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(Research Article)

Enhancing television broadcasting: Exploring the Gray-Hoverman Antenna Design

Ira Mae Caray [1, *], King Paulo Ditchon [1] and Edwin Romeroso Arboleda [2]

[1] *Department of Electronics Engineering, College of Engineering and Information Technology Cavite State University, Don Severino Delas Alas Campus Cavite, Philippines.*
[2] *Professor, College of Engineering and Information Technology Cavite State University, Don Severino Delas Alas Campus Cavite, Philippines.*

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Abstract

This study examines the design and performance of an own made Gray-Hoverman Antenna, an affordable alternative to commercial antennas optimized for UHF and VHF digital TV signal reception. Constructed with copper wire as the receiver and mesh galvanized steel as the reflector, the antenna demonstrated significant gain and directivity. Testing results showed the antenna's capability to receive 54 channels, including 38 digital TV channels. The findings indicate the effectiveness of Gray-Hoverman Antenna for HDTV viewing experiences.

Keywords: Gray-Hoverman Antenna; Digital Tv Channels; Analog Tv Channels; UHF and VHF signal reception; HDTV

1. Introduction

An antenna is a critical component in communication systems, designed to transmit and receive electromagnetic waves. It serves as the interface between radio waves propagating through space and electrical signals in a transmission line[1]. Antennas come in various shapes and sizes, each optimized for specific frequency ranges and applications, such as television broadcasting, radio communication, satellite transmission, and wireless networking.

The significance of antennas lies in their ability to enhance communication by improving signal strength, directionality, and range. Effective antenna design can significantly impact the quality and reliability of communication, making it possible to receive clear signals over long distances and in challenging environments[2]. Antennas enable a wide array of technologies that are essential in modern life, from everyday wireless devices to advanced satellite systems. For television broadcasting, a well-designed antenna is indispensable for accessing a wide variety of channels and ensuring a stable, high-quality viewing experience.

In television broadcasting, antennas are especially significant. They are essential for capturing over-the-air TV signals, allowing viewers to receive high-definition channels without the need for cable or satellite services. The performance of a TV antenna directly impacts the quality of the received picture and sound[3]. Advanced antenna designs, such as the Gray-Hoverman antenna, can improve reception by providing higher gain and better directionality, crucial for picking up weaker signals from distant stations.

In the Philippines, broadcasters manage TV transmission stations across two frequency ranges: Very High Frequency (VHF): 54 MHz - 72 MHz, 76 MHz – 88 MHz and 174 MHz - 216MHz (TV Channels 2 to 13) and Band IV - Ultra High Frequency (UHF): 512 MHz – 698 MHz (TV Channels 14 to 51) [4]. However, efficiently receiving this wide range of frequencies with a single antenna is challenging due to the selective nature of high-quality antennas [5, 6]. The Gray-

* Corresponding author: Ira Mae Caray

Hoverman antenna, initially designed by Doyt R. Hoverman in the 1960s, offered a potential solution by effectively covering both VHF-Hi and UHF bands with modern enhancements [7].

1.1. Gray-Hoverman Antenna

The Gray-Hoverman antenna is a type of HDTV antenna designed to receive digital television signals. It is known for its high gain and directional reception properties, making it effective for picking up weak signals from distant stations. The antenna consists of a series of elements arranged in a specific pattern to maximize signal strength and reduce interference. Originally designed by Doyt Hoverman in the 1950s, it was later improved and popularized by amateur antenna enthusiasts who optimized the design for modern digital TV reception [7, 8, 9].

1.2. Very High Frequency

VHF (Very High Frequency) refers to radio waves that operate between 30 and 300 megahertz, featuring shorter wavelengths compared to high-frequency (HF) bands. VHF bands are confined to a line-of-sight (LOS) range because they are not refracted by the ionosphere like lower frequency bands. However, under certain atmospheric conditions, a phenomenon called ducting can occur, allowing VHF signals to travel beyond their usual range, which is typically just a few kilometers in any direction [10].

1.3. Ultra-High Frequency

UHF (Ultra High Frequency) refers to radio waves operating in the frequency range of 300 megahertz (MHz) to 3 gigahertz (GHz). These frequencies have shorter wavelengths than those in the Very High Frequency (VHF) range. UHF waves are commonly used for television broadcasting, cell phones, satellite communication, GPS, Wi-Fi, and two-way radios. Like VHF, UHF signals are generally limited to a line-of-sight (LOS) range, meaning they typically travel straight from the transmitter to the receiver without being refracted by the ionosphere. UHF signals can, however, be affected by obstacles such as buildings and terrain, which can influence their effective range[11].

1.4. Coaxial Cable

A coaxial cable, often referred to as coax, is a type of electrical cable that consists of a central conductor, an insulating layer, a metallic shield, and an outer insulating layer. This design allows coaxial cables to transmit high-frequency signals with minimal interference and signal loss, making them ideal for various communication applications. In the context of TV reception, coaxial cables offer several advantages when used with antennas. They provide excellent shielding against electromagnetic interference (EMI), ensuring that the signal received by the antenna is transmitted to the television with minimal degradation. Additionally, coaxial cables are capable of carrying both audio and video signals, making them a versatile choice for TV setups[3].

2. Methodology

The Gray-Hoverman antenna, which is noted for its exceptional performance in receiving digital television signals, can be improved with certain materials to increase its efficiency. By adding a mesh galvanized structure, the antenna gains greater durability and corrosion resistance, resulting in a longer lifespan and consistent performance even under adverse weather conditions. Copper electrical wire is essential in the construction of driving components and reflectors due to its strong conductivity, which greatly increases signal reception and transmission. To further improve the antenna's capability, an antenna balun is used to match the antenna's impedance to that of the coaxial cable, lowering signal loss and enhancing overall signal quality. The insulated architecture of the coaxial cable allows it to properly convey received signals to the television while minimizing interference. Together, these materials produce a strong and efficient Gray-Hoverman antenna, capable of delivering high-quality digital TV signals over great distances.

3. Antenna design

Figure 1, is an illustration depicts the Gray-Hoverman antenna's layout and design aspects, including the proper placement of the driving elements and reflectors for optimal digital TV signal reception.

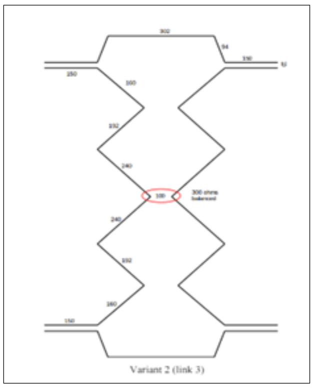

Figure 1 Diagram of a Gray-Hoverman Antenna

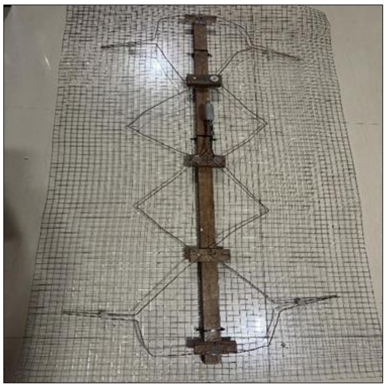

Figure 2 Actual Gray-Hoverman Antenna Design

Figure 2: Actual Gray-Hoverman Antenna Design **-** This figure depicts the finished Gray-Hoverman antenna design, illustrating the precise arrangement of its elements, such as the mesh galvanized structure, copper electrical wire, antenna balun, and coaxial cable, for optimal digital TV signal reception.

Figure 3 Testing the Gray-Hoverman Antena Design

This figure demonstrates the testing phase of the Gray-Hoverman antenna, highlighting the setup and evaluation of its performance in receiving digital TV signals under various conditions.

4. Results

A Gray-Hoverman antenna was constructed and customized by the researcher for this study. The key components of the antenna design included copper wire used as the receiver element and a mesh galvanized metal used as the reflector. The antenna was connected to a television via a coaxial cable. The performance of the customized Gray-Hoverman antenna was evaluated by the number of channels received across different types of broadcasting signals: analog TV, digital TV (DTV), community antenna television (CATV), and radio. The results are summarized as follows:

Table 1 Results of Channel Scanning

Category	Number of Channels
Analog Tv	11
dtv	38
catv	5
radio	0

Figure 4 Results of Channel Scanning

5. Discussion

The performance of the customized Gray-Hoverman antenna was thoroughly evaluated to understand its efficacy in receiving various types of broadcasting signals. This section shows the analysis of the antenna's ability to capture analog TV, digital TV (DTV), community antenna television (CATV), and radio channels. By examining the number and quality of channels received in each category, we can assess the impact of the design choices—specifically, the use of copper wire as the receiver element and mesh galvanized metal as the reflector. The results provide insights into the strengths and limitations of the antenna's design, guiding potential improvements for future iterations.

5.1. Analog TV Channels

The Gray-Hoverman antenna successfully received 11 analog TV programs, which indicates that the antenna's design is effective in capturing over-the-air analog signals within its reception range. The use of copper wire as the receiver likely contributes to the result since it is a great conductor which enhances signal reception.

A significant number of digital TV channels, a total of 38, were received by the antenna. This means that the antenna is also suited for digital signal reception. The mesh galvanized as the reflector may have improved the antenna's gain and directivity, thereby enhancing its reception of digital signals with higher clarity and stability.

5.2. Community Antenna Television (CATV) Channels

The reception performance of 5 CATV channels mean that while the antenna can pick up some available community cable signals, its primary use is optimized for over-the-air reception rather than cable television signals. Which is reasonable since CATV rely on a network of cables rather than broadcast signals.

5.3. Radio Channels

The antenna did not receive any radio programs, these results reflect that the antenna's design mainly focuses on television frequencies rather than radio frequencies thus Gray-Hoverman antenna is not optimized for the reception of AM/FM radio signals, which operate at different frequency ranges.

6. Conclusion

The customized Gray-Hoverman antenna, featuring copper wire as the receiver and mesh galvanized metal as the reflector, demonstrated effective performance in receiving a variety of television signals. It successfully captured 11 analog TV channels and 38 digital TV channels, showcasing its capability to handle both analog and digital broadcasts. The high number of digital TV channels received indicates the antenna's effective design for modern digital signal reception, likely enhanced by the mesh galvanized reflector, which improves gain and directivity. However, the antenna's performance was less effective for community antenna television (CATV) signals, capturing only 5 channels, and it did not receive any radio programs, reflecting its optimization for over-the-air television signals rather than cable or radio frequencies.

Overall, the results highlight the effectiveness of the customized Gray-Hoverman antenna for television reception, particularly for digital broadcasts. The choice of materials and design enhancements contributed to its ability to receive clear and stable signals over a wide range of channels. Future iterations of this design could explore modifications to extend its reception capabilities to include radio frequencies and improve performance for CATV signals, potentially making the antenna more versatile for a broader range of applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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