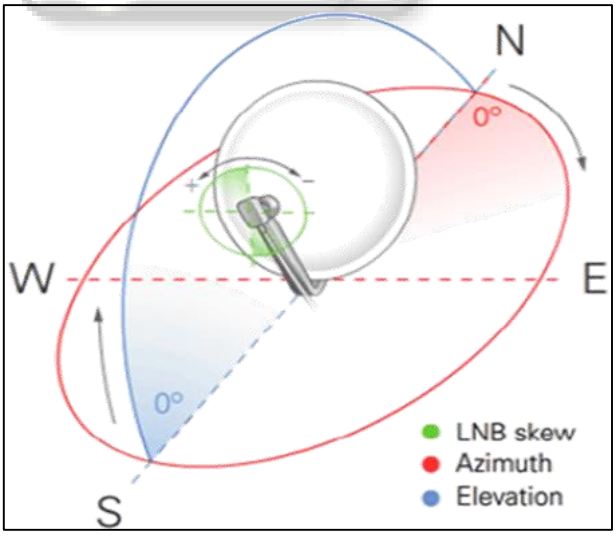

Fig. 2: Dish alignment

V. Model Automatic System

This paper was intended to drive the dish antenna automatically. The system comprises of a gps module, drv8811 drivers which in synchronization are used to drive the stepper motors to adjust the position of the dish antenna. Furthermore the LCD displays the initial angles and the gyrated angles. At output side a television set and a set top box is to be used to check the proper output inform of TV channels.

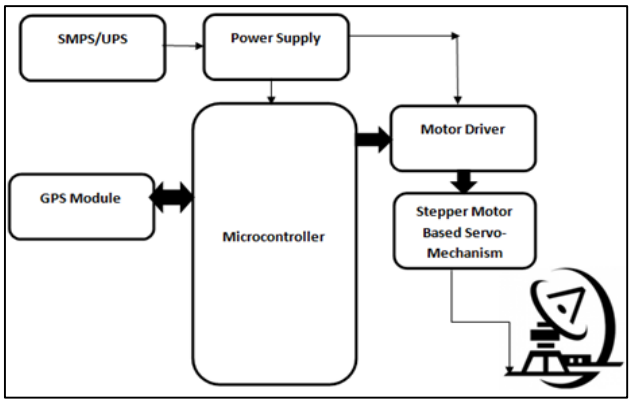

Fig. 3: Block diagram of the proposed system

In this system for automation a GPS module is used. Initially when the system is reset the GPS will hit a ping to find the exact location of the earth station and will give eight output strings which will individually have the position details in it.

Recommended minimum specific GNSS (Global navigation satellite system) data string is to be used in the proposed system which is $GPRMC. This data string gives various information from which, system checks if the received data is valid or not and after validation lat/long specifics is to be picked up and further implemented in a formulae to calculate the Azimuth and Elevation and rotate the Dish antenna to the direction needed.

VI. Result

1) Start the kit by pressing the SMPS power button on. Then first it display project name.

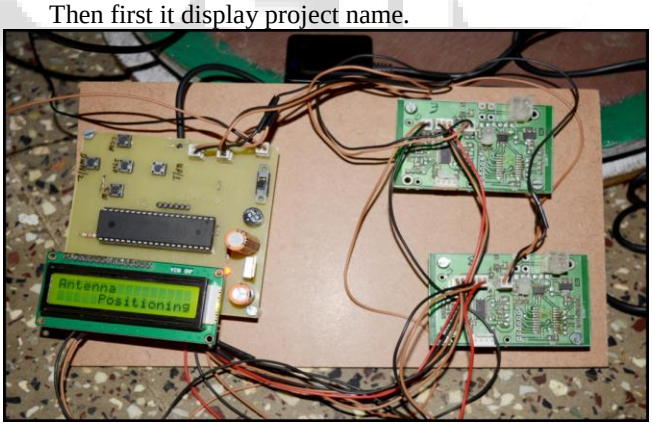

Fig. 3:

2) Then select required satellite to direct antenna towards it.

Fig. 4:

3) After selecting satellite system initialize the GPS and receive lat/long of where the proposed system is placed.

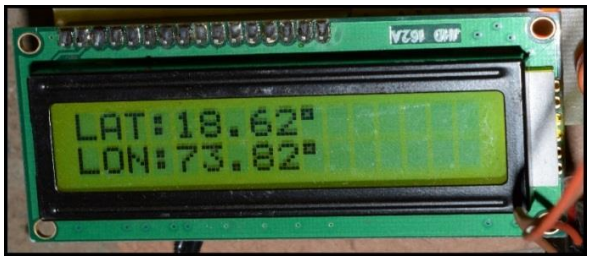

Fig. 5:

4) When data is received by GPS, then elevation and azimuth angle is calculated.

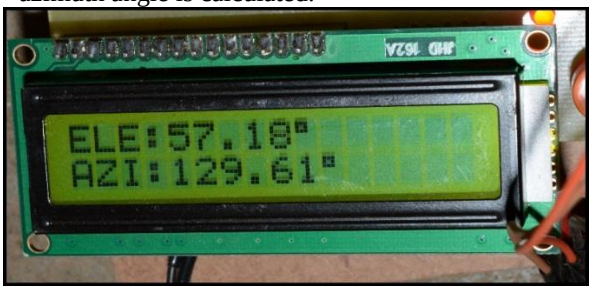

Fig. 6:

5) Then base motor rotate to set the azimuth angle and upper motor rotate to set elevation angle.

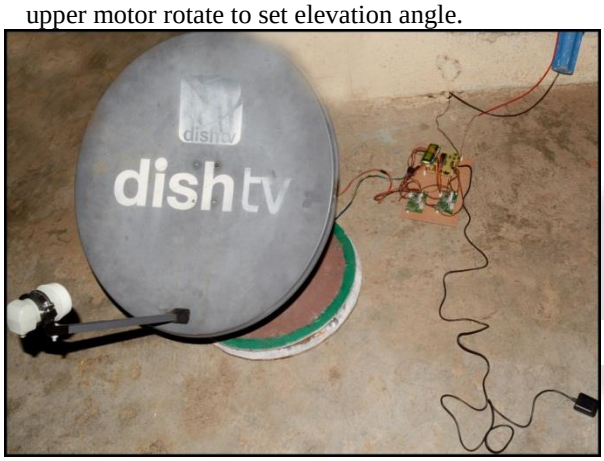

Fig. 7:

Observation: The proposed system achieved micro stepping, in order to rotate elevation motor to 1 degree 300 counts are provided and time taken is 0.98 seconds for the same. Similarly to rotate azimuth motor to 1 degree 448 counts are provided it takes 1.46 seconds. For adjustment of antenna from initialization to final antenna positioning total 5 to 6 minute are taken.

Below screenshot shows signal strength and signal quality for NSS6 satellite.

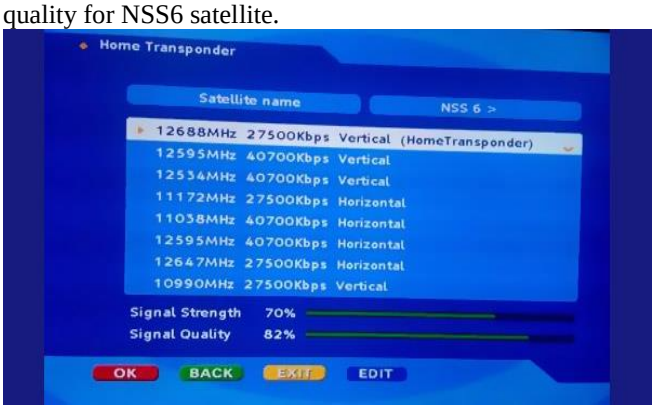

Fig. 8:

VII. Conclusion

Proposed system works according to the result displayed in the result section. Satellites are tracked properly irrespective of its position and within 5 minutes the servo mechanism aligns the dish to desired look angles.

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