BUILD, TEST AND MAKE MEASUREMENTS OF A YAGI-UDA ANTENNA ARRAY

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ABSTRACT

- We were assigned to construct a Yagi-Uda Antenna Array to capture TV Derana television channel.
  Frequency range – around 603 MHz, Transmission Station – Nuwara Eliya .
- The wave length for the given frequency was calculated and the antenna was constructed with aluminum tubes whose suitable dimensions were determined according to the data given in the handout for this mini project.
- After construction, the antenna was tested on 'roof top' and appropriate measurements were taken using a spectrum analyzer.
- The testing process was carried out rotating the antenna a whole 360^0.(Anti clock wisely, Relative position - North)
- The readings that were recorded were plotted in two graphs(Clock wisely) to compare the readings obtained from the Yagi antenna with those of the antenna with last two directors removed and the Half Wave dipole.
- In the construction process of the antenna many difficulties were faced and strategies were employed to overcome them. Those will be discussed in the latter part of the report.
- In the testing process also there were technical difficulties that we came across. Many of them could be solved in consultation with the Telecom lab instructor.

Channel Details

Name of the broadcaster - Power House Limited.
Broadcasting station - Derana TV

Coverage –

Channel Number	TX location	Frequency Range
UHF36	NuwaraEliya (Kikiliyamana)	602 – 608 MHz

Kikiliyamana mountain and the transmission tower

The new TV Derana transmission tower

METHODOLOGY

Antenna construction

- Material used

    1. Aluminum tube with diagonal 1.4 cm (as the supporting boom)
    2. Aluminum rods with diameter 0.5 cm (as directors, reflector and dipole)
    3. The circuit and other components including the plastic cup (pre-provided)
    4. Plastic end-caps, nuts and bolts

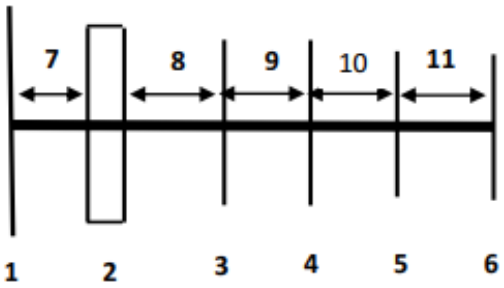
- The structure was setup as follows with the following measurements.

    Provided frequency = 603 MHz

    Relevant wave length =

    $$\lambda = \frac{v}{f} = \frac{299792458\ m/s}{603 \cdot 10^6\ Hz} = 49.71$$

    cm



1 - 0.475λ = 0.475*49.71 = 23.6 cm

2 - 0.46λ = 0.460*49.71 = 22.9 cm

3 - 0.44λ = 0.440*49.71 = 22.8 cm

4 - 0.44λ = 0.440*49.71 = 22.8 cm

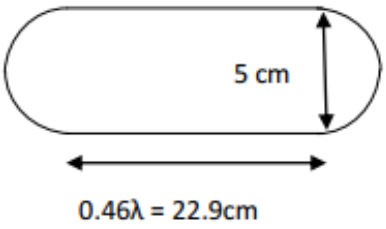
5 - 0.43λ = 0.430*49.71 = 21.4 cm

6 - 0.40λ = 0.400*49.71 = 19.9 cm

7 - 0.25λ = 0.250*49.71 = 12.4 cm

8, 9, 10, 11- 0.31λ =15.41 cm

Dipole measurements



- The antenna was fixed with a feed line (coaxial cable) and mounted onto a rotatable stool so that the antenna can be rotated through 360^0.
- The coaxial feed line was fixed to a spectrum analyzer to see the radiation pattern and measurements.
- The peak value of the plot shown on the spectrum analyzer is noted down and five such readings were taken while the antenna is pointing at the same direction, by repeatedly refreshing the spectrum analyzer. The mean of the five readings was noted down.
- The same steps were repeated by changing the direction of the antenna by 5^0 each time and the readings were recorded.
- The farthest two directors to the dipole were removed and the previous steps were continued.
- Finally two Aluminum tube with the length equal to half the length of the dipole are fixed to the plastic cup as shown below and the readings are taken same as in previous occasions.

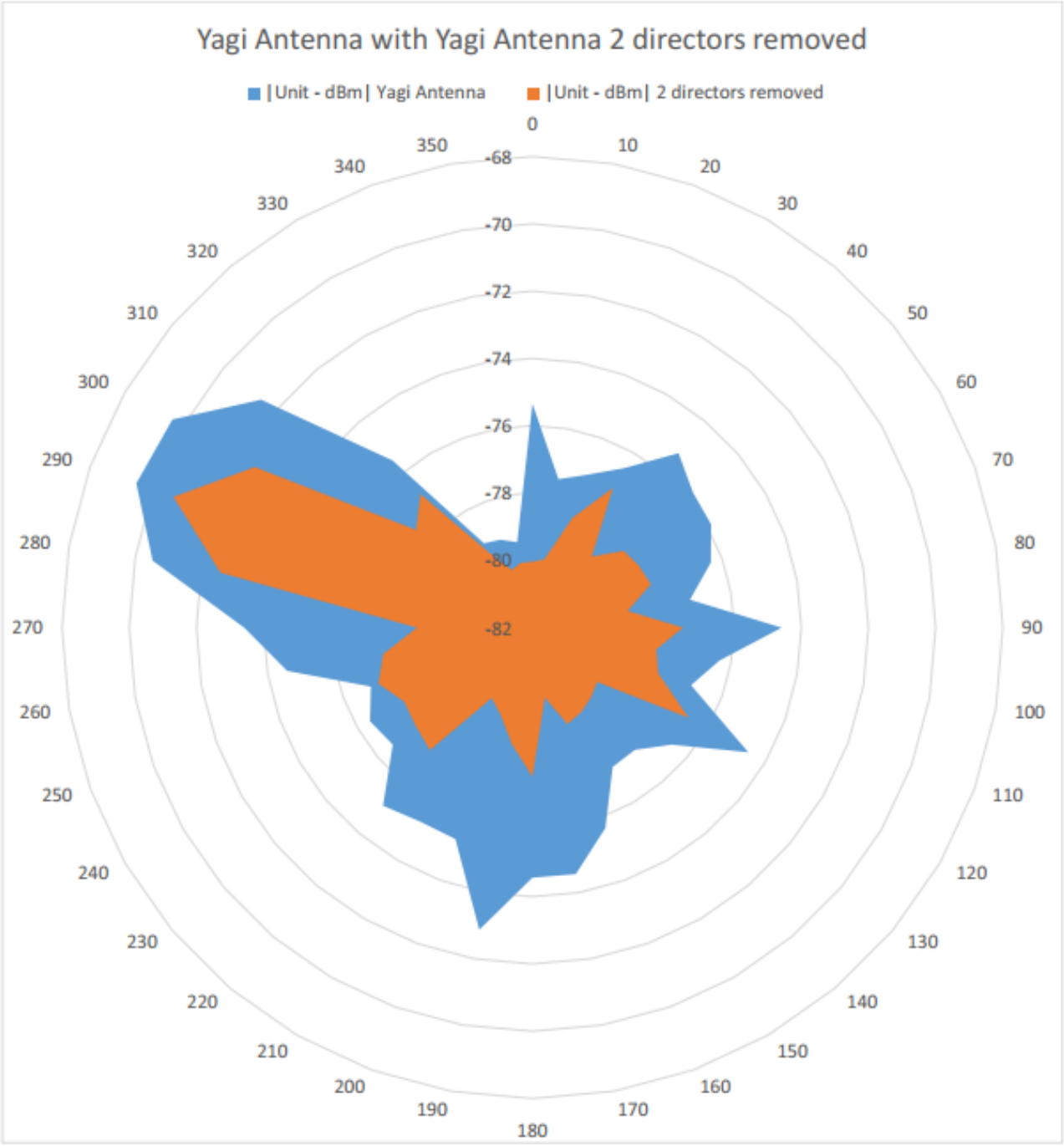
|Unit – dBm|

ANGLE	Yagi Antenna	2 directors removed
0	-75.348	-80.044
10	-77.52	-79.942
20	-77.159	-78.534
30	-76.528	-77.202
40	-75.23	-79.25
50	-75.76	-78.452
60	-75.858	-78.335
70	-76.354	-78.245
80	-77.24	-79.123
90	-74.582	-77.52
100	-76.345	-78.258
110	-76.98	-78.02
120	-74.584	-76.636
130	-76.584	-79.484
140	-77.254	-79.292
150	-77.219	-79.1
160	-75.658	-78.951
170	-74.56	-79.88
180	-74.562	-77.564
190	-72.88	-78.485
200	-75.304	-79.23
210	-75.336	-79.587
220	-75.09	-77.25
230	-76.58	-77.457
240	-76.42	-77.589
250	-76.88	-77.123
260	-74.586	-77.492
270	-73.425	-78.56
280	-70.523	-72.568
290	-69.458	-70.634
300	-69.632	-72.456
310	-71.459	-77.486
320	-75.522	-76.82
330	-79.11	-79.432
340	-79.22	-80.174
350	-79.42	-80.044

Consider the 90 degree direction:
Gain of B relative to A = -2.938 dB

Loss in Gain due to the removal of directors = 2.938 dB

See the plot below.


Yagi Antenna with Yagi Antenna 2 directors removed
|Unit - dBm| Yagi Antenna
|Unit - dBm| 2 directors removed
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
-68
-70
-72
-74
-76
-78
-80
-82

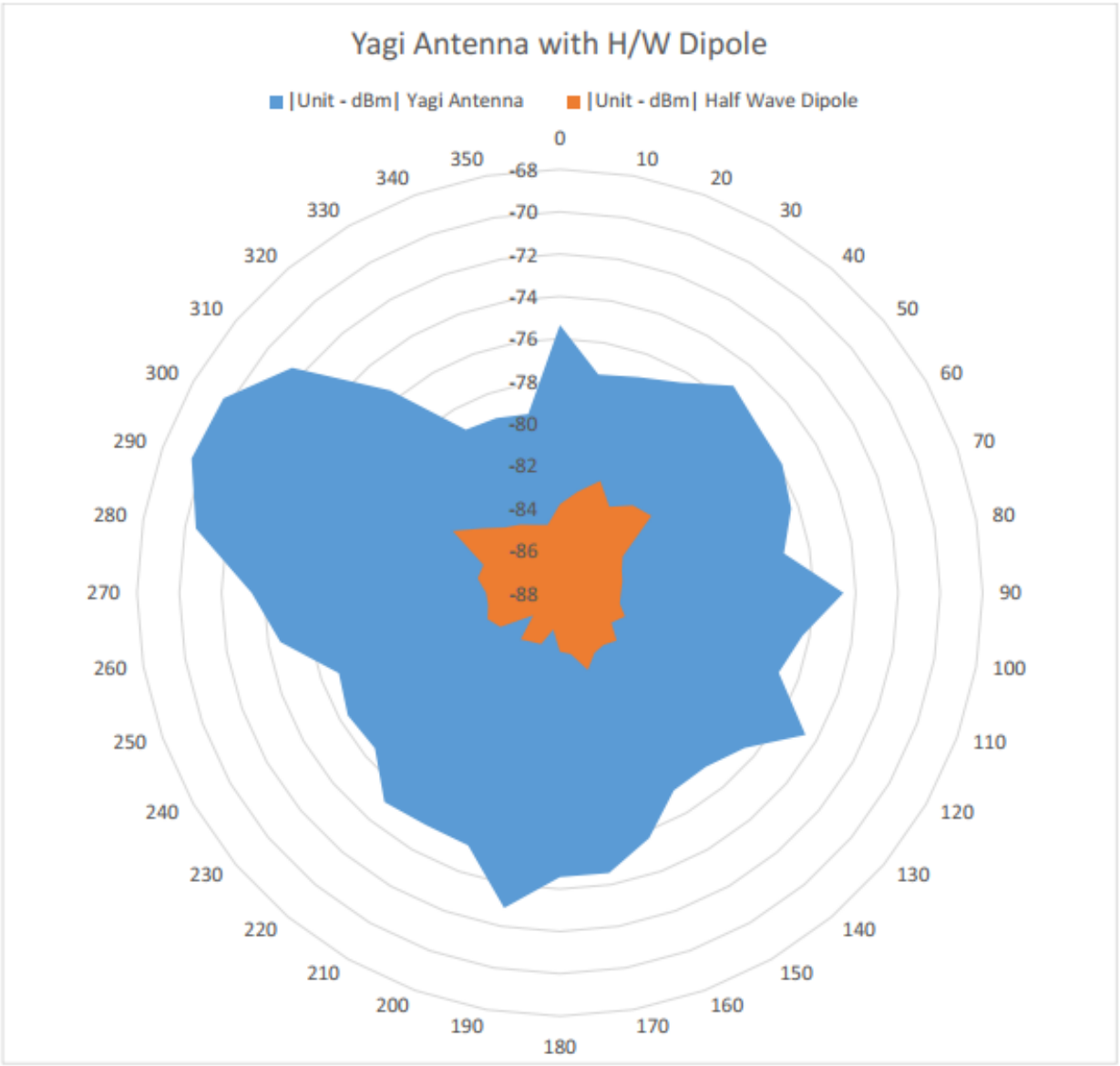
|Unit – dBm|

ANGLE	Yagi Antenna	Half Wave Dipole
0	-75.348	-83.812
10	-77.52	-83.15
20	-77.159	-82.378
30	-76.528	-83.31
40	-75.23	-82.616
50	-75.76	-82.336
60	-75.858	-84.564
70	-76.354	-84.882
80	-77.24	-84.986
90	-74.582	-85.112
100	-76.345	-85.122
110	-76.98	-84.72
120	-74.584	-85.18
130	-76.584	-84.484
140	-77.254	-84.778
150	-77.219	-84.718
160	-75.658	-84.118
170	-74.56	-85.066
180	-74.562	-85.22
190	-72.88	-86.232
200	-75.304	-85.42
210	-75.336	-85.33
220	-75.09	-85.12
230	-76.58	-86.354
240	-76.42	-84.758
250	-76.88	-84.364
260	-74.586	-84.566
270	-73.425	-84.522
280	-70.523	-84.054
290	-69.458	-84.156
300	-69.632	-82.159
310	-71.459	-83.254
320	-75.522	-83.972
330	-79.11	-84.282
340	-79.22	-84.58
350	-79.42	-84.736

Consider the 90 degree direction:
Gain of B relative to A = -10.53 dB

Loss in Gain due to the removal of directors = 10.53 dB

See the plot below.


Yagi Antenna with H/W Dipole
|Unit - dBm| Yagi Antenna
|Unit - dBm| Half Wave Dipole
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
-68
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88

|Unit – dBm|

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Consider the 90 degree direction:
Gain of B relative to A = -10.53 dB

Loss in Gain due to the removal of directors = 10.53 dB

See the plot below.

Discussion

- Difficulties were faced in trying to bend the Aluminum tube to the appropriate measurement to make the dipole. Since the Aluminum tube was prone to break easily, sand had to be filled tightly into the tube so that the pressure exerted by the bending instrument is equally distributed along the circumference of the tube. The bending had to be done slowly without loosening the grip of the handle of the bending instrument.
- Due to many obstacles in the surroundings, the transmission of signals is obstructed therefore the chance of the readings going wrong was high. Therefore for testing purpose a ground with a higher elevation is selected to minimize the hindrance caused by the surrounding objects.
- The reading of the spectrum analyzer was varying even if the antenna was stationary pointing in one particular direction. This may be due to the instant weather changes and a few surrounding objects. To avoid this five consecutive readings were taken while the antenna is pointing to one particular direction and the mean of those five readings was taken to avoid the erroneous readings and to take a fair power gain for the pointing direction.

- The power received by the antenna keeps varying as it is rotated in every direction. When pointed at some direction the power received by the antenna is considerably high and vice versa. It was observed that when the antenna is pointing at the following directions, the power gain is high

    1. 30^0-40^0
    2. 80^0-90^0
    3. 115^0-125^0
    4. 170^0-190^0
    5. 280^0-310^0

- Highest power content is observed when the antenna was rotated 280^0-310^0, that direction is slightly towards the broadcasting station at Kikiliyamana Mountain.

- When the last two directors of the antenna was removed and tested, clearing there was a reduction of capturing transmission power as the process of directing the signals towards the dipole does not happen efficiently. Still the directions where high power is captured remained unchanged.
- Finally when the antenna was tested with only the tube whose length is equal to the length of the dipole, the lowest power capture was recorded, understandably no any directors for the signals be directed. Yet those directions of high power capture remained unchanged.

Acknowledgment

Our team would like to express our deepest appreciation to all those who provided us the possibility to complete this report. The completion of this undertaking could not have been possible without the participation and assistance of many people whose names may not all be enumerated.

A special gratitude goes to Prof. Dileeka Dias who guide us with the theoretical knowledge and Mr. Samiru Gayan and the technical officer who helped us with lot of hard situations.

We thank you for all of their great support.