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SHORT COMMUNICATION

Performance Evaluation of Telemetry Stations based on Site Selection

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ABSTRACT

In a test range, selection of sites for deployment of mobile telemetry stations plays a crucial role for acquiring and tracking any airborne vehicle under test. Efforts have been made to correlate the tracking performance of the auto track stations based on site selection for various test flights conducted from different launching pads. Some of the tracking methodologies discussed in this paper are single-channel amplitude comparison monopulse (SCACMP) technique and E-SCAN technique. Also, the performance of a simple telemetry data acquisition system using helical antenna is compared with these auto track stations.

Keywords: Single-channel amplitude comparison monopulse technique, computer designate mode, mobile telemetry stations, airborne vehicles, tracking-test ranges, E-SCAN technique, tracking methodologies

1. INTRODUCTION

In a typical test range scenario, multiple telemetry auto track stations are deployed to acquire telemetry data not only for redundancy but also to cater for the various diversities in space. Such diversities may occur either due to the null depths of the onboard antenna or to the fact that radio-frequency waves suffer from polarisation, space and frequency diversities at two different points in space. Thus, the deployment of multiple auto track stations and the associated task of site selection becomes crucial for any test range configuration.

Normally, the choice of a site for a particular auto track station is done with a compromise between its pedestal rates and the line-of-sight availability. However, site selection is normally not done taking into account the methodologies of tracking incorporated in the auto track system in use. An attempt has been made to understand the effect of site selection on the auto track methodology incorporated in the telemetry stations. In this paper, single-channel amplitude comparison monopulse (SCACMP) and E-SCAN systems have been compared for their performance in real-time during various flight campaigns from different launching pads.

2. TRACKING METHODOLOGIES

The conventional monopulse systems[1,2] consist of five crossed dipole feeds (Fig. 1) so as to generate the azimuth error, the elevation error, and the sum signal in the three different channels for further processing by coherent receivers. However in a single-channel monopulse system, the errors are being utilised to modulate the data channel at the feed and utilising a single channel instead of

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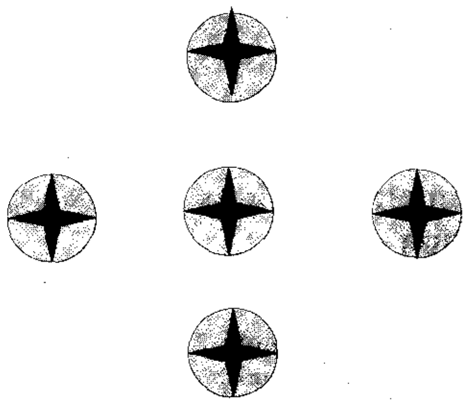

Figure 1. Conventional monopulse systems

the three channels, thus, avoiding complexities at the receiver level. Such an SCACMP telemetry auto track station with the G/T value of 3 dB/ °K was used for the study.

Another system having E-SCAN technique of auto track was also utilised. Such a system[3-5] also consists of five crossed dipole feeds with the central element always being active and an electronic switching taking place between the dipoles of elevation and the azimuth planes. Here, superposition of two beams instead of three beams occurs in space as of SCACMP system. Thus, tracking is achieved by a shift in the phase centre of the beam patterns. Such a system with a high G/T value of 16 dB/°K was used.

3. SYSTEM LOOP PERFORMANCE

A comparative study of the system loop performance of both the systems was taken up using the antenna image (angle data and antenna controller status) during real-time as logged by a central computer of both the systems for various flight campaigns. The SCACMP system on some occasions was placed very near to the launching pad (typical distance of 2 km to 3 km) and on some occasions, at an appreciable distance from the launching pad (typical distance of 40 km to 50 km). The whole process was repeated for the E-SCAN system.

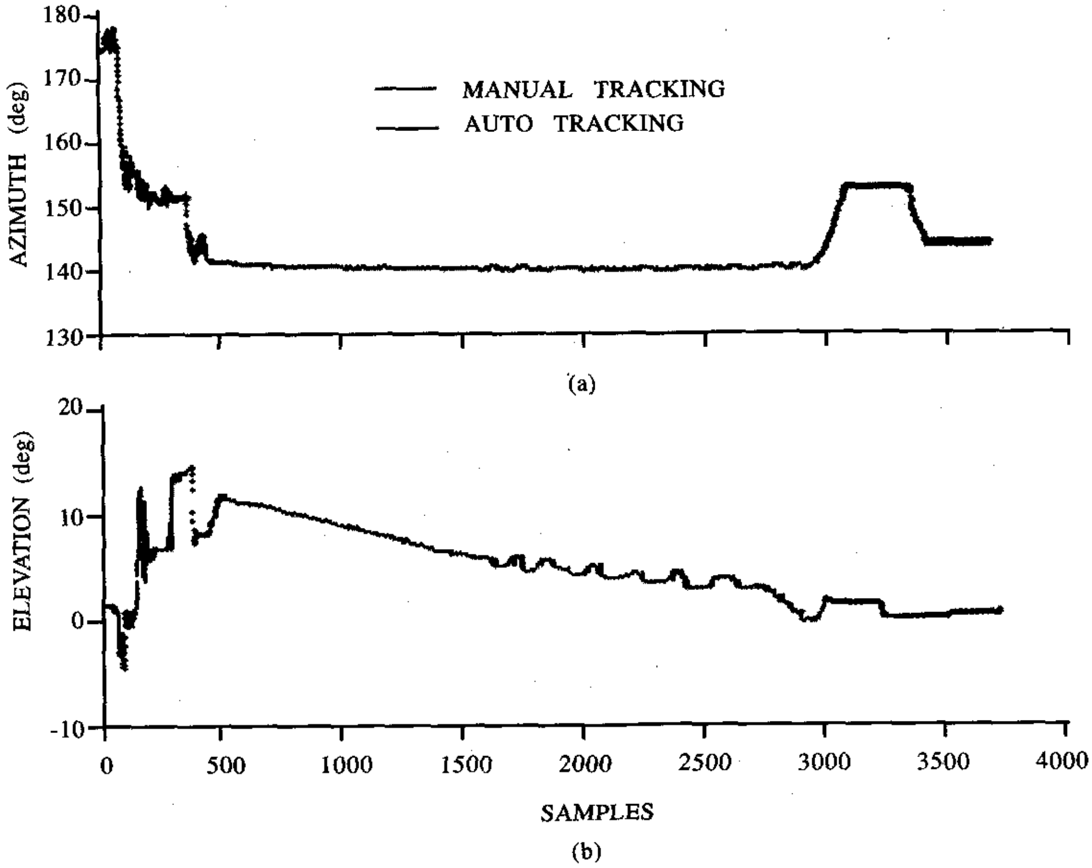

Figure 2. System loop performance of a SCACMP system when placed very near to the launching pad

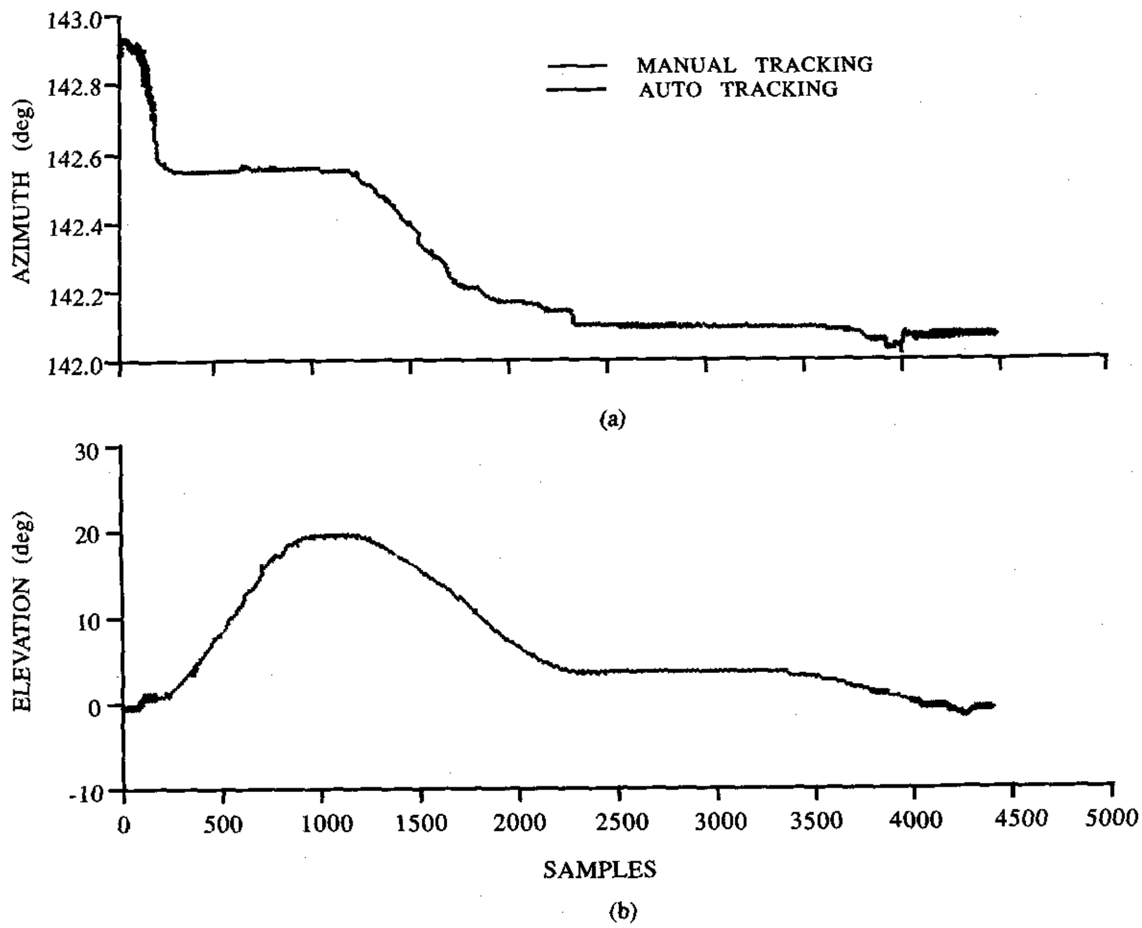

Figure 3. System loop performance of a SCACMP system when placed very far to the launching pad

When the monopulse system is placed very near (Fig. 2), it represents a typical situation where the system repeatedly goes to side-lobe tracking while initiating auto track after lift-off. The operator is forced to initiate auto track after an appreciable time, while the vehicle has an appreciable height. This is because of the fact that at close proximity of the launching pad along with the signal from the boresight, the reflected signals from nearby locations also become predominant. Under these conditions, the SCACMP system has a probability to lockon to the false target, which later gives confusing results. When placed very far (Fig. 3), the same system can perform better because false targets due to reflection becomes ineffective compared to the actual boresight at such distances.

The E-SCAN system seems to have *no* such problems at either close locations (Fig. 4) or at far-off distance from the launching pad (Fig. 5).

The superior performance of the E-SCAN system can be explained mainly on the basis of difference in philosophy of achieving auto track. Unlike the SCACMP system where all the elements are active continuously, here, respective elements in the azimuth and elevation planes are active, thus always incorporating an additional spatial shift while tracking. This additional shift in space further differentiates the reflections from the actual boresight, giving a better resolution of the radio-frequency source. Moreover, the fact that in the E-SCAN system, the elements of both the planes are not active simultaneously provides a better crosstalk performance compared to SCACMP system. Thus, auto track with E-SCAN system seems to be more stable and jerk-free compared to SCACMP system. The only disadvantage of E-SCAN system seems to be the theoretical prediction of being blind to

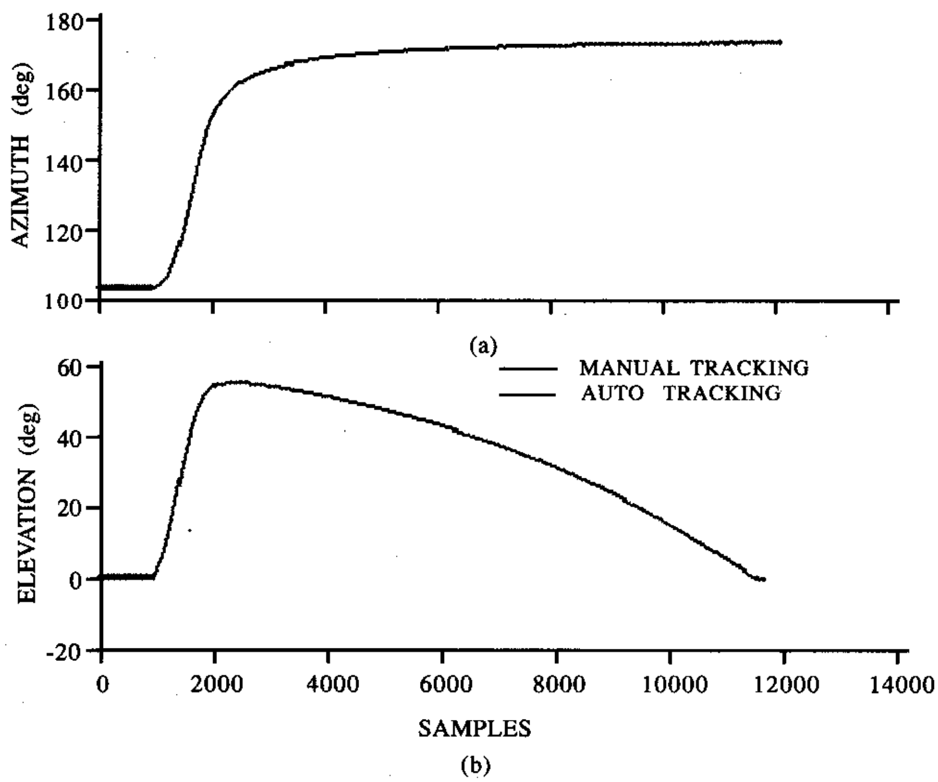

Figure 4. System loop performance of E-SCAN system when placed very near to the launching pad

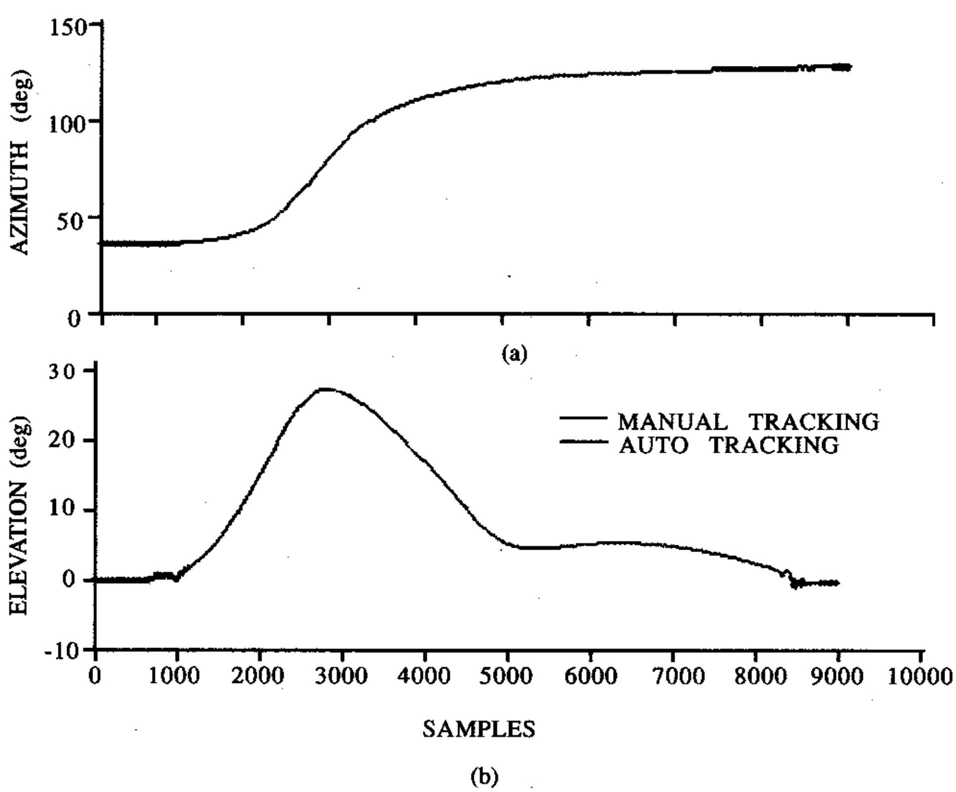

Figure 5. System loop performance of E-SCAN system when placed very far to the launching pad

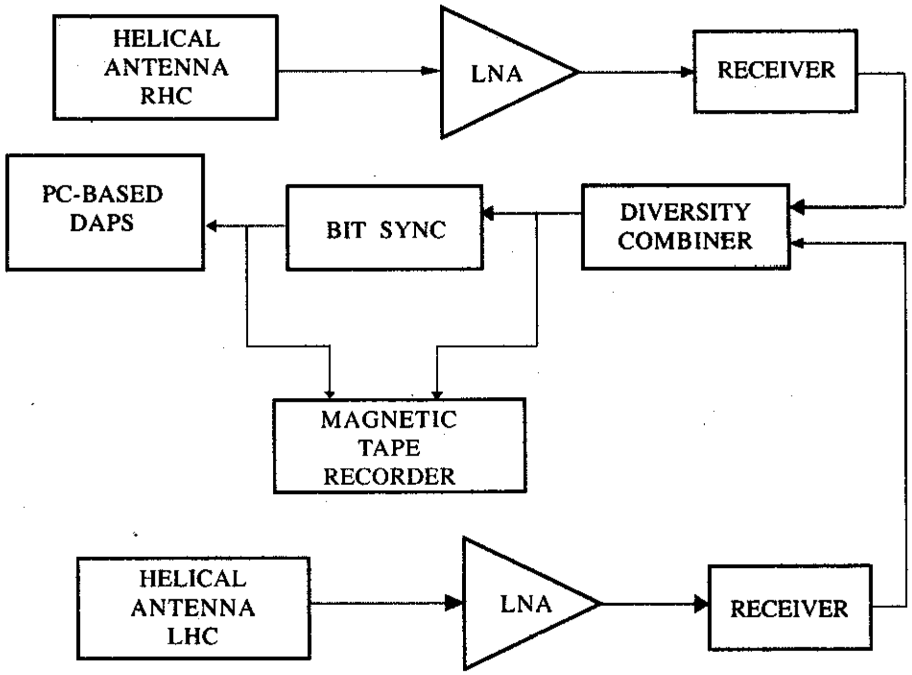

Figure 6. Dual polarised helical antenna-based data acquisition station for telemetry data acquisition

rotating target, which has not been investigated in the present study. However, the authors suggest that scanning the elements with two different polarities can be a better approach to deal with rotating targets.

The plots shown here are typical cases. However, similar results are observed during most of the flight campaigns, and thus can be generalised to a greater extent.

4. HELICAL ANTENNA-BASED RECEIVING STATION

The test range has also configured a helical antenna-based telemetry acquisition system[2] which is extensively used during various flight campaigns. Figure 6 represents the dual polarised helical antenna (nine-and-a-half turn, 30° beamwidth and 15 dB gain)-based data acquisition station which can be used as a full-fledged station for telemetry data acquisition using manual tracking for short-range flights. Low gain, dual polarisation reception and the available beamwidth can easily cater for the requirement of data acquisition from close proximity of the launching pad at acceptable signal-to-noise ratio by simple manual tracking or by remote-steering at computer designate mode for any short-range flights. Such a station can also be useful to acquire data at the initial phase of any long-range flight where SCACMP system faces difficulties.

5. CONCLUSIONS

The performance of different auto track stations during real-time on the basis of site selection was investigated. It has been found that the SCACMP system suffers from problems of side-lobe tracking due to lockon to false targets when placed very close to the vehicle under test. The same system performs much better when placed at a far-off distance. The E-SCAN system seems to have a better resolution of the target and a superior auto track performance in both the cases. Thus, it is recommended that SCACMP system should not be placed very near to launching pad even if pedestal rates can cater for it. It has also been suggested to deploy the helical antenna-based acquisition system at close proximity of the launching pad while configuring the range with SCACMP system.

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REFERENCES

1. Serman, Samuel H. Monopulse principles and techniques. Artech House,1984.
2. Goswami, M.; Alli, S.M. & Pradhan, A.K. Performance evaluation of telemetry tracking systems applied to short and long range missiles–a case study. *In* International Conference on Communication, Computers and Devices, December 14-16, 2000, IIT Kharagpur. pp. 775-78.
3. Technical manuals–8 foot reflector and two band feed tracking antenna. Scientific-Atlanta Inc, 1987 and technical manual for tracking and acquition feeds of GRS#1 system. Orbit Advanced Technologies Ltd, 1997.
4. Pedroza, Moises. Antenna pattern evaluation for link analysis. *In* Proceedings of International Telemetry Conference, SanDiego, CA, USA, 1996. pp. 111-18.
5. Dunn, Daniel S. & Augustin, Eugene P. A single-channel monopulse antenna with low effective sidelobes. *In* Proceedings of the International Telemetry Conference, SanDiego, CA, USA, 1992. pp. 661-70.

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