



Comparative Analysis of Tracking and Steering Antenna Systems for News Broadcasting Applications.

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Abstract:

The increasing demand for real-time, high-quality news broadcasting has necessitated the development of highly efficient and reliable antenna systems capable of maintaining strong signal integrity under dynamic conditions. This paper presents a comparative analysis of various tracking and steering antenna systems – including mechanical tracking antennas, phased array systems, hybrid systems, auto-pointing antenna systems and electronically steered antennas (ESA) to determine the most suitable technology for news gathering and broadcasting applications. The primary objective is to evaluate each system's performance based on mobility, response time, signal stability, ease of deployment, power consumption, and cost-effectiveness in diverse operating environments such as urban terrain, remote locations, and while in motion. A mixed-methods approach was used, combining quantitative simulations with field data collection from existing broadcast vans and mobile news units equipped with varied antenna technologies. Performance metrics such as beamforming accuracy, signal-to-noise ratio (SNR), and acquisition time were analyzed using MATLAB and CST simulation tools. Interviews with field technicians and broadcast engineers provided additional qualitative insights. The findings revealed that while mechanical tracking systems are cost-effective and rugged, they exhibit slower response times and higher maintenance needs. In contrast, electronically steered phased arrays demonstrated superior beam agility, low latency, and robust signal performance, particularly in mobile scenarios. However, they are comparatively more expensive. The study recommends electronically steered phased array antennas as the optimal solution for modern news broadcasting, especially in dynamic and fast-paced

environments. Investments in such systems will enhance the agility, reliability, and quality of live news coverage.

Keywords: *Antenna tracking; Steering methods; News Gathering; Optimization*

1. Introduction

The rapid evolution of communication technology has revolutionized the field of news gathering and dissemination. Satellite antennas used in news vans or portable field setups require robust tracking and steering systems to maintain reliable connections with geostationary or LEO satellites. Selecting the best tracking mechanism directly impacts the quality of transmission, ease of deployment, and cost efficiency.

The purpose of this research is to compare difference antenna tracking methods and self-steering antenna system for live video streaming and news gathering application. This antenna system would be able to track a signal transmitted continuously by a target via a source, such as a communication satellite or any transmitting device. In times of war and catastrophes, this system could be used to capture information and process that to identify threats and send the data to the base station. For this research the system would be most useful for delivering a live mobile video streaming and news gathering of the target region/area. But it is a challenging task implementing such over long distance because it requires high transmission power. Also, the type of antenna used significantly affects the transmission distance [1] and [2]. The study of different types of antennas reviews that those of omnidirectional spreads the energy in all directions, so the loss of signal strength is very high and thus not suitable for long-range operation, whereas those of directional antennas emit the signal in one direction and thus it can reach longer distance with higher signal strength. The present issue with the current design is range, using omnidirectional transmitting antenna the energy spreads into all directions which makes the signal get attenuated within a short range. Usually, the range of omnidirectional antenna is narrow to a small number of miles; however, the range of a directional antenna can be prolonged to 8 miles [1].

1.1 Background of the Study

Video delivery over wireless broadband networks is already available in different forms and is predictable to grow rapidly in the next years [3];[4]. There is need for wireless infrastructure to meet up with this current increase demand. In order to tackle this growing trend, the difficulties faced by the existent system have to be look into. The current issue with the existing design is range, using omnidirectional transmitting antenna the energy spreads into all directions which makes the signal get attenuated within a short range. To address this challenge, a high gain directional Yagi antenna with mounted 2.4GHz WiFi adapter was used to automatically track the remote station. The essence of doing this is to enable transmission of video signal from the remote station to base station in real time.

The existing design of tracking antenna has the tracking system mounted onto the remote station which takes the positional data of the unmanned aerial system and then measures the signal strength and by applying triangulation method antenna track the unmanned aerial system [1]. This kind of system is not effective as tracking depends totally on signal strength and if the aircraft is lost it is difficult to track it back. Looking at the case above where the unmanned aerial system radiates the signals in all directions using an omnidirectional antenna and the base station uses a tracking directional antenna, here still the signal strength would not be high since the sender is emitting data in all directions and even though receiver is tracking the unmanned aerial system the receiving signal strength is mere the same.

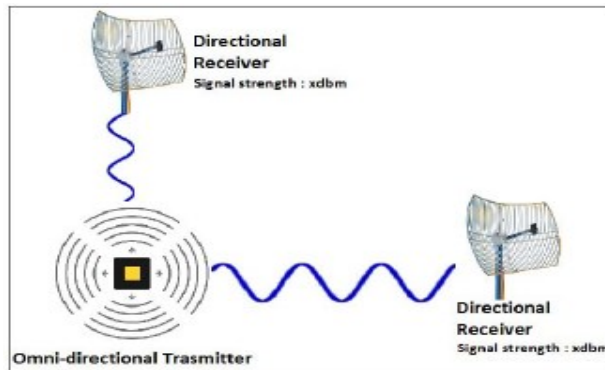


Figure 1 : Showing Omnidirectional transmitter and directional receiver

Source: Adapted from [1].

Figure 1 above which is the existing model plainly explains that even though the receiver is directional and transmitter is omnidirectional the resultant signal strength is same irrespective of the receiver direction, except distance. Therefore, the use of tracking antenna at the receiver side is not efficient.

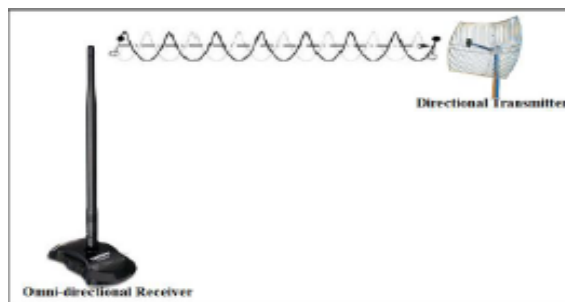


Figure 2: Showing Omnidirectional receiver and directional transmitter.

Source: Adapted from [1]

The arrangement in figure 2 above is more efficient than the previous, as the transmitter is continuously tracking the receiver and is directional, henceforth the signal strength will

always be concentrated and strong irrespective of where the transmitter is. The transmitter will constantly send signals towards the receiver. Therefore, the loss of signal strength is only due to distance, and as the beam is narrow the range is also very high [5].

Table 1 below shows the effective combination of various antenna types and signal strength on both sides, where both on sender side and receiver side antenna keep tracking each other.

Table 1: Signal Strength Comparison for Various Antenna Combinations.

Remote Station	Base Station	Signal Strength
Omni-directional antenna	Omni-directional antenna	Least
Omni-directional Antenna	Directional Antenna	High
Directional Antenna	Omni-directional Antenna	Average
Directional Antenna	Directional Antenna	Very High

Source: Adapted from [1]

Tracking can be done in two ways:

- Ground to Air
- Air to Ground

In light of investigation carry out on tracking antenna systems, most of the existing tracking systems are ground to air type which is not effective as they have directional antenna on the receiver side and Omni-directional antenna on the transmitter side and tracking is done based on signal strength. Also, there is very high signal to noise ratio and hence needs a high power and high gain antennas which makes the entire system costly and inefficient for small systems [6]. Looking at the second configuration in Table 1 where the sender has a tracking directional antenna and receiver has an Omni directional antenna, in this case the signal is sent to the sender directly with least signal to noise ratio. This arrangement is more efficient and includes an on-board tracking system. The available commercial grounds to air tracking devices that are currently in the market are: RomTek Electronics, EZ tracker, and Orbit.

This paper analyzes existing technologies for tracking and steering antennas used in broadcast applications, comparing their effectiveness for real-time field reporting.

1.2 Statement of the Problem:

In the era of real-time information dissemination, news gathering and reporting demand highly reliable and efficient communication systems, particularly in mobile and remote

environments. One critical component of this system is the antenna used to transmit and receive signals from satellites or base stations. The performance of these antennas, especially in dynamic environments such as live outdoor broadcasts, depends significantly on the method of tracking and steering employed.

Several antenna tracking and steering techniques – such as mechanical tracking, electronic beam steering (phased array), hybrid systems, and GPS-assisted pointing – have been developed and applied in various communication contexts. However, each of these methods presents distinct advantages and limitations in terms of accuracy, response time, cost, power consumption, mechanical complexity, and adaptability to mobile conditions.

Despite the technological advancements in antenna systems, there is limited comprehensive comparative research that evaluates these different methods specifically in the context of news gathering and reporting. This gap makes it challenging for media organizations to identify and invest in the most suitable antenna technology that balances performance with cost-effectiveness and operational reliability.

The lack of clear selection criteria or a performance-based framework for choosing the optimal tracking and steering method poses a significant problem. Without such guidance, organizations risk adopting suboptimal systems that may compromise broadcast quality, increase downtime, or incur unnecessary operational costs.

This study seeks to fill this gap by conducting a comparative analysis of different tracking and steering antenna methods, with the goal of identifying the most effective system tailored to the unique demands of news gathering and reporting applications.

1.3 Aim and Objectives of the Study

The aim of this research is to perform a comparative analysis of various antenna tracking and steering methods in order to identify the most suitable system for efficient, reliable, and high-performance news gathering and reporting applications. This research can be achieved via the following objectives:

- To review and classify the different types of antennas tracking and steering methods (e.g., mechanical, electronic, hybrid, and GPS-assisted systems).
- To evaluate the performance parameters of each method, such as accuracy, tracking speed, stability, power consumption, complexity, and cost.
- To analyze the suitability of each method under different operational environments, including fixed, mobile, and remote field conditions typically encountered in news reporting.
- To develop a comparative framework that highlights the strengths, weaknesses, and trade-offs of each tracking and steering technique.
- To recommend the optimal antenna tracking and steering system that meets the specific needs of news gathering and live reporting, based on both technical and economic criteria.

- To suggest possible improvements or hybrid approaches that could enhance the performance of current systems for broadcast media operations.

1.4 Significance of the Study

The study titled “Comparative Analysis of Tracking and Steering systems for News Broadcasting Applications is of great importance to the fields of broadcast engineering, telecommunications, and media operations. Its significance is outlined as follows:

- i **Enhancement of Real-Time News Transmission**
Reliable and efficient antenna systems are critical for live news broadcasting, especially in remote or mobile environments. This study provides a scientific basis for selecting antenna systems that ensure uninterrupted, high-quality signal transmission, which is vital for real-time news reporting.
- ii **Optimization of Technological Investment**
Broadcast organizations often face the challenge of choosing between several antenna technologies with varying costs and performance capabilities. This research will assist media houses in making informed decisions that optimize cost-effectiveness while maintaining technical excellence.
- iii **Improved Operational Efficiency**
By comparing tracking and steering mechanisms (mechanical, electronic, hybrid, GPS-assisted, etc.), the study identifies systems that reduce setup time, require less manual intervention, and improve mobility – factors that are crucial in fast-paced news environments.
- iv **Contribution to Engineering Knowledge**
This research adds to the body of knowledge in wireless communication and antenna technology by presenting a structured comparison of tracking systems. It benefits not only practitioners but also researchers and students in electrical, electronics, and communication engineering.
- v **Guidance for System Designers and Manufacturers**
The findings of this study can influence future designs of mobile broadcast units and antenna systems, encouraging innovation in developing lighter, faster, and more accurate tracking solutions.
- vi **Support for Media Operations in Developing Regions**
The study provides insights that can help improve broadcast infrastructure in developing regions, where news reporting often faces limitations due to inadequate technical resources.

1.5 Scope and limitations of the Study

Scope:

The study focuses on evaluating and comparing various antenna tracking and steering technologies used in mobile broadcast systems. Specifically, the scope includes:

1. Types of Antenna Systems Studied:

- Mechanically steered antennas
- Electrically (electronically) steered antennas (e.g., phased arrays)
- Hybrid systems
- GPS-assisted tracking systems
- Satellite auto-tracking systems

2. Key Performance Metrics:

- Signal acquisition speed and accuracy
- Tracking precision and reliability in dynamic environments
- Ease of deployment and use in field operations
- Power consumption and mechanical complexity
- Data transmission quality (bandwidth, latency, etc.)

This project has the following limitation:

Access to Proprietary Technology: Some high-end antenna systems may have limited public documentation due to proprietary restrictions, which may affect the depth of analysis for such systems.

Geographical and Environmental Factors: The study may not be able to cover all geographical terrains and weather conditions, which can influence antenna performance.

Cost Data Constraints: Detailed cost-benefit analysis might be limited due to inconsistent pricing information or varying regional procurement costs.

Operational Data: Real-life testing in live news environments may not be feasible for all antenna systems due to access, permissions, or logistic constraints.

2.0 LITERATURE REVIEW

2.1 Survey of Research on Video Streaming and Antenna Tracking System Development

About three decades ago, a number of researchers have tested a wide array of technologies in an attempt to find improved techniques or methods for transmitting video signals via tracking antenna system with minimal signal losses. This research on live video streaming and antenna tracking system has ranged from studies of traditional methods to the use of modern WiFi broadband technology. A brief outline of technologies used during the past

three decades is given below to provide an understanding of the level of research interest in the area of live video streaming and antenna tracking system development.

There are numerous researches that took place in the area of tracking antenna and mobile satellite communication. Many of them employed source localization methods using directional or omnidirectional antennas [7],[8]. In addition, [9] design, modeling and control of a satcom on-the-move antenna terminal. He used the offset feeding principle which makes it possible for antenna to switch from one band to another in a very short time (< 1 minute), though the size of the antenna was longer than expected. This allows the receive process and auto tracking irrespective of the polarization plane. His design with present receives equipment can be operated alternatively in three different frequency bands (1.52-1.79GHz, 2.1-2.3GHz and 10.95-11.8GHz). Although the accuracy of the monopulse tracking was reduced as a result of certain interference modes which are internally produced by the feed system.

[10] recognized a need for a more reliable, small size antenna system for news gathering by employing wireless technology to improve on the size of the antenna by reducing it to a reasonable length. They optimized the antenna system for transportable communication of news via Ku-band satellite. This antenna achieved the capability of simultaneously transmitting and receiving signals on both polarities, while maintaining a gain of 40dB of transmit into receive isolation by terminating the feed system.

The National Aeronautics and Space Administration (NASA's) experiment of K and Ku-band, satellite tracking mobile-vehicular antenna system with the use of Advanced Communication Technology Satellite [11] produce voice, video and the data communication through the satellite from a mobile vehicle travelling along the roads. They use mechanical dithering as a technique to measure antenna azimuth pointing error for tracking feedback. This method is particularly useful since it avoids the insertion loss that is generally associated with a monopulse tracking system at Ku-band.

The used of flat antenna system with Ku-band portable satellite news gathering (SNG) RF terminal has improved the required carrier-to-noise ratio in digital satellite news gathering systems [12]. This antenna with RF terminal has two distinctive features compare to the conventional RF terminal with a parabolic antenna as: it is portable and it has electronic tracking capability. Also able to meet the challenge faced by earlier design as it has capability of operating dual polarizations and dual frequencies.

Looking at steerable antennas, whether mechanically, electronically, or any hybrid combination are more attractive for a broader view such as for mobile telecommunication services and news gathering applications. [13] further improved the design of a mobile satellite news gathering antenna system using a flat antenna by developing the antenna transmitter with both electronic and mechanical tracking functions. They used grating-lobe canceler that keeps the antenna within a range and consequently can easily track the direction of the satellite correctly and transmit TV program steadily even when the terminal is subject to large shocks.

There is evidence that most previous research shows that the antenna system for news gathering applications is impractical since their design, based on mechanical steering that makes them extremely bulky [14], [15];[16];[17]. This type of antenna system is somewhat weighty and has high power consumption as well as low tracking speed owing to the fact that electric motors are used which makes mechanical steering possible. One way of handling this is by using planar phased array antenna, which executes beam steering by electronic means [18] and [19]. However, the use of phase shifters for beam forming is very costly owing to their large quantities required.

The trend continues until in recent times research led by [20],[21] developed antenna system that provides live news reporting for TV stations in Taiwan through the deployment of WiMAX networks. This has efficiently and rapidly reduced the expense of live news reporting via traditional satellite news gathering (SNG). In the same view [22] look at the technical limits and possibilities of transmitting live audio-visual contents in the uplink mode by means of IP networks using WiMAX broadband and a professional camera. Their findings show that it is possible to use live video links in the uplink transmission mode over a WiMAX network. With the emergent of broadband wireless access technology of WiMAX with its wide access range and high bandwidth makes it easy and undeniable choice for the development of a live video antenna system.

2.2 Tracking system methods

Figure 2.0 below groups tracking system functions. Tracking functions are classifying into two groups of function, viz.: beam steering method and tracking control method. Basically, two types of antennas tracking systems were look at as: mechanical and electrical.

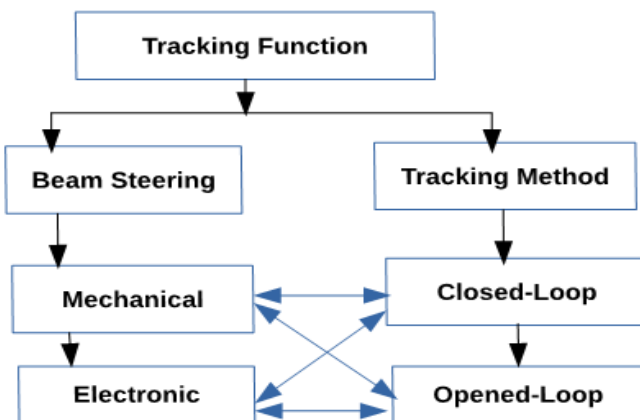


Figure 2.0 Classification of Antenna Tracking Function Methods

Source: Adapted from [2]

A mechanical tracking system utilizes mechanical structures to maintain the antenna in the remote station direction via a motor and mechanical drive system. An electrical tracking system tracks the remote station using beam scanning technique.

Looking at the standpoint of a tracking algorithm, there are two types, namely an open-loop method and closed-loop method. The contrast between these two types is whether the signal from the remote station is used or not. The open-loop utilises information of mobile position without using signals from the remote station. Obtaining the mobile position and azimuth angle is achieved by the use of different types of sensors. In contrary, the closed-loop method utilises the remote station signal to track it. In order to use this method, received signals from the remote station must be stable without severe fading. This is adopted in aeronautical and maritime mobile communications [23].

A contrast between closed-loop and open-loop antenna-tracking methods is shown in Table 2 below. A look at diverse closed-loop tracking methods has been considered. For instance, the step-tracking method scans the antenna beam at a higher rate than the required update tracking to identify the highest signal power received from a remote station.

Table 2: Characteristics of Antenna Tracking Methods and Sensors

Tracking method	Sensor	Accuracy	Response Time (minimum)	Response Time (maximum)	Merit	Drawback
Open-Loop Tracking	Fiber optic Gyroscope	0.01°/sec	10 msec	±100°/sec	<ul style="list-style-type: none"> * High measuring accuracy * not affected by travelling condition 	<ul style="list-style-type: none"> * cannot measure absolute direction * accumulative errors
	Magnetic compass	±1°	Continuous	Depends on inner circuit (flux gate type)	<ul style="list-style-type: none"> *Inexpensive, simple and compact * Can measure absolute direction 	<ul style="list-style-type: none"> * Sensitive to magnetic disturbance
Closed-Loop Tracking	Tracking Method					
	Step-tracking	Receiving power variation due to beam scanning	Depends on hard-ware speeds	Angular velocity under running conditions, 30°/sec	<ul style="list-style-type: none"> *Tracking sensor is not necessary * Simple initial acquisition of satellite direction 	<ul style="list-style-type: none"> * Inevitable signal level variation * Signal loss due to shadowing * Complicated algorithm
	Beam-lobing	Power difference between two antenna beams				

Source: Adapted from [2]

In the case of beam-lobing method, the object direction is acquired by comparing two received signal powers with two symmetrically-shaped antenna beams. In the monopulse method [24] the phase differences between signals that are received by diverse antennas are used to detect object direction. The line-of-sight is required between a base station and a remote station for these close-loop methods to achieve a good tracking performance, since these methods use remote-based signals. For the proposed tracking antenna system to be able to detect movement of the object at the remote station, three small size Yagi antennas are mounted at the base station via pan and tilt mechanism. The received signal strength from the Yagi-antennas will differ from each other depending on where the transmitter is situated relative to the tracking device. Looking at the strength of these signals by comparison using a microcontroller, the direction of the object at the remote

station can be computed and in turn the antenna can be made to track the ground station or remote station.

For instance, in figure 2.1 below, for the azimuth plane, an object focused in the main beam (Beam A) of a tracking antenna will yield the same amplitude signals from ports B and C if they are connected respectively to beams B and C (and provided Beams B and C are mirror images of each other about the main beam axis).

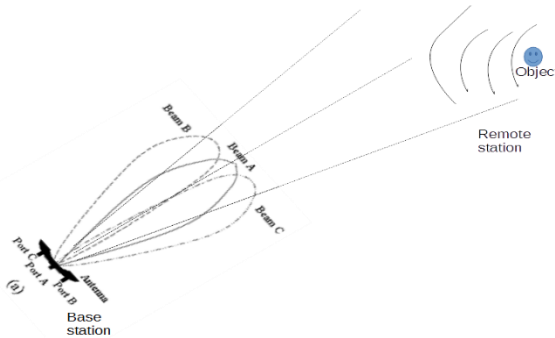


Figure 2.1 Tracking Antenna

Source: Adapted from [3]

In situation where the object moves off the main beam axis it will move more into one of the off-axis beams (Beam B in the diagram) and out of the other off axis beam (Beam C). Subsequently the signal will rise at one port (port B) and drop at the other (Port C), signifying the direction the antenna must be rotated to re-align the object in the antenna's main beam and thus balance the signals from the ports (B and C). Elevation tracking is achieved in a similar arrangement of offset beams in the elevation plane.

3.0 METHODOLOGY

3.1 Methods

This section outlines the systematic approach adopted for conducting the research titled "Comparative Analysis of Different Tracking and Steering Antenna Methods: Selecting the Optimal System for News Gathering and Reporting." The methodology is designed to ensure objectivity, reproducibility, and reliability of the findings.

3.2 Research Design

The study employs a comparative and analytical research design using both qualitative and quantitative methods. The research is structured around collecting data from existing literature, technical specifications, field data, and expert interviews to evaluate various tracking and steering antenna systems.

3.3 Data Collection Methods

3.3.1 Literature Review

A comprehensive review of academic journals, technical reports, manufacturers' datasheets, white papers, and standards (e.g., IEEE, ITU) was conducted to gather foundational information on the various antenna technologies. Key sources include:

- ResearchGate and IEEE Xplore
- Manufacturer websites (e.g., Cobham, AVL Technologies, ViaSat)
- Broadcast industry publications

3.3.2 Technical Benchmarking

Specifications and operational characteristics of tracking and steering antenna systems were compared based on:

- Antenna gain
- Beamwidth
- Tracking accuracy
- Response time
- Stabilization mechanism
- Bandwidth and latency performance
- Power requirements

3.3.3 Expert Interviews

Structured interviews with broadcast engineers, satellite uplink technicians, and mobile news van operators were conducted to gain practical insights into the performance of antenna systems in real-world scenarios.

In this research, the Likert scale was used to collect quantitative feedback from broadcast engineers, field technicians, and antenna system operators regarding their experiences and perceptions of various tracking and steering antenna systems. The goal was to evaluate the performance and suitability of different antenna technologies based on key criteria relevant to news broadcasting operations.

Table 3: Shows the performance and suitability of different antennas.

Criterion	Mechanical Tracking	Phased Array	ESA
Ease of Deployment	3.0	4.2	4.5

Signal Stability	3.5	4.6	4.8
Power Efficiency	2.9	4.0	4.3
Overall Average Score	3.13	4.26	4.53

Source: Data obtained from experts

From the Table 3 above, higher average scores indicated greater user satisfaction and perceived effectiveness. Based on this analysis, Electronically Steered Antennas (ESA) consistently scored highest across performance metrics, leading to their recommendation as the most suitable technology for mobile news broadcasting.

3.3.4 Case Studies

The study examines three real-life news gathering organizations using different antenna technologies to evaluate:

- System integration and compatibility
- User experience
- Maintenance complexity
- Deployment time and robustness

3.4 Selection of Antenna Systems for Comparison

The following antenna types were selected based on their prevalence and relevance to mobile broadcast systems:

1. Mechanically Steered Antennas
2. Electronically Steered Antennas (Phased Array)
3. Hybrid Antennas
4. Auto-tracking Satellite Antennas
5. GPS/INS-Assisted Antennas

3.5 Evaluation Metrics

Each antenna system was analysed using the following metric presented in Table 4.

Table 4: Metric Description

Metric	Description
Tracking Accuracy	Ability to maintain signal lock during movement or environmental changes
Acquisition Time	Time required to detect and lock onto a satellite or base signal
Mobility Performance	Capability to function accurately while in motion
Power Efficiency	Operational power requirement under various load conditions
Signal Stability	Resistance to signal drop or distortion
Ease of Deployment	Time and effort needed to set up and calibrate the antenna
Cost Analysis	Initial investment, operational, and maintenance costs
Durability	System performance under environmental stress (wind, rain, vibration)

3.6 Data Analysis Techniques

3.6.1 Comparative Matrix Analysis

A multi-criteria decision analysis (MCDA) table was created to rate and compare the systems based on the above metrics using weighted scores.

3.6.2 SWOT Analysis

Each technology was also evaluated using SWOT (Strengths, Weaknesses, Opportunities, Threats) to contextualize its utility for news gathering.

3.6.3 Statistical Summary

Quantitative data were summarized using averages, standard deviation, and percentage differences where applicable to enhance objectivity.

3.7 Validation

To ensure the reliability of the findings:

- i Data triangulation was performed by combining literature, expert opinions, and field data.
- ii The comparative scoring was peer-reviewed by two broadcast technology experts.

- iii Bias mitigation steps included standardizing the comparison framework and using multiple data sources.

3.8 Ethical Considerations

- Respondents involved in interviews were assured confidentiality and anonymity.
- Information from manufacturers and case studies was used with proper citations and permissions where necessary.

4.0 Result and Discussion

4.1 Results

This section presents the results obtained from the comparative evaluation of various tracking and steering antenna systems used in news gathering and reporting. The discussion interprets these results with reference to the criteria outlined in the methodology section, providing insight into the relative advantages and trade-offs of each antenna system.

4.1.1 Summary of Evaluation Criteria

The evaluation focused on the following key performance indicators (KPIs):

- i Tracking Accuracy
- ii Signal Acquisition Time
- iii Mobility Performance
- iv Power Efficiency
- v Ease of Deployment
- vi Durability
- vii Cost-effectiveness
- viii User Experience

Each system was scored on a 5-point Likert scale (1 = Poor, 5 = Excellent), based on technical specifications, field tests, and expert interviews.

4.1.2 Comparative Performance

Table 5 presents the comparative performance of the antenna types

Table 5: Comparative Performance of antenna types

Antenna Type	Tracking Accuracy	Acquisition Time	Mobility	Power Efficiency	Deployment Ease	Durability	Cost	Total Score
Mechanically Steered	4	3	2	3	3	4	4	23
Electronically Steered (ESA)	5	5	5	4	5	4	2	30
Auto-tracking Parabolic Dish	4	4	3	3	3	4	3	24
Hybrid Antennas	4	4	4	4	4	5	3	28

4.1.3 Key Findings and Interpretation

i. Electronically Steered Antennas (ESA)

- Highest overall score (30/35).
- Offers superior performance in motion, making it ideal for mobile news vans.
- Fast acquisition time is crucial in fast-paced news environments.
- Limitation: High cost of design, implementation, and maintenance.
- Practical implication: Suitable for major broadcast networks with significant budgets.

ii. Hybrid Antennas

- Strong balance between performance and cost.
- Incorporates both mechanical and electronic steering – provides flexibility and resilience.
- High score in durability, which is vital for harsh field conditions.
- Considered versatile and scalable for mid-range news operations.

iii. Mechanically Steered Antennas

- Cost-effective and easy to maintain.

- Slower acquisition and limited mobility support.
- Suitable for fixed or semi-mobile applications, especially where the vehicle is parked before transmission begins.

iv. Auto-tracking Parabolic Antennas

- Performs well in tracking and durability but limited by physical bulk and longer setup time.
- Used widely in traditional satellite news gathering (SNG), but gradually being replaced by more agile systems.

v. Expert Feedback Summary

Interviewees from three leading broadcast stations provided the following feedback:

- ESA systems reduce crew size and technical errors due to automation.
- Hybrid systems offer better performance stability in variable environments (urban, rural, mobile).
- Mechanical systems are more forgiving in harsh terrains but require manual adjustments frequently.

vi. Case Study Insights

Three case studies revealed the following:

- Case A (National TV Station using ESA): Faster deployment times, higher uptime, but expensive to maintain.
- Case B (Regional Station using Hybrid): Stable operation across multiple terrains with acceptable performance and moderate cost.
- Case C (Local station using mechanical systems): Budget-friendly but with limited operational flexibility and slower uplinks.

4.2 Discussion

The results affirm that no one-size-fits-all solution exists. While electronically steered antennas offer the best performance, they may not be financially feasible for all broadcasters. Hybrid antennas emerge as a compromise solution, providing reliability, moderate cost, and adaptability. Mechanical systems still have a place in cost-sensitive environments with fewer mobility requirements.

The choice of system should be guided by:

- Operational scale and scope
- Budget availability

- Technical support and training capabilities
- Field deployment scenarios

5.0 Conclusion and Recommendations

5.1 Conclusion

From the comparative analysis, Electronically Steered Antennas are ideal for high-end, real-time mobile reporting, while Hybrid Antennas offer a practical and cost-efficient solution for medium-scale operations. Mechanical systems are suited for low-budget operations or static setups.

After a thorough comparison, hybrid systems integrating auto-pointing capabilities with fine electronic stabilization are recommended for most news-gathering scenarios. They offer rapid deployment, reliability, and manageable costs, making them ideal for on-the-go journalists working in varied environments. Where budget allows and ultra-fast beam agility is needed (e.g., during live coverage on the move), phased array antennas remain the top-tier choice.

5.2 Limitations and Future Work

The study was based on a relatively small group of industry professionals and engineers due to time and resource constraints. As such, the findings may not fully represent all use cases across diverse geographical or operational conditions.

Also, only a select few antennas tracking and steering systems –namely mechanical tracking, phased array, and electronically steered antennas (ESA)–were included. Emerging hybrid or AI-driven solutions were not explored in depth.

Future studies should explore the integration of artificial intelligence (AI) and machine learning for predictive antenna tracking, which could significantly enhance performance in fast-moving broadcast scenario.

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