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MODIFIED DESIGN STRUCTURE OF A METAMATERIAL MICROSTRIP PATCH ARRAY ANTENNA FOR RF ENERGY OPTIMIZATION

MODIFICIRANA OBLIKA STRUKTURE META-MATERIALA MPA ANTENE ZA RADIO-FREKVENČNO OPTIMIZACIJO

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We propose a modified design of a microstrip patch array antenna for RF energy optimization over 2.45 GHz WLAN communication applications. Initially, a one-patch and a two-patch array antennas were developed and considered as the base for the construction of a four-patch array antenna in the GSM 1800 frequency range. The energy usage by the WLAN application model includes a radiofrequency WLAN supply, a wireless connection, the proposed array antenna, impedance network matching, a voltage rectifier and a storage circuit that achieves higher efficiency. The proposed antenna design is utilized to examine the distance effect on the received RF power and it achieves the maximum efficiency of 47 % at 2.45 GHz at a 1-meter distance from the source. Improved gain is acquired at the expense of a greater array-antenna size with a -26 dB return loss, proving that it is much more efficient than other structures. Moreover, when experimentally analysed with HFSS, it delivers sufficient energy over WLAN applications.

Keywords: patch antenna, WLAN, RF energizer, voltage rectifier, VSWR

Avtorji v članku predlagajo modificirano oblikovanje mikrotračne vrstne "čip" (v obliki nalepke oziroma obliža, MPA; angl.: microstrip patch antenna) antene za radiofrekvenčno (RF) energijsko optimizacijo WLAN (angl.: wireless computer network) komunikacijskih aplikacij za frekvence nad 2,45 GHz. Na začetku so razvili anteni z eno in dvema nalepkama in ju uporabili kot osnovo za anteno s štirimi nalepkami v frekvenčnem območju GSM 1800. Za doseganje višje učinkovitosti porabe energije so avtorji v raziskavo modela WLAN aplikacije vključili radio-frekvenčno WLAN-a, brezžično povezavo, predlagano vrstno anteno, ujemanje impedance omrežja, napetostni usmernik in spominski tokokrog. Predlagano obliko antene so avtorji uporabili za preizkus učinka razdalje na sprejeto RF moč in dosegli maksimalno 47 % učinkovitost pri 2,45 GHz in oddaljenosti enega metra od izvora. Izboljšanje doseženega doprinosa je šlo na račun vrstne antene večje velikosti s povratnimi izgubami -26 dB. To dokazuje, da je bila dosežena višja učinkovitost kot jo imajo druge strukture te vrste. Eksperimentalna analiza z uporabo visokofrekvenčne simulacijske programske opreme (HFSS; angl.: high frequency simulation software) je tudi dokazala dobavo zadostne energije preko WLAN aplikacij.

Ključne besede: vrstna antena, simulacija, brezžično lokalno omrežje, radio-frekvenčna energija, napetostni usmernik, razmerje napetostnih stojnih valov

1 INTRODUCTION

Nowadays, the WLAN (wireless local area network) technology is the most successful and an extremely fast wireless communication solution due to its low-profile, flush-mounted, lightweight and simple design[1] in the 2.45 GHz operating band.[2] The WLAN technology efficiently performs based on RF (radio frequency) energy and, therefore, the most appropriate antenna is required to optimize RF energy. The microstrip patch array antenna is an appealing design that offers numerous benefits for optimizing RF energy.[3,4] A microstrip patch array antenna comprises of two ends, one with a radiating patch and the other with a dielectric substrate. The patches are usually constructed of conductive materials like gold or copper, and they come in various shapes, including rectangles, circles and diamonds. The radiating patch and feed lines are photo-etched over the dielectric substrate.[5,6]

This antenna has compact physical dimensions with regard to the desired wavelength frequency,[7–9] its design is moderately complicated, its cost is moderate, and it is simple to manufacture.[10,11] When designing the antenna structure, its properties and performance are bigger challenges.

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With respect to the antenna design, various feeding methods, including aperture coupling, coaxial feeds, microstrip line and proximity coupling are used to stimulate microstrip patch array antennas. Microstrip line feeds are simpler to manufacture, allowing a change of the inset location, especially for prototypes.[12]

The feed mechanisms used in the patch antenna design have a substantial impact on the resonant frequency, return losses, voltage standing wave ratio (VSWR) as well as bandwidth. Impedance matching throughout the intended frequency is required for a patch antenna. Feed gap optimization, multiple feeds, shaping ground plane, bevels and offset feeding methods are the various band-matching techniques.[13] Antenna arrays are made up of several microstrip antennas that are interconnected and structured in a regular pattern to form one antenna. Since it allows high gain, a relatively narrow beam, huge aperture efficacy and various emission patterns, the antenna array approach is utilized to create microstrip antennas.[14]

The main contribution of this paper is the development of a structural model of a microstrip patch array antenna for RF energy optimization over 2.45 GHz WLAN applications.

Initially, the design structures of one-patch and two-patch array antennas are discussed. Here, the length and width measurements are more essential in designing the array. From this design, the proposed microstrip four-path array antenna is developed.

The fundamental structural model of the RF energy optimization circuit comprises a matching circuit, antenna, voltage multiplier and energy storage. RF signals are generated by the RF transmitter and transmitted through the path loss channel to the receiver where it matches the receiver antenna.

The antenna operates in the 1800 GSM band, appropriately collected and optimized for the RF signal once it enters the proposed antenna design. The objective of the four-patch array antenna is to achieve the maximum gain value of 9.2 dB and to correspondingly optimize the energy signals. Improved gain is acquired at the expense of a greater array-antenna size, thus the proposed design proves to be better than other designs.

In this paper, Section 2 includes a literature review relating to this topic. Section 3 includes a description of the proposed microstrip four-patch array antenna for optimizing RF energy over 2.45 KHz WLAN applications. Section 4 talks about our experimental analysis where HFSS (high-frequency simulation software) allows functioning at 2.4 GHz, evaluating the return loss, VSWR, voltage and efficiency of the proposed design. Finally, Section 5 makes the conclusion regarding the performance of the antenna design in various load WLAN applications.

2 RELATED WORKS

A transducer is a device wherein the RF electrical current present in the waveguide is converted into electromagnetic waves in free space. This is a crucial design issue in a communication system in order to provide a comprehensive coverage of the most recent wireless uses in a variety of industries. An antenna as well as its specifications must meet the needs of many diverse purposes. In communication systems, traditional antennas are huge and heavy. As a result, the transceiver unit as a whole is somewhat massive.

Scientists are searching for antennas for advanced communication systems that are of a lower size[15] and lightweight; thus, there is a reduction in weight as well as the size of the transceiver. As a result, the microstrip patch array antenna (MSPA) is the only alternative that can meet the requirements of being small in size, lightweight and less expensive. The microstrip patch array antenna,[16] microstrip slots,[17] traveling antenna and printable dipole antenna are all examples of patch antennas utilized in wireless-network communication systems.

In this research, the MSPA is developed for wireless-network communication applications and the maximum gain is achieved using an array antenna. Likewise, a defective ground configuration will improve the bandwidth as well as return loss metrics. Microstrip patch array antennas have become extremely prevalent, used for various purposes due to their minimal profile, minimal cost, mechanical robustness and ease of fabrication. Their design is the most critical factor to consider in our research. It is essentially a metallic patch hanging from the ground. Its narrow bandwidth, minimal efficiency and reduced MSPA gain are major drawbacks. Utilizing a thick substrate, creating slots within a patch utilizing various patch forms, using varied feed positions with a low constant dielectric substrate, and building array antennas may help overcome these restrictions. The microstrip array antenna design is then presented differently by the researchers aiming at enhancements in the radiation properties, reduced size, minimal cost, and so on. In recent decades, several new approaches have been used for constructing microstrip antennas. The DGS (defected ground structure) is a principle being uniquely utilized in the MSPA design. A technology known as the DGS is employed to improve the MSPA's performance attributes. This is a method of purposely altering the ground through installing flaws of multiple shapes and diverse area sizes to enhance the antenna performance. The insulated current distribution is disrupted based on the defect's form and magnitude. The antenna's impedance input and current flow may be affected by this pattern. The DGS also controls the excitation as well as propagation of electromagnetic waves via the substrate layer. As a result, we can use the DGS to enhance and optimize the antenna performance attributes. In wireless-network communication, the MSPA with DGS is utilized mainly in ISM (industrial, scientific and medical) band implementations. The ISM band has been employed in numerous wireless-network communication applications because it is an unlicensed frequency spectrum. For the frequency-allocation purpose, the ISM band is employed in the current aerospace, cordless-phone, vehicular and man-portable systems, Bluetooth devices, as well as wireless communication networks.[18] Academics and industry leaders in the telecommunication fields have given the ISM band a lot of thought. This study proposes an MSPA comprising the 1 × 4 array topology and an integrated DGS supporting the wireless network communication in the ISM band.

In an antenna design, a multiband receiver module provides a competitive benefit over a single-band antenna, that is, the capacity to collect higher electromagnetic radiation values. Furthermore, a harvesting model of RF using a multiband antenna has certain drawbacks, including a greater system complexity and, most importantly, the matching network's inability to perform effectively over many frequency bands. In our research, the multiband antennas used for harvesting the RF energy are thoroughly explored. The units harvesting the RF energy in antenna systems are tested and examined using a variety of antennas of a minimal, moderate and maximal complexity.

Low-complexity RF energy harvesting receiver units include monopole,[19–21] yagi-UDA antennas, bow-tie[22] dipole and log-periodic antennas. Moderate-complexity RF energy harvesting receiver units include inverted-F,[23] patch antennas,[24,25] multi-slot[26,27] and spiral antennas.[28] High-complexity RF energy harvesting receiver units include greater amounts. Furthermore, advanced complex systems[29–31] that operate as multiple-frequency RF energy collectors are reported in the review. In addition, multiband RF energy harvesting systems are successfully tested using the type with antenna arrays.[32]

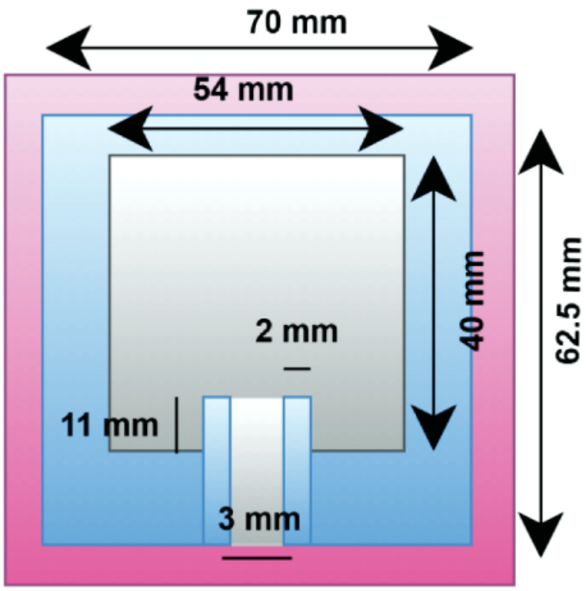

Figure 1: Inset fed microstrip patch antenna

3 SYSTEM MODEL

An antenna is the most important component for collecting RF signals. The proposed design of this four-microstrip patch array antenna (MPAA) is employed for optimizing the RF energy and developed from one-patch and two-patch array antenna structures to achieve high gain and better communication efficiency over 2.45 GHz WLAN applications.

The microstrip patch antenna (MPA) is usually a rectangular inset fed antenna depicted in **Figure 1**. It is the only one-patch array antenna with dimensions of 40 mm × 54 mm.

The structural plane of the patch array is supported by an FR_4 substrate with dimensions of 62.5 mm × 70 mm. To increase its efficacy, a substrate dielectric constant (relative permittivity) of $\varepsilon_r = 4.6$ is chosen.

At a resonance frequency of 1800 MHz, the patch array antenna dimensions are determined. When designing the parameters, the length and breadth are computed utilizing numerical calculations listed below to achieve an effective signal reception for any number of patches within a design structure.

The patch array width (W) is expressed with Equation (1):

$$W = \frac{C}{2 f_0 \sqrt{\varepsilon_r + 1}} / 2 \tag{1}$$

where $\varepsilon_r = 4.6$, the speed of light $c = 299.792 \times 106$ m/s, and $f_0 = 2.45$ GHz.

The effective dielectric constant ($\varepsilon_{\text{reff}}$) is expressed with Equation (2):

$$E_{\text{reff}} = \frac{(E_r + 1)}{2} + \frac{(E_r - 1)}{2} \sqrt{1 + \frac{12h}{w}} \tag{2}$$

The expression for obtaining the effective length (L_{eff}) is provided with Equation (3):

$$L_{\text{eff}} = \frac{C}{2 f_0 \sqrt{\varepsilon_{\text{reff}}}} \tag{3}$$

Length extension is calculated with Equation (4):

$$\Delta L = 0.412h \frac{(\varepsilon_r + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_r - 0.258)\left(\frac{W}{h} + 0.8\right)} \tag{4}$$

To provide the supply for an array antenna, various ways are considered. The patch dimensions and the feeding mechanism are important considerations when building a patch array antenna. The dimensions of every patch are 40 mm × 54 mm, and they are necessary for keeping the working frequency at 2.45 GHz. The favourable feeding approach employed for the microstrip line with dimensions of 23.8 mm × 3 mm is the one that allows impedance matching and high gain. The proposed patch array antenna is supplied by a feed link, whose power is evenly divided between the patches. As illustrated in

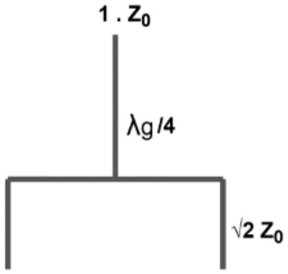

Figure 2: T-junction power splitter

Figure 2, a T-junction power splitter was utilized in the symmetrical design.

The dielectric layer and the ground plane are visible beneath the top line. This may be regarded as the characteristic resistance of two lines with $\sqrt{2Z_0}$ and the length is given as $L = \lambda_g/4L = \lambda_g/4$, whereby at the central frequency, the wavelength λ is acquired. At f_0, the splitter $Z = 2Z_o$ satisfies $S_{11} = S_{22} = S_{33}$.

At the point of the centre frequency, due to symmetry, the incident signal of Port 1 is divided evenly. Following the one-patch antenna, the substrate dimensions for the two-patch array antenna are 82.5 mm × 130 mm. The wavelength λ at a centre frequency of 2.45 GHz is 60.6 mm; hence, the distance separating the two patches is estimated as 4λ. The T-junction power divisor has symmetrical dimensions, which are 50 mm × 1 mm for the top line, and 19 mm × 3 mm for the main line. The two-patch array antenna is shown in **Figure 3**.

The proposed four-patch array antenna is developed from a two-patch design as shown in **Figure 4**. The RF-signal collecting antenna is designed to acquire a better gain. The four-patch array antenna substrate is 144 mm × 130 mm in size. To make a four-patch array antenna, we separate the two patches at a length of $4\lambda = 66$ mm, whereby wavelength λ is present at the 2.45 GHz resonant frequency. The patch length and the breadth of each component are identical to those stated previously for the single-patch and two-patch component antennas, as estimated from the above-mentioned expressions. The microstrip line position and the length input are varied within the optimization procedure in order to attain an increased gain. An improved gain is acquired at the expense of a greater array-antenna size; however, in the event of an RF-energy optimization system, our goal is to attain the maximal gain, while the size optimization is not our concern.

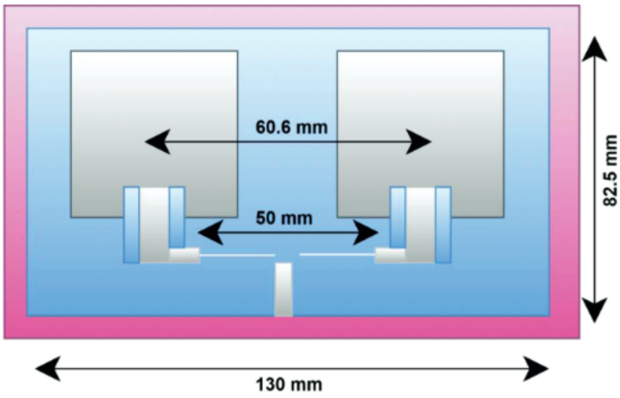

Figure 3: Two-patch array antenna

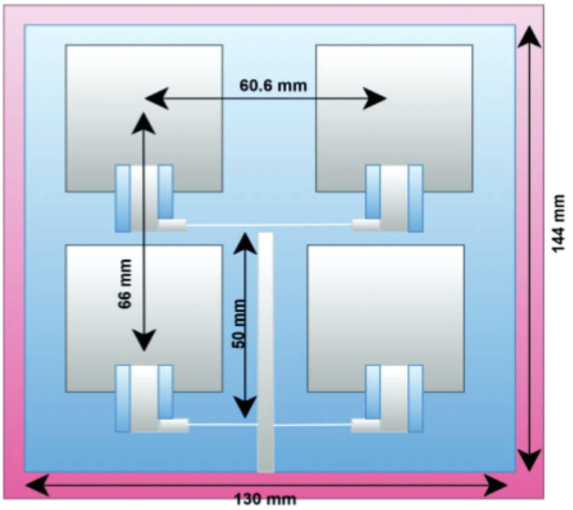

Figure 4: Four-patch array antenna

Table 1 shows the estimated values for the modified design antenna obtained with the above-mentioned formulas.

Table 1: Four-patch array antenna parameters

Required antenna parameters	Value
central frequency (GHz)	2.45
substrate height (mm)	2
patch array length (mm)	40
patch array width (mm)	54
dielectric constant	4.6

As energy is the most important consideration, it is necessary to obtain the maximum broadcast signal at the optimization input. Under this condition, a weak signal leads to an unnecessary power loss. The four-patch array antenna resonates at the 2.45 GHz frequency, achieving an increased gain. With respect to its construction, the proposed modified antenna comprises four rectangular array patches, each having a slot of 11 mm × 3 mm. The FR_4 substrate including the top layer contains the array patches from the structural plane, placed on an identical ground plane. This antenna structure optimizes the obtained RF signal and utilizes it in various WLAN applications.

Radio waves are used everywhere in our life, coming from the television, radio, phone towers, wireless connections and other sources. As a result, the usage of wireless devices has grown in recent decades; consequently, there is an energy demand, necessitating the development of innovative energy-scavenging methods. The energy is optimized by limiting the power rate. The most acceptable band to investigate in connection with an ambient radio frequency (RF) energy source is Wi-Fi

(2.45 GHz). The energy optimized with microstrip patch array antenna RF signals is determined by the RF signal wavelength and transmitted power, and the length ranging from the RF energy source to the harvesting node can be optimized for WLAN applications. The Friis Equation (5) is used to compute the power delivered to free space by a transmitter.

$$P_R = P_T \frac{(G_T G_R \lambda^2)}{(4\pi d)^2 L} \tag{5}$$

The power being received is represented as P_R, P_T stands for the transmitted power, L stands for the path loss, G_T represents the gain of the transmitter antenna, G_R denotes the gain of the receiving antenna, and the emitted-signal wavelength is λ.

The distance between the transmission antenna and receiving antenna is denoted by d. The RF signal acquired through the antenna is considered as an AC signal that must be transformed into a DC signal before low-power devices may be charged. The efficiency η of the RF-DC conversion is expressed with Equation (6):

$$\eta = \frac{P_{DC}}{P_{received}} \times 100 \tag{6}$$

$P_{DC} = U_{DC}/R_L$, in which V_{DC} denotes the DC output voltage under a load, R_L denotes the load resistance and $P_{received}$ denotes that the RF power is provided as the input into the rectifier.

As illustrated in **Figure 5**, the fundamental structural model of the RF energy optimization circuit comprises a matching circuit, antenna, voltage multiplier and energy storage. The initial sub-component RF energy signal is obtained from the receiver antenna, and RF power is converted into a DC output to optimize the RF energy signals.

The RF energy optimization system is divided into two parts: the transmitter and the receiver. These signals are generated by the RF transmitter and transmitted through the path loss channel to be received by the receiver antenna. The RF energy of over 2.45 GHz is shown in **Figure 6**. The antenna receives the RF signals through the wireless channel and they are then transformed into DC power by a voltage rectifier unit. A matching network provides the optimum production of power transmitted from the antenna towards the voltage rectifier. Although external energy seems unavailable, the stored circuit ensures that power is delivered to the load without interruptions. A WLAN signal supplier is employed in this research to produce RF energy optimized signals at 2.45 GHz with varied power sources including 1 W, 550 mW and 250 mW.

Figure 5: RF-energy optimization

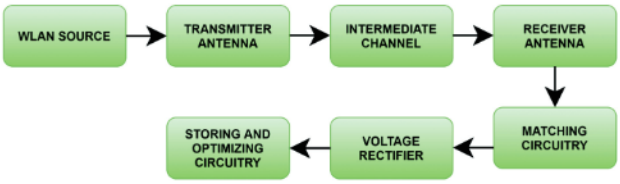

Figure 6: RF-energy optimization over 2.45 GHz WLAN

An ADS wireless-channel prototype with a realistic Rayleigh fading is utilized. The receiver RF power is determined by the RF transmitter's frequency response. The signal is sent to a voltage rectifier that is made up of phase capacitors and silicon HSMS-2850 Schottky diodes. An appropriate capacitor is employed for the circuit storage because it can store enough energy to power specific applications, including wireless sensors. In the experiment, for 1 W WLAN radio frequency only one frequency power supply running at 2.45 GHz is used.

The collected energy is heavily influenced by the structural-transmitter source strength and the spacing between the transmitting antenna and receiving antenna. The design includes the realistic channel data and the power incident on the receiver antenna over a wide range of distances. The receiver antenna is equipped with an optimization design that collects energy at a 2.45 GHz frequency. Furthermore, the receiving side is energized using one power frequency source based on the received power data acquired from the proposed circuit.

Prior RF energy optimization is limited to single-band collection antennas that are inefficient. Moreover, the design and deployment of the band and array antennas for the RF energy optimization have recently received a lot of attention. It is noted that ADS, together with the Sonnet results, is proved to have the operating bands around the WLAN frequencies, as well as having virtually identical levels of return loss, indicating the maximum power of the load. Significant resonances are formed at 2.4 GHz, having a reflection coefficient of –25 dB.

In the modified antenna design of the RF energy signal, impedance matching becomes critical. It lowers the transmission loss between the rectifier and antenna, increasing the rectifier-circuit voltage. The ADS is utilized to create alternative matching networks of LC for the frequency bands having the optimum capacitor and inductor values, resulting in good RF-DC conversion efficacy. The frequency range across the power delivery is maximum and can be changed by small changes in the matching-network characteristics. For the functioning of low-power devices, DC voltage at a specific frequency band is obtained from the conversion of RF signals. A HSMS-2850 Schottky diode is utilized, which has a 250 mV voltage at the threshold and a 0.18 pF capacitance of the diode. It possesses minimal forward voltage, unidirectional current flow as well as minimal substrate leakage. The receiver of the RF energy optimization system contains an incorporated voltage rectifier as well as a matching network. For the matching impedance, a cou-

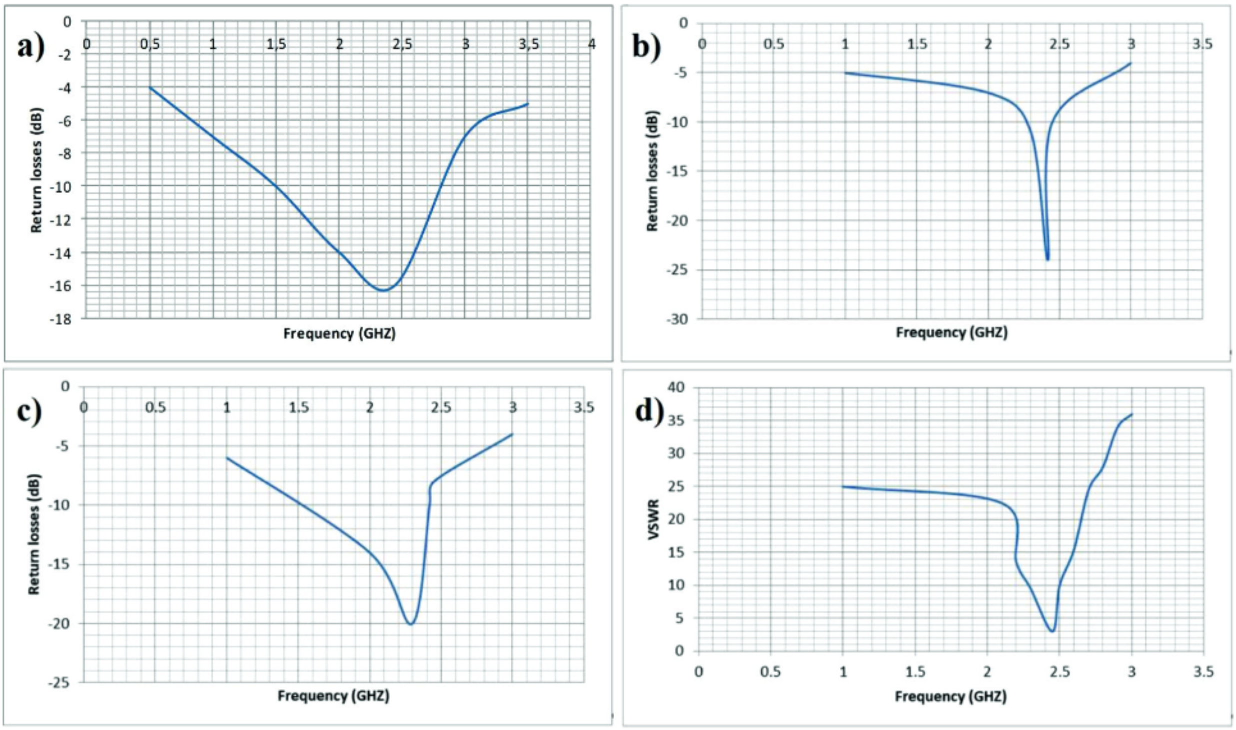

Figure 7: Return losses for: a) one-patch antenna, b) two-patch antenna, c) four-patch antenna and d) VSWR vs frequency dependence

pler is utilized to connect the antenna modelling to the voltage rectifier.

The number of rectifier steps used is critical in ensuring that the output voltage is sufficient for the operation of low-power devices. The optimum number of stages must be connected to the network since non-linear devices undergo a rise in parasitic losses with an increment in the stage count, affecting the total system efficacy and performance. In this scenario, four stages are utilized to deliver 1.3 mW of maximum power across a 10 k load with a 6 dBm power supply. The number of stages is increased considerably, reducing the total efficacy and voltage gain; therefore, it is important to choose several stages that may deliver enough voltage for various WSN applications. The typical turn-on sensor-node voltages range between 1.8 V to 3.6 V; therefore, our enhanced four-stage system seems capable of delivering the maximum desired voltage rate for the sensor-node purposes.

Since RF signals are missing, the energy storage enables a smoother power supply to the load, utilized as a backup resource. A capacitor connected across the load is included, for storage, in the circuit design, producing a DC voltage output. Lacking a capacitor connected across the load, the DC output signal is poor; hence, it is tuned to hold enough charge. A parallel connection to the capacitor is made with an optimum load resistor. Without a load resistor, the voltage would appear to be a DC output and could remain on the capacitor eternally. Thus, the RF energy optimization is achieved over 2.45 kHz WLAN communications using the proposed antenna design.

4 RESULT AND DISCUSSION

High frequency structure simulator (HFSS) is used significantly to optimize the efficiency, and the dimensions are fine-tuned bringing the resonance to the required frequency with an appropriate return loss. The value of return loss for the one-patch array antenna is –16.33 dB, as shown in **Figure 7a**. According to **Figure 7b**, the microstrip patch array antenna is first developed with a –22.8 dB return loss for the two-patch array antenna. The proposed modified antenna design is a four-patch array with a –26 dB return loss, as displayed in **Figure 7c**. The antenna keeps operating in the 1800 GSM band and is thus appropriate for the RF signal collection and optimization. The objective of the modified design of the four-patch array antenna is demonstrated, indicating that the maximum gain value produced is 9.2 dB. The framework is designed to function as an RF receiver signal in an RF optimization system. An improved gain is acquired at the expense of a greater array-antenna size, thus the proposed design is more effective than others.

Table 2: Receiving power at various source levels at the frequency of 2.45 GHz

P_s/W	Distance (m)									
	1	2	3	4	5	6	7	8	9	10
1	18	1.7	–7.8	–15	–20	–24	–27	–30	–33	–35
0.55	15	–1.7	–11	–18	–23	–27	–30	–33	–36	–38
0.25	11	–5.5	–15	–22	–27	–31	–34	–37	–40	–42

The VSWR variation with respect to the frequency for the 2.45 GHz WLAN communication is shown in **Figure 7d**. The 2.45 GHz antenna comprises a range limit of 2.372 GHz to 2.434 GHz for the VWSR < 2 of the proposed design.

The distance effect on the received power at various power source levels within a precise distance range from the transmitter, as shown in **Table 2**, is investigated within an experimental set-up in an interior environment that correspondingly optimizes the RF energy signals.

Simulations are run for several P_s values, including 1 W, 550 mW and 250 mW, to examine the source-power effect on P_r vs distance, as displayed in **Figure 8a**. This figure indicates that an increased P_s causes P_r to progressively rise at a constant distance, while an increasing distance causes it to decrease over WLAN applications. The capacitance values vary and their corresponding storage capacitor voltage is plotted as a time function in **Figure 8b**. A suitable capacitor size is utilized to store adequate energy for the necessary uses, including wireless sensor networks and Internet-of-Things (IoT) applications. Furthermore, the charging time is the key element for the selection of the capacitor; when it is very small, the outputs at the node might encounter energy shortages; when it is excessively lengthy, extra energy is wasted owing to a capacitor leakage. The supplement source such as a super-capacitor or battery is unable to store sufficient energy.

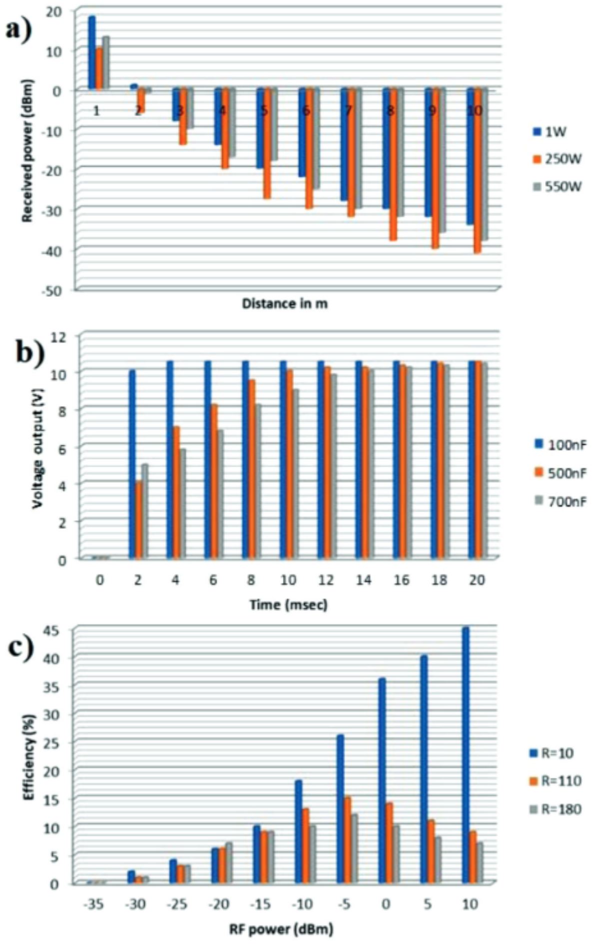

Figure 8: a) Source-power effect vs distance, b) voltage output vs time at a load, c) RF power vs efficiency

The number of rectification stages has a significant effect on the energy optimization circuit voltage output. The voltage output is linearly proportionate to several stages. The maximal resultant voltage is 3.6 V when P_r = 5 dBm and the resultant voltage is 15 V when P_r = 20 dBm. Whenever the transmitter is 1–10 m away from the receiver, it enables the relationship between the incident power and voltage output. The load impedance in a specified energy optimization system is critical, and its impact is shown in **Figure 8c**. The RF energy signal efficiency is displayed versus P_r for various load levels, ranging from 10–180 k for WLAN communication. If P_r = 5 dBm, the influence of the load impedance upon the system performance for a load of 10k achieves the highest possible efficacy of 47 % at 2.45 GHz. As a result, we may conclude that the modified design is optimized to give an optimum RF energy signal for a load of 10 k at specified operating circumstances and frequency. Once the receiving power is minimal, between –35 dBm and –16 dBm, a load of 60 k provides the highest efficiency. Thus, the antenna design optimizes RF energy signals based on their size; furthermore, the RF signal in a WLAN application is discussed with respect to various loads.

5 CONCLUSION

In this paper, a modified design of microstrip four-patch array antennas is proposed to achieve a higher gain. The implemented antenna would operate as a receiver in the 1800 MHz GSM band, collecting RF signals with a 9.2 dB gain at the 2.45 GHz resonance frequency. Two-patch and four-patch antennas built to receive the RF signals generated by GSM 1800 MHz phone towers are considered as the basis for the proposed design. Four-patch array antennas with a higher gain will perform better because they can capture additional RF signals. The RF signal is converted to DC and may capture electromagnetic energy once the antenna is paired with a rectifier. The research examines and optimizes the obtained RF energy for a WLAN source using a microstrip patch array antenna. A WLAN supply, wireless channel, microstrip patch array antenna, impedance network matching, storage circuit and four-stage voltage rectifier are all part of the WLAN application model. At a varied source power including 1 W, 550 mW and 250 mW, we investigate the distance effect on the received power to satisfy various loads. The experimental result demonstrates that the system design can supply a 1.3 mW power output over a load of 10 k and can be utilized to activate low-power devices such as wireless sensor networks, achieving a net efficiency of 47 % at 2.45 GHz.

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