Affordable Small Radio Telescope

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Project Guide
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Abstract

The prime intention of this project was to design a small radio telescope, which can be assembled and used by school students. Another aspect was to keep the cost less than Rs. 2,000. Therefore, commercially available satellite television receiving system is used. Parabolic dish antenna is used for receiving radio signals in KU band. Although system has less sensitivity and pointing accuracy, it can detect solar radiation as well as black body radiation. The system can manually be pointed to any radio source and reading can be noted with the help of a satellite finder.

1 Introduction

The goal of this project is to design and assemble a radio telescope kit, or an affordable small radio telescope (ASRT), that can be used to demonstrate radio astronomy techniques to students. This in turn would inspire the students to pursue further activities in science and technology. Radio astronomy experiments using this telescope complement the optical astronomy experiment that are commonly performed in schools. One major advantage is the feasibility of daytime observations, thereby allowing such experiments to be integrated into regular school lessons.

Key components for this radio telescope system were off the shelf available and hence easy to build. ASRT is also easy to use and cheap, affordable to most schools in India, particularly the rural areas. The system can be assembled and installed by school students with proper guidance from teachers and instructions given here.

The carrier frequency used in Satellite TV communication fall in KU band of radio frequency spectrum ($12 - 18$ GHz). The idea of radio astronomy with satellite dish was realised when it was noticed that TV signal gets affected due to solar radiation as sun occupies the same position in the sky as the geostationary satellite to which the antenna is pointing. Later tests with antenna pointed towards Sun showed significant signal strength and the system was optimized for solar observations.

1.1 Satellite Antenna

The satellite dish antenna has a LNB (Low noise block) and a parabolic dish reflector. This dish reflects the incoming radiation towards LNB. LNB provides the signal amplification without adding much noise.

1.2 Satellite Finder

The satellite finder is a tool used by DTH system service engineers for detecting the satellite signal strength. It may be analog or digital. We have used commercially off the shelf available analog satellite finder.

2 Procedure

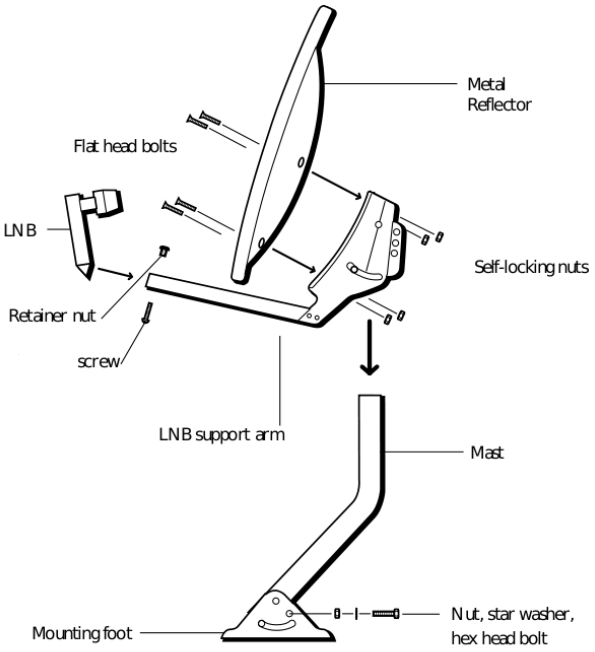
2.1 Requirements

All you require is

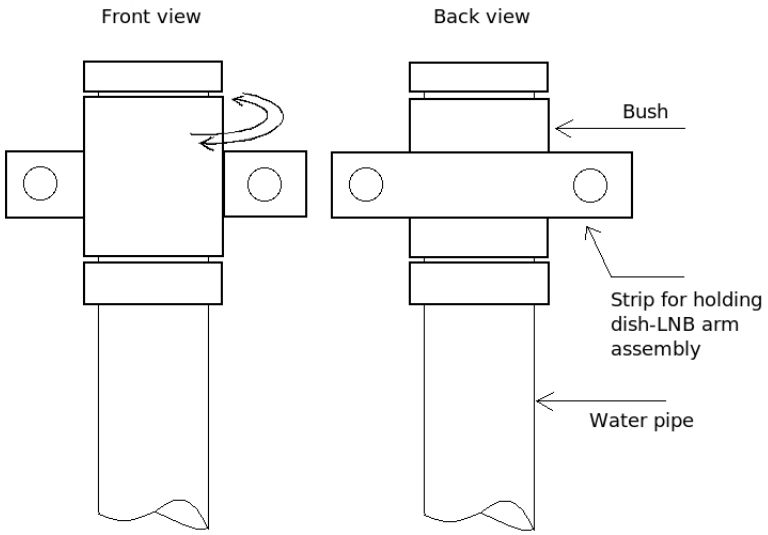
1. Satellite dish antenna with receiver.
2. Satellite finder.
3. Mechanical stand for mounting the antenna.

2.2 Mechanical stand

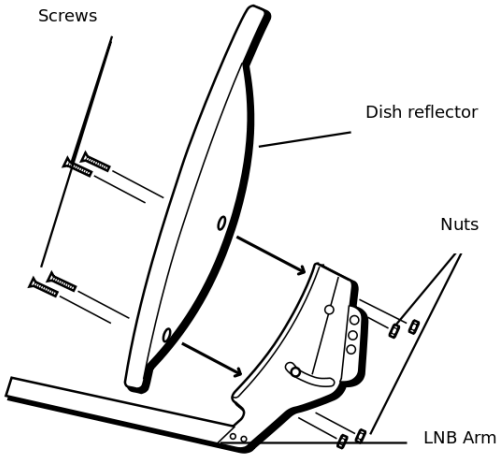
For this project we have made use of metallic water supply pipe available in a hardware shop. An appropriate base can be bolted to this pipe or welded to it to provide stability. Other required mechanical parts come with satellite dish. Following is the procedure how to assemble the dish.



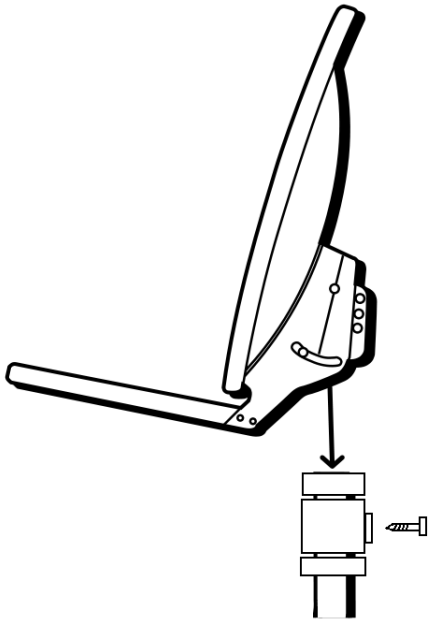
Step 1. These are the accessories usually available with the dish antenna.



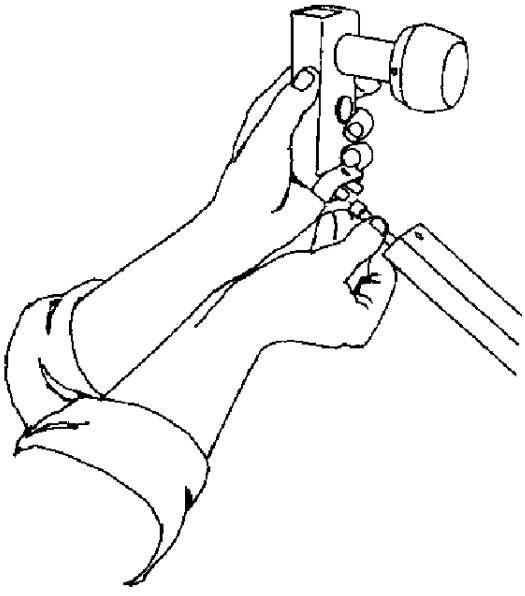
Step 2. This is the pole which we made with a water supply pipe.



Step 3. Attach the Dish reflector to support arm as shown in above diagram.



Step 4. Place the dish-LNB arm assembly on top of the pole.



Step 5. Place the LNB on LNB arm.

2.3 Electrical connections

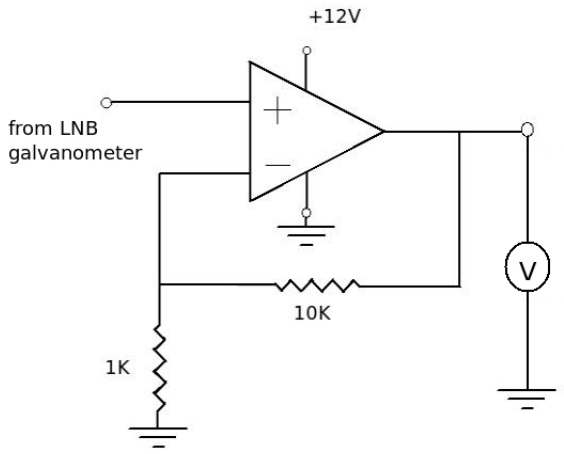
1. Run a coaxial cable (RG6) from your TV receiver to satellite dish.
2. Fix the Type F connector on both the ends.

3. Take another piece of coaxial cable from LNB to Sat-Finder and fix the type F connector on both the ends.
4. Now connect the output of LNB to "LNB In" at satellite finder.
5. Connect Receiver to another end of satellite finder.

2.4 Additional Amplifier

The circuit diagram for additional amplifier is shown in the figure.

1. Remove the back cover of satellite finder.
2. Connect the galvanometer output to the input of amplifier.
3. Connect the output of amplifier to line-in or mic connection of PC.
4. Provide 12V supply to OP-AMP.
5. Do not forget to make ground line common for satellite finder and PC.



3 What all can be done?

You can perform various things with this small setup. You can detect solar radiation, your own body radiation, radiation from hot and cold wall.

3.1 Sun

Sun is a broadband transmitter, so the radiation from the sun can easily be detected with ASRT. As you move the dish antenna towards sun you will see increase in signal strength. A daily monitoring of solar radiation can be used to study its variation. Please see the RPL website for results.

3.2 Satellite

You can detect many geo-stationary satellite with this telescope. The satellite signal strength is usually constant and this can be used to calibrate the solar radiation, which varies with 11-year cycle.

3.3 Body Radiation

You can walk around the telescope and you can find that as you come closer to the antenna signal strength increases. If your satellite finder generates audio you can create music just by moving your hand around the antenna.

4 Experimental Procedure

4.1 without amplifier

1. Connect LNB out to satellite finder input.
2. Connect satellite finder to Receiver.
3. Point the dish to blank sky (Cold sky).
4. Rotate the knob on satellite finder to set reading at 4.
5. Move the dish slowly towards the sun with step of 1 degree in Azimuth angle.
6. Repeat the same procedure for Elevation angle.
7. Note down satellite finder reading.
8. Now move the dish away from the sun.

4.2 with amplifier

1. Connect LNB out to satellite finder input.
2. Connect satellite finder to Receiver.
3. Point the dish to blank sky (Cold sky).
4. Connect amplifier output to voltmeter.
5. Rotate knob such that you should see 1.25V on voltmeter.
6. Move the dish slowly towards the sun with step of 1 degree in Azimuth angle.
7. Repeat the same procedure for Elevation angle.
8. Note down the voltmeter reading.
9. Now move the dish away from the sun.

You will see increase in the signal strength as you move your dish towards the sun. and signal strength falls down as you move your dish away from the sun.

This procedure can be repeated for detecting geo-stationary satellites. Some of them are as follows :

S.No.	Satellite	Azimuth	Elevation
1.	Insat 3A, 4B	132.5	58.7
2.	Insat 2E, 3B, 4A	154	65.8
3.	NSS 6	130.3	57.5
4.	Thaicom 2,5	166.4	67.6
5.	ABS1	177.2	176.4
6.	Measat 3	135.9	60.3
7.	Intelsat 12	240.8	50.6
8.	Express-Am2	162.1	67.1