



Faculty of Science and Technology Assignment Cover Sheet

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Assignment Title: Report

Due Date: 18th April, 2024

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Lecturer Name: Er. Roshan Khanal

To be completed if this is an individual assignment

I declare that this assignment is my individual work. I have not worked collaboratively nor have I copied from any other student's work or from any other source except where due acknowledgment is made explicitly in the text, nor has any part been written for me by another person.

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Lecturer's comments: _____

Total Marks: _____

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I/We acknowledged receiving feedback from the lecturer on this assignment.

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Extension certification:

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Acknowledgement

I would like to thank Nilai University for assigning this project on Yagi antenna design. It provided a valuable opportunity to learn about the components, working principle, and applications of these antennas.

This assignment helped me to know about Yagi antenna's. I would also like to thank my lecturer Er. Roshan Khanal and my friends for their helpful insights and discussions during this assignment.

Abstract

An essential part of medium- and long-distance wireless communications, the Yagi antenna provides directional transmission and reception capabilities. It is a basic component of wireless communication systems. This paper offers a thorough examination of Yagi antennas, covering its uses, design concepts, advantages, and disadvantages. This article attempts to offer insights into how Yagi antennas can maintain their dominant position in wireless communication going forward by in-depth investigation and analysis.

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Introduction

Among the field of wireless communication, the Yagi antenna continues to be a timeless example of dependability, efficiency, and simplicity. This antenna design, which bears the name of its creator, Hidetsugu Yagi, has withstood decades of technical advancement to continue being a fundamental component of numerous communication systems. Due to its unique features, such as its high gain and directional release pattern, the Yagi antenna is recommended for medium- and long-distance wireless communications.

This work explores the design concepts, applications, strengths, and shortcomings of the Yagi antenna, going deep into its details. Gaining a knowledge of the Yagi antenna's principles allows us to appreciate how it has shaped the development of wireless communication networks. The Yagi antenna is still relevant in modern communication systems because of its efficiency and variety in applications ranging from point-to-point wireless communications to amateur radio operations and television broadcasts.

Furthermore, to learning more about the Yagi antenna's complex workings, we also discover that it has the capacity to adapt to changing technological conditions and prosper in them. We can gain important insights into how the Yagi antenna might continue to play a significant part in wireless communication in the future by analyzing its advantages and disadvantages. The Yagi antenna provides dependable connectivity and bridges the gap over medium and long distances.

Objectives

Some objectives of Yagi-Uda antenna are:

1. **Increase Signal Strength:** The primary objective of a Yagi antenna is to boost the signal received by your device. This is particularly beneficial in areas with weak signal strength, like fringe reception zones for television or remote locations with limited cellular coverage.
2. **Improve Directivity:** Yagi antennas excel at focusing radio waves in a specific direction. This directivity allows the antenna to target desired signals while reducing interference from unwanted sources coming from other directions.
3. **Extend Range:** By amplifying the received signal and focusing it in a particular direction, Yagi antennas can enable communication or reception over greater distances compared to omnidirectional antennas.
4. **Specific Frequency Targeting:** Yagi antennas can be designed to operate efficiently at specific radio frequencies. This allows for targeted reception of desired signals, such as those used for WiFi, amateur radio (HAM), or particular television channels.
5. **Cost-Effective Solution:** Compared to other directional antennas, Yagi antennas offer a relatively simple design and can be constructed at a lower cost. This makes them an attractive option for various applications requiring improved signal reception or transmission.

Weakness of Yagi antenna

Yagi antennas have a few disadvantages in addition to their many benefits.

1. **Restricted Bandwidth:** Yagi antennas are usually made to function well within a particular frequency range. A reduction in gain and performance may result from departures from this range.
2. **Bigger Size:** Yagi antennas can be bulkier and more massive than omnidirectional antennas, particularly when there are more directors. This can be a drawback for apps that have limited space.
3. **Single Direction Focus:** A Yagi antenna's directional nature is both a strength and a drawback. Although it is very good at picking up signals in a particular direction, this also means that for best reception, the antenna must be precisely oriented toward the source of the signal.
4. **Wind Susceptibility:** Compared to omnidirectional antennas, Yagi antennas may be more wind-prone due to their boom structure. Strong wind conditions may make this problematic and require the use of a robust mounting bracket.
5. **Strength over Beamwidth Exchange:** A Yagi antenna's gain (signal strength) improves with the number of directors added, but the antenna's beamwidth (less directional) decreases. If the location of the signal source isn't exactly set or requires some aiming flexibility, this could be a drawback.

Strength of Yagi antenna

A number of advantages make Yagi antennas a popular option for a range of applications:

1. Outstanding Signal Gain: A Yagi antenna's primary advantage is its capacity to greatly increase the received signal strength in the intended direction. Its constituents produce electromagnetic waves, which constructively interfere to accomplish this.
2. Improved Directivity: Yagi antennas are very good at directing radio signals. There are two main advantages to this directivity:
 - Less Interference: Yagi antennas receive less noise and interference from unwanted signals originating from other directions since they concentrate on the targeted signal source. As a result, the received signal gets stronger and clearer.
 - Extended Range: Yagi antennas can efficiently communicate or receive signals over larger distances than omnidirectional antennas because of their concentrated signal strength in the forward direction.
3. Simple and Economical Design: Compared to other directional antennas, the Yagi antenna's design is comparatively simple. Because of their reduced production costs, they represent a cost-effective way to enhance signal transmission or reception.
4. Durability: Yagi antennas are often composed of sturdy materials and are resistant to inclement weather. They are a dependable choice for extended usage in outdoor settings.

Solution

Overview

The highly directional Yagi antenna, sometimes referred to as the Yagi-Uda antenna, is frequently used for point-to-point communication in radio and television applications. It is made up of one or more director elements, a reflector, and a driving element. The antenna may broadcast or receive signals more successfully in a certain direction thanks to the precise arrangement of these components, which produces directional gain.

Configuration and Testing

a. Configuration:

- **Driven Element:** The driven element, which is usually a dipole antenna, is the antenna's main radiator and is attached to the feedline.

Formula: $L = 2/\lambda$

Where:

L is the length of the dipole (driven element) in meters.

λ (lambda) is the wavelength of the operating frequency in meters.

- **Reflector:** The reflector, which is a little longer element positioned behind the driven element, improves the antenna's forward radiation pattern by reflecting radio waves generated by the driven element.

Formula:

$$L_r = L_d \times (1 + \text{Adjustment Factor})$$

Where the adjustment factor is typically around 0.05 (5%).

b. Testing

- **Assembly:** Build the antenna components using the determined lengths and spacings.
- **Mounting:** Using exact spacing and alignment, fasten the components to a non-conductive support structure (boom).
- **Attach the feedline to the driven element and make sure it is properly grounded.**

- **SWR Measurement:** To find the antenna's standing wave ratio (SWR), use an antenna analyzer or SWR meter. If required, change the element lengths or spacing's to obtain a low SWR at the intended frequency.
- **Field testing:** Position the antenna where it is supposed to be and evaluate how well it works in actual use. Check the direction and strength of the signal.

Comparison

In comparison, Yagi antennas provide a number of benefits over other antenna types:

- **Directionality:** The great directionality of Yagi antennas allows them to concentrate energy in one direction, reducing interference and boosting signal strength.
- **Gain:** Yagi antennas are good for long-distance communication because they usually have a higher gain than omnidirectional antennas.
- **Compact Size:** Although Yagi antennas have a high gain, they are lightweight and relatively compact, which makes them suitable for installation on towers, rooftops, and other structures.
- **Cost-Effectiveness:** Yagi antennas provide good performance at a reasonable price point, making them frequently cost-effective point-to-point communication solutions.
- **Versatility:** Yagi antennas are suitable for a wide range of applications, including amateur radio, TV, and Wi-Fi. This makes them essential for a variety of communication systems. Other directional antennas are less flexible and require modifications for several bands, which reduces their range of use.
- **Easy for installing:** Yagi antennas are simple to orient and install. Others, such as phased array or parabola array antennas, may require exact alignment increasing to the complexity of installation.
- **Interference rejection:** Yagi antennas are excellent at reducing unwanted signal interference and improving signal clarity. While some interference rejection is provided by other directional antennas, Yagi antenna efficiency may be higher.

Comparison with other antenna.

Feature	Yagi antenna	Other antenna
Directionality	It is highly directional and it focuses on one direction.	It is less directional and omnidirectional.
Gain	It is typically high gain.	It may be lower or higher depending on types.
Size and Height	It can be bulky and heavy.	Size and weight depends
Frequency range	Optimized for specific frequency or narrow frequency range	Frequency range may be broader or narrower depending on type
Construction Complexity	Relatively simple construction.	Construction complexity varies widely
Interference Rejection	Excellent at reducing interference from unwanted signals	Interference rejection varies depending on design.
Cost	Generally cost-effective solution	Cost can vary widely depending on type and features.

Table 1 comparison

The Future of Yagi Antennas

Yagi antennas have been a trustworthy option for directional radio reception for a long time due to its affordability, ease of use, and effectiveness. Future advancements that could impact Yagi antennas include the following:

Advancements in Materials and Design

1. **Lighter and More Compact Designs:** Yagi antennas may become lighter and more compact as a result of new materials like composites or smart materials. They would therefore be more appropriate for scenarios requiring limited space or portable applications.
2. **Multi-Band Designs:** By investigating novel materials and design strategies, Yagi antennas may be able to function well over a greater range of frequency bands. Applications that require transmission or reception across many frequencies might benefit from this increased flexibility.
3. **Active Yagi Antennas:** Integrating active components like amplifiers into Yagi antennas could further enhance signal gain and potentially overcome some bandwidth limitations. However, this would increase complexity and cost.
4. **3D Printed Designs:** The growing adoption of 3D printing technology could enable the creation of customized Yagi antennas with optimized shapes and features for specific applications.

Niche Applications and Specialized Uses

1. **Metamaterial-Based Designs:** Metamaterials, engineered materials with unique electromagnetic properties, could be incorporated into Yagi antennas to achieve even more precise beam control and potentially achieve unconventional radiation patterns.
2. **Yagi Antennas for Higher Frequencies:** Advancements in materials and design principles could allow Yagi antennas to operate effectively at even higher frequencies, potentially reaching the millimeter wave and terahertz bands, which are becoming increasingly important for applications like high-speed wireless communication and radar systems.

3. Integration with IoT Devices: As the Internet of Things (IoT) continues to grow, miniaturized Yagi antennas could be integrated into various IoT devices to improve their communication range and reliability.
4. Yagi Antennas for Space Applications: The potential for lightweight and high-gain designs could make Yagi antennas suitable for specific applications in satellites or spacecraft communication systems.

Overall, the future of Yagi antennas is likely to see continued development in materials, design, and niche applications. While they may face competition from newer antenna technologies in some areas, their inherent advantages in simplicity, affordability, and effectiveness ensure they will remain a valuable tool for various radio frequency applications for years to come.

Images of Yagi Antenna



Figure 1 EAntenna 70 MHz LFA



Figure 2 direct TV Tree Interference



Figure 3 Network Tower



Figure 4 radio Telescope effelsberg

Conclusion

Hidetsugu Yagi invented the Yagi antenna, a dependable, effective, and user-friendly wireless communication technology. A directed release pattern and strong gain make it appropriate for medium- and long-range communications. This study examines its applications, design principles, advantages, disadvantages, and effects on wireless communication networks. The Yagi antenna bridges the gap across medium and long distances by adjusting to changing technological conditions and offering dependable communication.

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Marking Scheme

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Marking Scheme

Assignment Criteria	Maximum Marks	Student Mark
1. Cover page	0.5	
2. Table of contents	0.5	
3. Objective	0.5	
4. Introduction	0.5	
5. Solution	6	
a. Overview	(2)	
b. Configuration and Testing	(2)	
c. Comparison	(2)	
6. Conclusion	0.5	
7. References	0.5	
8. Images	0.5	
9. Formatting	0.5	
Total	10	