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SATELLITE TVRO SYSTEMS RECEPTION UNDER TROPICAL WEATHER CONDITIONS EFFECTS

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Abstract

TVRO systems suffers from the tropical weather conditions effects. This paper evaluate the system based on its effects of that conditions. This paper presents a Satellite TVRO system reception with regard to various weather conditions effects such as day time, night time as well as clear sky and rain sky conditions have been highlighted. The Geo arc that has been derived from such system represent the application of TVRO. The TVRO structures a Geo-arc formation and formulation in terms of satellite signals losses.

Key Words: Reception, TVRO system, Tropical effects, Rainy Sky,

1 Introduction

The parabolic antenna, commonly called the dish owing to its shape, is the most visible outdoor component of a TVRO system aiming at a distant satellite. Briefly, the design of a TVRO antenna system may be considered in four parts, namely the parabolic dish reflector, the antenna mounting and tracking, the head unit and the cables for signal transmission, power and tracking controls. In this paper, only the parabolic dish reflector is discussed, considering its characteristic features, efficiency and construction. [1]

2 Antenna Beamwidth Measurement

The antenna beamwidth measurement is important, as we shall use the result to verify the accuracy of our antenna positioning system and the effectiveness of our geo-arc satellite tracking. The basic procedure to measure the beamwidth of the antenna is as follows:

Point the antenna boresight to a satellite, for example PALAPA C2. Display the frequency spectrum from 950 MHz to 1750 MHz using the Spectrum Analyzer (HP8590L). Select a strong signal peak and measure its IF frequency such as CNNI at 1170 MHz. Tune the satellite receiver to 1170 MHz IF frequency. The TV set should now display a clear, live CNNI program.

Measure the signal power strength at its boresight, namely the maximum value. Shift the antenna dish slightly in the East – West azimuth direction and record their respective signal strengths.

Table 1 shows the measured results for the antenna beamwidth

The data is plotted as shown in Fig. 1. From the results the beamwidth obtained is 1.8^o. The [2] antenna beamwidth was given in the following equation (1)

$$\theta_{3dB} = 70\frac{\lambda}{D} \text{ degrees} \qquad (1)$$

where λ = 0.0754 m for the CNNI at RF frequency 3980 MHz and D = 2.89 m. Thus the computed beamwidth is 1.826^o, which agrees with the measured value

Dish Position	Relative Angle (degrees)	C (dB)	C (Relative)
4878	1.6	49	-8
4880	-1.4	52	-5
4882	-1.1	53	-4
4884	-0.9	54	-3
4886	-0.6	55	-2
4888	-0.4	56	-1
4891	0	57	0
4894	0.4	56	-1
4896	0.6	55	-2
4898	0.9	54	-3
4900	1.1	52	-5
4902	1.4	50	-7
4904	1.6	49	-8

Table 1: Antenna beamwidth measurement

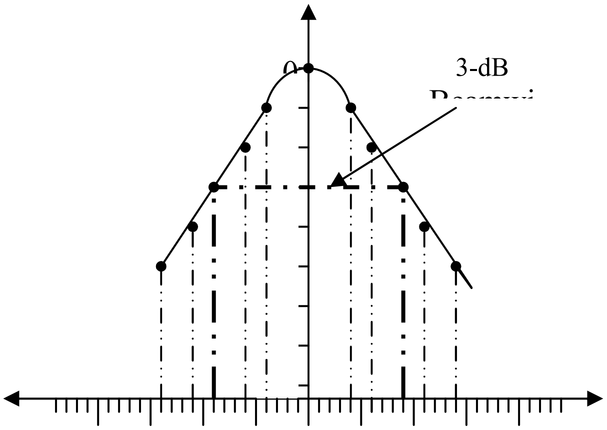

Fig.1: Antenna beamwidth plot

2.1 Antenna Pointing and Geo-Arc tracking Accuracy

Antenna pointing accuracy is one of the most essential factors to ensure good tracking of a TVRO system. The antenna pointing must be very precise so that the geo-arc would appear very close to the authentic arc. The antenna beamwidth was shown to be only 1.8°. Hence, if the antenna is mispointing by a small fraction from its true value, for example 0.9°, then the system will lose half the signal strength, which may result in poorer quality TV picture. If the mispointing error is larger, the TV picture may be noisy with lots of sparklies. In a worse situation, the antenna may completely miss the satellite target, resulting in total loss of reception. In the following sections, The antenna mispointing error must be minimal, and the geo-arc tracking is near perfect. As antenna position system (APS), based on the modified polar mount design, is efficient. [3]

2.2 Carrier-to-Noise (C/N) Ratio Measurement and TV Picture Quality

As mentioned earlier, the signal power may be easily measurement using the HP8590L Spectrum Analyzer (2GHz). Indeed, being FM modulation, the signal power and the carrier power are the same. The noise power could also be measured by using the Spectrum Analyzer. Fig. 2 shows the frequency spectrum plot of ASIASAT2. By moving the cursor to the peak of a particular signal such as CCTV-4 (China) as illustrated in the plot, the signal or carrier power of 60 dB can be read from the screen. Likewise, by moving the cursor to the foot of the signal peak, The noise power read as 43 dB. Hence, obtaining a
C/N ratio of 17 dB.

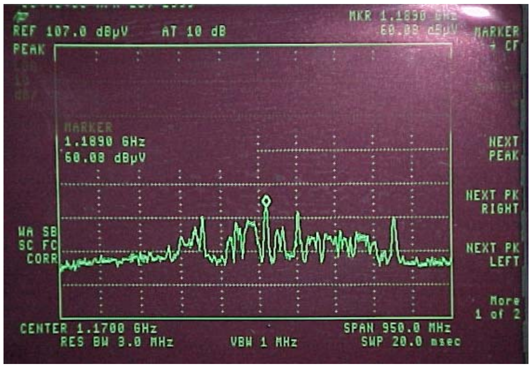

Fig.2: Frequency spectrum plot of Asiasat2

2.3 TV Picture Quality

It is worth noticing to observe the relationship between TV picture quality and the C/N ratio. In the conducted experiments, it was noted that for a good quality picture output the minimum C/N ratio is about 9 dB, which corresponds to the threshold point of the FM demodulation performance curve C/N ratio below the threshold level will result in unsatisfactory S/N ratio at the FM demodulator output. Samples of good and bad TV pictures with their respective C/N ratios given are presented as follows: The CCTV-4 (China) signal from ASIASAT2 has a measured C/N ratio of 17 dB. The TV picture is crystal clear and its quality is excellent.

2.4 Polarity Skew and Picture Quality

Satellite signals are normally transmitted either in horizontal polarization (HP) or vertical polarization (VP). The HP or VP signals may suffer from depolarization in the 36000 km propagation journey. The polarity skew can play an important role in improving the signal strength level in the event that the polarized signal suffers from depolarization. The relative signal strength levels with respect to the polarotor skew positions for PALAPA C2 CNNI, which is a VP transmission. Here, the position of the polarotor does not seem to be critical, for a wide margin of the position can be accommodated for good quality picture reception. This is because the CNNI program signal is relatively strong. Goodt quality pictures can be obtained for polarotor positions from 0 to 10. Between positions 10 to 24, the picture qualities were acceptable. Beyond position 24, the 9 dB threshold cutoff point, the picture quality became fuzzy. In the case where signal is not as strong as CNNI, for example a channel such as RCTI (Indonesia) at IF frequency 1476 MHz which has a C/N ratio of only 10 dB, the position of the polarotor became very critical. [4]

2.5 Linear and Circular Polarization

Satellite signal transmission may be either linear or circular polarization. Linear polarization is more common. Among the 16 C-band geostationary satellites visible over the Malaysian sky, only two were transmitting in a circular polarization, namely INTELSAT 703 and INTELSAT 704. Their program receptions were of unsatisfactory quality. A view of the Sun Gemini from INTELSAT 704, having a C/N ratio of 8 dB and thus showing a lot of white dots. The poor reception is due to was no insertion of a dielectric plate or Teflon in the mouth of the feedhorn which could deteriorate linear polarization reception .

2.6 Carrier Power in Old and New Satellites

A strong carrier power from the satellite is essential. It should exceed the noise power by at least 9 dB. Every satellite has a life span, typically 10 to 15 years. It is obvious that as the satellite ages its transponder power weakens. The satellite should be replaced or discarded if its C/N ratio at the FM demodulator input falls below 9 dB. In the course of our research investigation, we observed that there was a considerable change in the carrier power of ASIASAT1 at 105.5°E. In 1998, we noticed that the transponder output of ASIASAT1 yielded a C/N ratio of about 9 to 12 dB. Recently in 1999, we discovered that the C/N ratio became 19 dB, a remarkable increase. Indeed, what happened was a replacement of the old ASIASAT1 by a new ASIASAT3A. In addition, there was an increase in the number of channels too. Table 2 and 3 shows different signals readings of old and new satellite on the same orbital position.

Ch.	IF tune MHz	A	***P***	C_P dB µV	N_P dBµ V	(Q)
PTV2	1050	6.6	V	55-56	43-44	Good
Zee Cin.	1090	SC	V	53-54	43-44	Med
Zee TV	1170	6.6	V	54-55	44-45	Med
Zee	1210	6.6	V	55-56	44-45	Good

Table 2: Old Asiasat1

Ch.	IF MHz	Audio MHz	***Po***	C dBµV	N dBµV
Alfa TV	1010	6.6	V	61-62	43-44
PTV 2	1050	**6.6**	**V**	**59-60**	**43-44**
Zee Cin.	1090 *Scr.*	**6.6**	**V**	**56-57**	**43-44**
Zee TV	1170	6.6	V	56-57	44-45
Zee	1210	6.6	V	54	44-45
Punj	1450	6.6	V	60-61	43-44
Mara	1490	6.6	V	57-58	43-44

Table 3: New Asiasat3

2.7 Signal Strength Levels in Clear Sky and Rain Conditions

It is very vital to consider the effects of weather conditions [6] on the received signal strength. Two sets of the signal power measurement were taken, one from CNNI of PALAPA C2 and the other from MTV (India) from PanAmSat 4. Our TVRO system is located at longitude 101.7°E. The PALAPA C2 satellite is located at 113.0°E with a slant distance of 35950 km and an elevation angle of 79.5°. The PanAmSat 4 satellite is located at 68.0°E with a slant distance of 37031 km and an elevation angle of 50.7°. CNNI is selected because it has a strong signal. Table 4 shows the signal strengths under various weather conditions. There was an increase of about 1 dB for the night reception as compared to the day reception. When it rains, the signal strength drops by about 1 dB. In all the weather conditions, the C/N ratios exceeded the 9 dB FM demodulator threshold point. Hence, the picture qualities remained excellent even under rainy condition. [5] The MTV program from PanAmSat 4 was chosen to illustrate the loss of picture reception during rain. The MTV signal strength recorded during a clear sky was about 54 dB or a C/N ratio of about 10 dB. It was weaker because of the longer slant distance. Table 3B shows the signal strengths before and during rain. There was a significant signal power drop of about 4 dB, which is much greater than the drop in the case of CNNI. The reason is the PanAmSat 4 is lower in its elevation and has a longer slant distance. The signal will have to propagate through a thicker layer of rain and atmosphere. The 4 dB signal power drop brought down the C/N ratio to about 6 dB and hence a very noisy picture reception. These shown in table 4A and 4B

Table 4A : PALAPA C2 CNNI signal strength records

C (dBµ)	C/N (dB)	Condition
57-58	14	Day Clear Sky
56-57	13	Day and Rain
58-59	15	Night clear sky
57-58	14	Night and Rain

C (dBµ)	C/N (dB)	Weather Condition
53-54	10	Clear sky
49-50	6	rainy sky

Table 4B: PanAmSat 4 MTV signal strength records

2.8 Channel Information of the Geo-arc Satellites

The success of our TVRO system design and construction is evident. Our TVRO system was able to track all the 16 C-band analogue satellites in the geo-arc visible over Malaysia as shown in Fig. 4. The TV pictures from some of the satellites have already been shown in the previous sections, for example CCTV 4 (China) from ASIASAT2, Sun TV from INTELSAT 703 and Sun Gemini from INTELSAT 704..

PanAmSat4 at 68.0°E
Thaicom 2/3 at 78.5°E
INSAT 2D at 83.0°E
ASIASAT2 at 100.5°E
ASIASAT 3A at 105.5°E
PALAPA C2 at 113.0°E
APSTAR 1A at 134.0°E

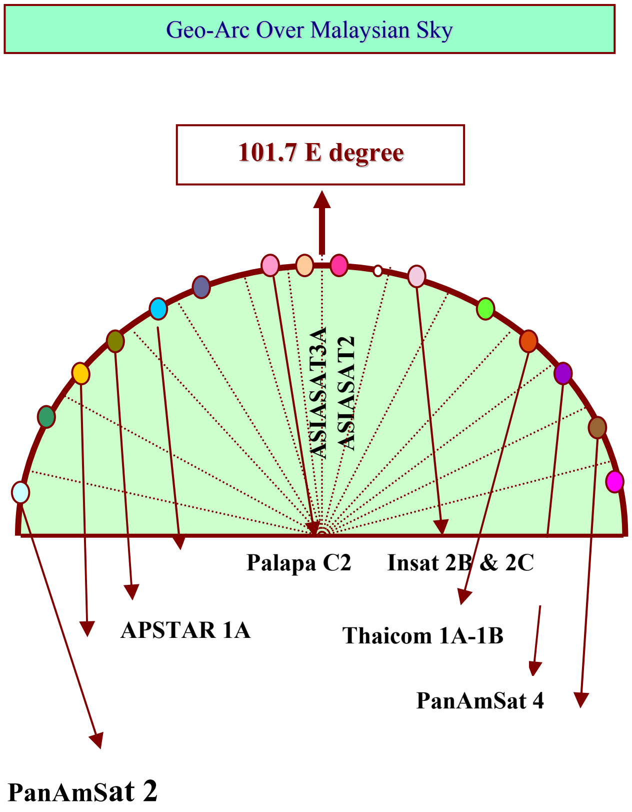

Fig. 3: Geo-Arc over Malaysian sky

3 Conclusion and Discussion

This paper discussed TVRO system formation and fomulation, The successful Geo Arc with authenticity been outlined and sketched. The design of TVRO based on various factors such as the effects of tropical weather conditions which has been indicated that the results obtained in various weather conditions. These factors which include the polarizations depolarizations, C/N ratio, skew positions, and geo arc accurate formation have been discussed

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