EXPERIMENTAL INVESTIGATION ON THE DESIGN OF MICROSTRIP ANTENNA ARRAY INTEGRATED WITH FILTERS FOR BODY AREA NETWORKS

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ABSTRACT

This research provides a novel strategy: the integration of microstrip antenna arrays with specialized filters—in response to the growing demand for dependable communication systems in Body Area Networks (BANs). BANs are essential for healthcare applications because they require reliable and effective communication both within and outside the human body. The main objective of the project is to create microstrip array antenna at 2.4 GHz using graphene substrate. The design, simulation, fabrication, and experimental evaluation of such integrated systems are all covered in this paper. The antenna model designed in HFSS provided a good return loss of -32db. The results of our study support the feasibility of the suggested microstrip antenna array for BANs that is integrated with filters. The system increases communication range while simultaneously successfully reducing outside interference, which boosts energy efficiency. Notably, the experimental outcomes closely match the predictions made by the simulation, reiterating the viability of our approach. The development of reliable communication systems for wearable and implanted healthcare technologies is considerably aided by the findings of this study. Our research provides insightful information that paves the path for new developments in the combination of antennas and filters to enhance BAN performance in the future.

Keyword : - *Wearable, Microstrip antenna, HFSS, Graphene film.*

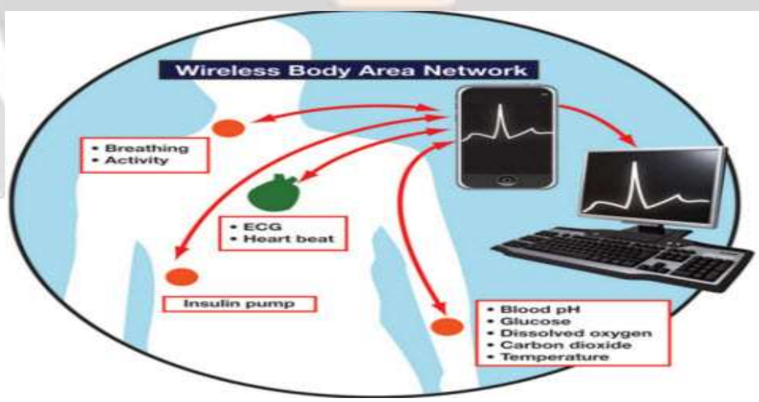
1. 1 INTRODUCTION

An antenna is a special sensor that converts electrical current into electromagnetic (EM) waves and vice versa. Antennas are used to transmit and receive non-ionizing radiation, including weak radio waves, microwaves, infrared (IR) radiation, and visible light. Radio wave antenna and microwave antenna are widely used in most industries and in our daily life. Infrared and visible light antennas are rare. Although their uses are often specialized, they can still be used in many areas. Antennas are generally divided into transmitting antennas and receiving antennas. However, many antennas can double as transceivers. The transmitting antenna receives electrical current from the transmitter.

The antenna uses current to generate electromagnetic waves at specific frequencies that are dispersed by the air and can be received by one or more antennas. For example, a radio station may broadcast music as an FM signal, which is a type of radio in the EM spectrum. The station transmitter sends music in the form of electric current at the desired frequency to the antenna. Antennas convert electrical current into radio waves that radiate in all directions. Receiving antennas capture electromagnetic waves transmitted through the air. The antenna produces a small current from these waves, which varies depending on the signal strength. This current is sent to a device where it is converted to suit a specific location. For example, a car's antenna can receive the FM signal from a radio station. The antenna converts the weak radio signal into electric current, which is then fed to the car radio. The radio spreads the electric current, converts it into another channel and sends it to the speaker as music.

1.1 BODY AREA NETWORK

Body area network (BAN), also known as wireless body area network (WBAN) or body sensor network (BSN) or medical body area network (MBAN), is a wireless network for devices in the computer. BAN devices can be placed in the body as implants or pills, placed in a permanent place on the body, or made with human devices. They can be carried voluntarily to many places such as in the pocket or in the hand. or inside. Many bags. Although there are differences in small equipment, mainly in the body in the junction area of many small body sensor units (BSU) and a central body (BCU), Smart devices with large decimeter (stickers and tablets) sizes are still played. games. The main role is to act as a data center or data gateway and provide a user interface to view and manage BAN applications. The development of WBAN technology began in 1995 with the idea of using Wireless Personal Area Network (WPAN) technology to enable communication between people, nearby and around them. Six years later, the term "BAN" began to refer entirely to systems that communicate within, on and near the human body. WBAN systems can use WPAN wireless technology as a gateway to reach long distances. Wearable devices on the human body can be connected to the network through gateway devices. This allows doctors to access patient information online using the internet, regardless of the patient's location. BAN devices can be placed in the body as implants or pills, placed in a permanent place on the body, or made with human devices. They can be carried voluntarily to many places such as in the pocket or in the hand. or inside. Many bags. Although there are differences in small equipment, mainly in the body in the junction area of many small body sensor units (BSU) and a central body (BCU), Smart devices with large decimeter (stickers and tablets) sizes are still played. games. The main role is to act as a data center or data gateway and provide a user interface to view and manage BAN applications.



1.2 MICROSTRIP ARRAY NETWORK

array antennas are versatile and important in modern wireless communications, known for the design and use of microstrip patch antennas. These flat antennas are preferred in applications such as radar and satellite communications for mobile phones because they are thin and light. Array configurations arrange multiple antenna segments in a grid to enable electronic beam steering, an important feature for communications. Control of this beam is done by controlling the level and amplitude of the signal fed to an individual in the array, allowing for precise targeting. Microstrip arrays offer high gain, high accuracy, and can be adapted to different communications applications because they can be designed for wide-area or multiband operations. Their low-profile design allows integration into compact devices, while their cost-effective manufacturing process makes them an economical option for mass production. However, these antennas face issues related to bandwidth, performance and component integration that require careful consideration in design. Microstrip array antennas represent a combination of electromagnetic theory and engineering techniques. These systems, often based on printed circuit boards, create direct current electronic systems required in many applications, from array radar systems to tracking and monitoring to satellite communications terminals leading to global connectivity. The advantage of microstrip arrays is that they can control the electrical direction of the main electrical lobe. The antenna can be changed quickly by controlling the phase and amplitude of the signal sent to individual chip components.

1.3 1.3 ADVANTAGES AND DISADVANTAGES

Microstrip array antennas have several advantages and disadvantages, which are important to consider in various applications. Here's an overview of both:
Some of the principal advantages are given below:

- Light weight and low volume.
- Low cost of fabrication, therefore it can be manufactured in large quantities.
- High Gain.
- Low profile planar configuration which can be easily made conformal to host surface.
- Can be easily integrated with microwave integrated circuits (MICs).
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rough surfaces.

Microstrip patch antennas suffer from some drawbacks as compared to conventional antennas.
Some of their major disadvantages are given below:

- Narrow bandwidth
- Low efficiency
- Low Gain
- Low power handling capacity.
- Surface wave excitation
- Extraneous radiation from feeds and junctions
- Poor end-fire radiator except for tapered slot antennas

Microstrip array antennas are versatile and well-suited for many applications, but their design and performance depend on careful consideration of the specific requirements and trade-offs in the antenna.

2. LITERATURE SURVEY

Shera Prabjyot Singh1, Ashish Singh2, Deepak Upadhyay3, Sunilkumar Pal4, Mahesh Munde5 "Design and Fabrication of 2.4 Ghz Microstrip Patch Antenna for WLAN Application Using HFSS" The antenna is designed for Wireless Local Area Networks (Wireless Local Area). Networks), the resonance frequency is 2.4 GHz. In this study, the proposed antenna design and simulation results are presented. The proposed antenna is designed based on the design of HFSS simulation software. Fabrication after fabrication of MSA was achieved and reported in this study. The proposed antenna has a thin and easy-to-design structure, making it suitable for WLAN applications and easy manufacturing.

Rajni Bala 1, Rajdeep Singh1, Anupma Marwaha 1 and Sanjay Marwaha 2 “Wearable Graphene Curved Patch Antenna for Medical Telemetry Applications”, this article Conformal square patch is provided in the form of patch wire receiver design Wireless body area examines the effectiveness of graphene for biotelemetry in network networks (WBANs). Graphene's extraordinary properties as a conductor determine how the antenna will work. However, this antenna performs best in the ISM band at 2.4 GHz due to its good impedance matching, significant dB gain, and excellent electrical performance at frequencies in the GHz range. To install the Ultra Wideband (UWB), conformal graphene antenna is recommended to be positioned away from the body.

Nur I. Z. Azman, Muhammad K. Othman, Nur A. A. Zaini, and Mohamad A. Jusoh,” Graphene-Based Materials for Microstrip Patch Antenna”, this paper explores the effects of incorporating graphene-based materials into microstrip patch antennas. By leveraging the remarkable electrical properties of graphene, the antenna's performance is enhanced in terms of bandwidth, radiation efficiency, and miniaturization. The study demonstrates the potential of graphene as a promising material for advancing antenna technology in various applications, including wireless communication systems and satellite communications, owing to its unique capabilities and versatile characteristics.

Azman, N.I., N.A. Zani, Y.K. Yeow, F. Esa, R. Nazlan, and M. A. Jusoh, “Graphene-based materials for microstrip bandpass filters,” this paper discusses the use of graphene-based materials in the development of microstrip bandpass filters. The paper may explore how graphene materials can be used to improve the performance of microstrip bandpass filters. This will include discussion of the unique properties of graphene that make it suitable for this application, the design process involved, and the resulting improvements in filtering performance such as increased bandwidth, efficiency, or frequency selection. Overall, this paper contributes to electromagnetic research by examining the integration of graphene-based materials into microstrip bandpass filters; This could lead to advances in the use of filter technology, thus improving features and performance. It is necessary to read the entire article to understand the details and findings.

3. OBJECTIVE AND METHODOLOGY

3.1 OBJECTIVES

This project aims in designing and fabrication of wearable Microstrip patch antenna operating at 2.4GHz with improved gain & Bandwidth. The designed antenna is compact, low profile and affordable. The parameters like gain, bandwidth, radiating pattern are verified of using HFSS software. It monitors the SAR value for lower health risk to human body. This design aims to replace regularly used copper with graphene, which is highly conductive and flexible.

3.2 METHODOLOGY

Figure 2: Flow chart for Designing microstrip array antenna

Use electromagnetic simulation tools such as HFSS, CST or ADS to design and optimize the characteristics of your antenna.

- The first stages of this process involved creating microstrip patch antennas.
- The next step is the design of the microstrip array antenna.
- Integrating nanomaterials into antennas.
- Combination filter with antenna.
- Measure antenna performance and analyze characteristics including return loss, gain and bandwidth

3.2.1 ANTENNA DESIGN

Antenna design is a specialized discipline in electrical engineering that is primarily concerned with creating devices capable of transmitting or receiving electromagnetic waves such as radio waves, microwaves, or light waves. Antennas serve as essential components in a variety of communications systems, including radio and television broadcasting, cellular networks, satellite communications, and radar systems. The antenna design process involves several key considerations. First of all, the objectives of the antenna must be clearly defined. These goals include the intended purpose of the antenna, such as the desired operating frequency, radiation pattern, gain, and impedance requirements. The goals defined in this way serve as the main principles of the design process. Selecting the appropriate antenna type is another crucial step in the design process. Various types of antennas are available, including dipole antennas, patch antennas, yagi-uda antennas, and parabolic antennas. The choice of antenna type depends on factors such as operating frequency, radiation pattern requirements, and shape factors. Frequency considerations are central to antenna design. Antennas are designed to operate in specific frequency ranges, and the dimensions and structure of the antenna are affected by the operating frequency. These considerations include understanding the wavelength and physical size of the antenna elements. A critical aspect is the radiation pattern, which describes how the antenna radiates or receives electromagnetic waves in three-dimensional space. The required radiation pattern can be omnidirectional, directional, or tailored to meet specific requirements.

3.2.2 FILTER REQUIREMENTS

Integrating a filter into a body area network (BAN) microstrip array antenna involves incorporating a bandpass filter directly into the antenna design to selectively pass the desired BAN frequency range while rejecting out-of-band signals and limiting interference from other wireless devices. Built-in filters integrate the filter elements into the antenna structure, while external filters attach a separate filter to the antenna. Hybrid integration combines both approaches. The filter design must match the impedance and frequency response of the antenna, match the passband to the BAN frequency range, and suppress out-of-band signals. Filter integration improves BAN system performance by reducing interference, improving signal quality, and extending communication range, which is particularly beneficial for wearable BAN applications requiring compactness, efficiency, and reliability.

3.2.3 TESTING AND VALIDATION

Testing and verification are important stages in antenna design to ensure that the antenna meets specifications and performance in the real operating environment. This phase includes tests, measurements, and adjustments to ensure the antenna is performing well. Testing is the basic step and the physical structure of the antenna is tested. Engineers measure parameters such as gain, power model, impedance matching and bandwidth to evaluate how the antenna should meet specifications. Use advanced measurement tools and measurement techniques to collect accurate data. After the test, field testing comes into play to measure the performance of the antenna in the desired location. Field tests take into account real-world variables such as terrain, impact, and environment. These tests provide a good understanding of how the antenna will perform in real-world conditions and are crucial for proper design. Verification is the last step; Comparison of the antenna with the design objectives was done at the beginning of the project to ensure that it met the needs and requirements. This phase verifies through simulation and laboratory testing that the antenna performance is as expected. Evaluation and verification are repetitive processes that often require changes and improvements to the design to achieve optimum performance. This level is important to provide evidence of antenna performance, safety and compliance with regulatory standards. It also ensures that communication is reliable and effective by allowing possible problems to be detected and corrected before the antenna is deployed in practice.

4. PROPOSED WORK MODULE

HFSS (High-Recurrence Construction Test system) is a generally utilized electromagnetic reproduction programming instrument created by Ansys for planning and dissecting different sorts of radio wires, including microstrip fix receiving wires. HFSS gives a strong stage to demonstrating, re-enacting, and upgrading radio wire plans in light of electromagnetic standards. This is an outline of the way HFSS can be utilized for planning a microstrip roundabout fix radio wire:

1. Calculation Creation: HFSS permits you to make the math of the microstrip fix receiving wire by characterizing the aspects and state of the fix, the substrate material properties, and the taking care of component. You can utilize the product's instinctive UI or import computer aided design models for exact math portrayal.

- Full Recurrence (fr):

The full recurrence of the round radio wire can be assessed utilizing the successful range (Reff) and the speed of light (c) in the dielectric substrate:

fr ≈ c/(2πReff)

- Viable Range (Reff):

The viable range of the roundabout fix can be determined by considering the bordering field impacts. It is commonly more modest than the actual range of the rectangular patch. A surmised condition for the successful sweep is:

Reff ≈ R - 0.412h

Where:

Reff = Viable range

R = Actual sweep of the patch

h = Thickness of the substrate

- Fix Width (W):

The width of the round fix can be resolved in light of the ideal thunderous recurrence and the powerful dielectric steady (εᵉff):

W ≈ c/(2fr √(εᵉff))

Where:

W = Width of the patch

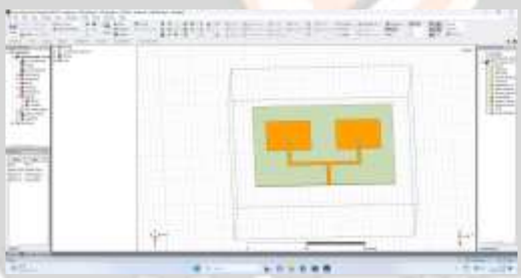


Figure 3: Antenna model from HFSS Software

4. CONCLUSIONS

consolidate our research outcomes, drawing definitive conclusions about the success and efficacy of our microstrip antenna array design and its integration with filters for BANs. We assess the extent to which our system meets the specific project objectives and BAN requirements. Our conclusions highlight the strengths and limitations of our design, providing a clear understanding of the achieved results.Our effort on integrating filters and microstrip antenna arrays for body area networks (BANs) is a promising step towards more effective and efficient wireless communication. In order to help wearable technology, healthcare, and other industries where BANs are essential, it is our aim that this study will spur other discoveries and developments in the sector

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