SIGNAL RECEPTION BY CROSSED YAGI-UDA ANTENNA

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Abstract: This paper aims at the process involved in receiving signals from beacon satellites at the ground station situated in the BVCOE, Navi Mumbai campus. Using the highly efficient tracking and receiving section the signals can be received from HF, VHF and UHF bands. Yagi Uda antenna in general has moderate to high gain which depends on the number of elements used, typically limited to about 20 dBi, unidirectional (end-fire) beam pattern with high front-to-back ratio of up to 20 db. It makes an excellent choice for point to point communication. Hence used widely in signal reception from satellite. Also it might help in studying the various changes in climate and development of communication technology.

IndexTerms **- Signal Reception, Yagi Uda Antenna, Satellite, RTL-SDR.**

I. INTRODUCTION

The ground station is the place for extra planetary telecommunication with satellite or reception of radio waves from the satellites. Earth stations communicate with the spacecraft by transmitting and receiving radio waves in the super high frequency or extremely high frequency bands. Specialized earth stations are used to telecommunicate with satellites. A ground station primarily receives telemetry data and the satellites can be tracked to receive these signals. Our ground station is fixed to an itinerant position and it consists of two crossed Yagi antennas which will be mounted on the roof of our college building. These antennas will be free to move from 0-360 degrees in azimuthal plane and 0-90 degrees in the elevation plane. Whenever the satellite will pass over our ground station the antennas will be able to track the satellite using the circuitry designed by us and receive data from it.

Dual stepper motor system is used to point the antennas to look angles to obtain signals from live satellites. This system is controlled using Arduino UNO. Depending on the satellite downlink frequency one out of two antennas is selected for the task. Using the Software-defined radio dongle signal is received from the antenna.

From here we first predict the arrival of a satellite to ground station's latitude and longitude using real-time tracking software and steering the tracking system to satellite's location and received signal is studied using SDR compatible software.

II. PROPOSED SYSTEM

The system that we are proposing here uses two cross-coupled Yagi Uda antennas which are designed to receive signals from the overhead satellite.

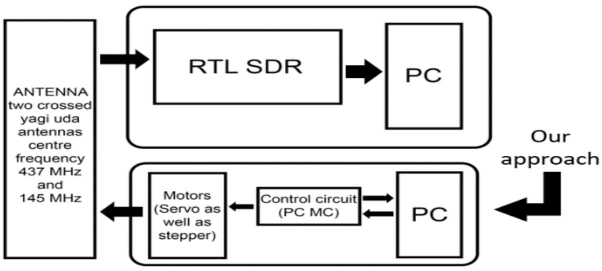

Fig. 1. Block diagram of a ground station

For the successful establishment of our Ground Station we conceptually defined our approach and divided the complete ground station in three sections, which are as follows-

A. Antenna Section.
B. Receiving Section.
C. Tracking Section.

Antenna Section

Many satellites transmit signal in VHF/UHF band with two frequencies around 130-140 and 400-450 Mhz for various purposes. A Yagi-Uda antenna is best suited for satellite signal reception at the ground when compared to axial mode helical and a parabolic antenna. A Quadri-filler-helix antenna also serves as alternate to Yagi. But, due to the suppressed hemispherical radiation pattern, low gain at lower elevation angles. Yagi is preferred choice for a ground station. Moreover, Yagi provides a larger directive gain which is best suited for weak signals.

Hence, this is the first section of our ground section to receive the signal from a functional satellite using two independent crossed Yagi antennas having frequencies of 145 MHz and 437 MHz. Up to now we have designed, fabricated and characterized the two antennas successfully. For designing and optimization we used NEC2 software and for characterization we used Network Analyzer to make sure the antennas meet the resonance condition. To characterize an antenna means to test an antenna for required frequencies and to check whether these are providing better response. Simple way to characterize an antenna is to test an antenna with a wave generator which sends an EM wave and is thus received by antenna at proper gain or we can check output pattern of an antenna on oscilloscope by rotating antenna clockwise or anticlockwise .

Receiving Section

The signal will be received using RTL-SDR dongle. With the exponential growth in the ways and means by which people need to communicate - data communications, voice and video communications, broadcast messaging, command and control communications, etc. – modifying radio devices easily and cost-effectively has become business critical. SDR technology (Software Defined Radio) brings the flexibility, cost efficiency solutions and the power to drive communications forward, with wide-reaching benefits realized by service providers through to end users. SDR defines a collection of hardware and software technologies where some or all of the radio's operating functions (also referred to as physical layer processing) are implemented through modifiable software or firmware operating on programmable processing technologies. These devices include field programmable gate arrays, digital signal processors, general purpose processors, programmable System on Chip or other application specific programmable processors. These technologies allow new wireless features and capabilities to be added to existing radio systems without requiring new hardware. It can be used as a computer-based radio scanner for receiving live radio signals in your area (no internet required). Depending on the model type it could receive frequencies from 500 kHz up to 1.75 GHz. SDRs other than the RTL may be used, but it must be supported by the GNU radio project and be able to receive frequencies from 950MHz to 1450MHz. An RTL has sampling circuit and analog to digital converters built in it.

Fig. 2. Software Defined Radio

Tracking Section

This is the third and last section of our ground station. Tracking is pointing the director of the antenna to align with the position of a satellite to receive data. Components used in this section are listed below.

1. Stepper Motor
2. Arduino Uno
3. Interfacing Circuit
4. Real - time Tracking Software

We have designed a tracking system that works using two stepper motors which enable the antenna to steer in both azimuthal and elevational plane. Another software called "Orbitron" helps to locate the satellite and predict the arrival of satellite. Then using the look angles obtained from orbiton data value of azimuth and elevation is given to Arduino serially.

To develop this mechanism, we had first used Proteus software which is microcontroller simulation software and simulated our model. Hence, we interfaced the Arduino and the stepper motor using proper micro step drivers 8078 and E5045.

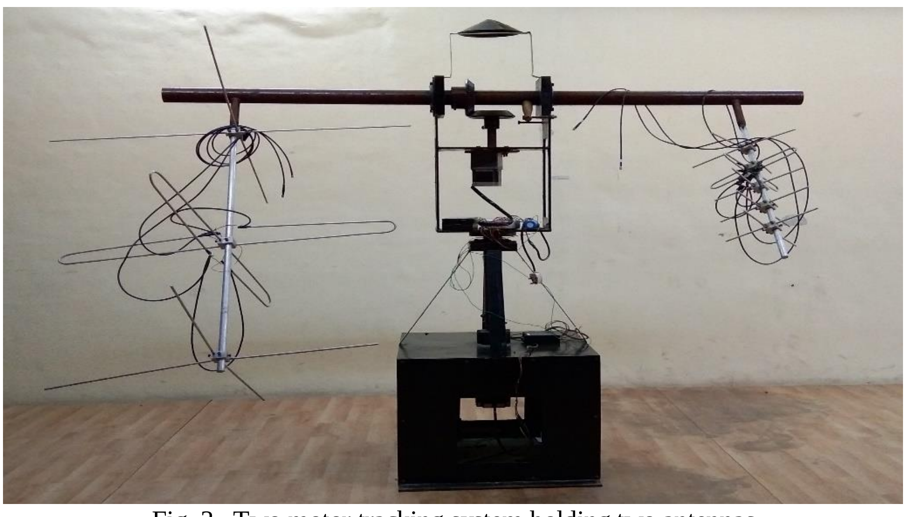

Fig. 3. Two motor tracking system holding two antennas

III. PROCESS OF SIGNAL RECEPTION

A satellite will be able to receive a signal only when the antenna is set at proper look angle. Look angles are required such that the earth station antenna "looks at" or points to the satellite directly. From a location on earth, the two look angles that are needed are azimuth and elevation. Azimuth is such an angle denotes the horizontal angle measured at the earth station antenna to north pole. Elevation angle denotes the vertical angle measured at the earth station antenna end from ground to satellite position. One stepper motor steers antenna in azimuthal plane and another stepper motor with a gear system rotates the antenna in the azimuthal plane. Now RTL-SDR is connected to antenna's coaxial cable and in turn connected to the pc which has SDR# installed on it.

Once everything is set, it is time to wait for satellite to come near ground station. The software called "Orbitron" helps in locating satellite also gives azimuthal and elevation angles. By giving these angles to Arduino serially, the satellite is pointed directly towards the overhead antenna.

When the antenna catches the signal from the targeted satellite, signal can be observed in SDR SHARP as RF waterfall graph. The received signal can also be recorded and the strength of received signal can also be measured. The span of time until when the signal can be received is very short. Hence efficient tracking system and receiving section ensures that the signal is received and its characteristics are seen.

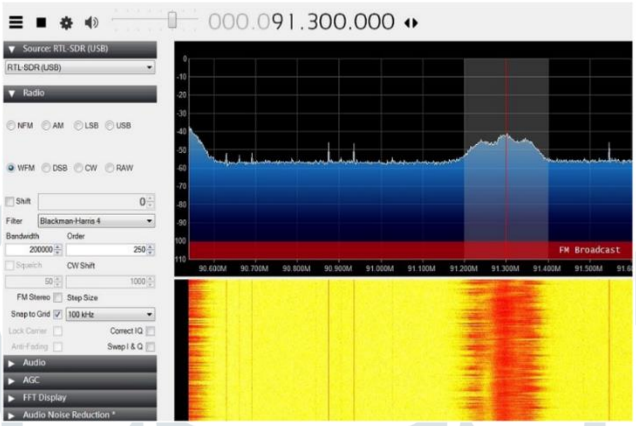

Fig. 4. FM signal characteristics obtained

IV. CONCLUSION

By establishing this ground station, we will be able to receive the signals from the active satellites using a proper stepper motor based tracking system. It will contribute in building India's TEC map which plays a vital role in the field of Telecommunication. With this project, we aim to contribute India's progress in the field of space and satellite technology. We hope our efforts serve as stepping stones for larger successes in the future.

V. FUTURE SCOPE

Receiving signals from the satellite and meanwhile measuring the TEC count might be very useful in forestalling the earthquakes by detecting it beforehand.

VI. REFERENCES

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