DESIGN AND ANALYSIS OF MULTI - ARM ANTENNA FOR SMART AGRICULTURE

Abstract

In this chapter, a small, closed Bicone strip antenna for internet-of-things (IoT) applications is demonstrated. The folded Bicone strip construction of the antenna has a closed hat with a hat height of 5.675mm. The novel antenna was initially intended without hat; however, hat, an extremely miniature antenna, was added to enhance overall antenna performance. From 780 to 940 MHz, the given antenna functions in many frequency bands. As compared to a normal Bicone strip patch antenna operating at the same frequency, the final design procedure reduces the antenna size at 865–867 MHz by 80%. Therefore, rigid and dynamic antenna designs meet the IoT's functional and physical specifications while achieving high electromagnetic efficiencies relative to their small size with reasonable gains.

Keywords: IOT, Agriculture, and Bicone strip.

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I. INTRODUCTION

The development of underground wireless communications necessitates multidisciplinary studies on a variety of subjects, including examinations of antennas and underneath system of communication design, in order to come up with an all-encompassing proposal for a beneath the ground based antenna design for digital agriculture. In this research, a bicone strip antenna design is proposed to increase the performance and range of communication associated with wireless subterranean telecommunications. This design is based on the analysis of beneath the surface radio waves propagation in subterranean wireless route. It is demonstrated that wireless subterranean communications are improved by subsurface beamforming employing bicone strip antenna [1].Any gadget will soon be a member of the Internet of Things (IoT), an exciting concept that is quickly developing. By 2020, more than 50 billion devices are anticipated to be linked by radio [2], according to Cisco. By 2023, there will be a total of fourteen billion IoT devices, an 18% growth, and by 2025, there may be 27 billion linked IoT devices. A broad spectrum of IoT applications, such as safety, corporate tracking, connected houses, connected towns, smart farming, etc., will employ IoT devices. In-depth studies on the problems with developing IoT technology have been published. Wide spectrum, minimal data rate, low power consumption, and affordability are the primary features and needs of IoT applications. As a result, Lo(ng) Ra(nge) Wide Area Network (LoRaWAN) are being created to satisfy these various demands. These new LoRaWAN technologies have been reviewed and put side by side which is attracting more attention from the academic and business areas. Numerous research have examined the performance and characteristics of LoRaWAN communications from a theoretical perspective.

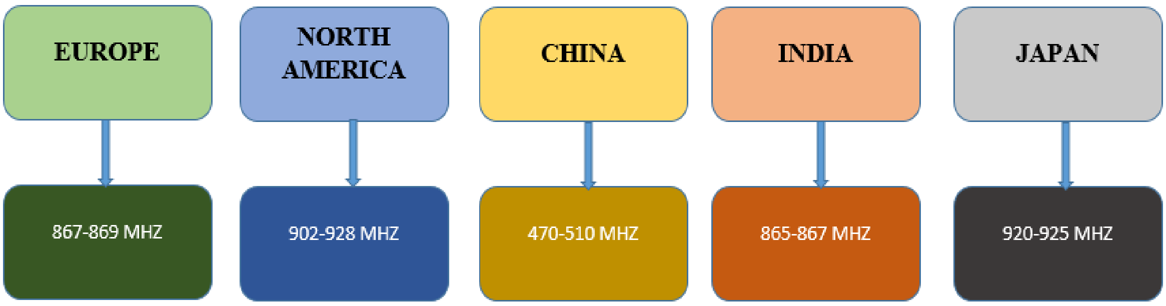


Figure 1: LoRaWAN Frequency Range (approximately) for various countries

LoRaWAN Frequency range for various countries is given in the Figure 1. The Internet of Things (IoT) for agriculture is a quickly developing technology that allows for the monitoring and management of agricultural factors to produce food that is both of high quality and quantity [3]. A number of essential enabling technologies for sustainable agriculture are included in Agriculture 4.0, the agricultural technology of the future. Conventional agricultural practices, such as cultivation, farming, watering, as well are transformed into efficient farming through the application of cutting- edge technology like the Internet of Things [4].

Exploring the impact of changing the PHY layer variables of the LoRa protocol—spreading aspect, connectivity, and encoding rate which have a direct relationship to the packet's duration on air on communications dependability and maximum reach is part of the study on the limitations of LoRaWAN. The selection of the spreading factor may have a greater impact on transmission range than protocol capacity setting, according to certain studies. We come to the conclusion as the matter is still up for dispute, even though it is well known that other variables like the weather, humidity, and antennas location have an impact on the effectiveness of communication. One of the main components of agricultural production is irrigation. It has long been an essential component of farming. It uses approximately eighty-five percent of the water supplies that are available. International water supplies have been significantly impacted over the past few decades by warming temperatures and excessive use of resources. Among the primary factors that the agricultural community has to take in consideration when planning water management in irrigation practices are the scarcity of clean water, the decline in the condition of the water, and the pH level of the water it receives. Effective irrigation is an agricultural technique that applies water management to crops while seeking to use less water overall. Internet of Things (IoT) and wireless networking technologies.

Many modern innovations cannot be used effectively in rural locations since of the absence of wireless connectivity. A number of new ideas for wirelessly extended-range communications that have been created with Long Range Wide Area Network (LoRaWAN). They make it possible for a revolutionary technological solution to interact in remote locations where there is no existing mobile network coverage. The assessment of LoRaWAN for usage in outdoors as well as inside applications for agricultural enterprises is the major advantage of this Agri-IOT.

The results that have been presented are the first step towards accurate response to physical changes through area-wide real-time monitoring of crucial agriculture data in rural regions [5]. The study works on security and confidentiality issues in intelligent farming are discussed. When WSNs were originally implemented in the agricultural sector, the majority of networks relied on limited range methods of communication. We introduce Wi-Fi-based WSNs for monitoring ecological variables in agricultural fields. ZigBee-based management systems are suggested to track conditions across several farms. Yet, the necessity for a significant amount of terminals to span the wide-scale region and the substantial expenditure of energy make the deployment of WSN utilizing these methods in expansive agricultural areas expensive systems [6].

Innovative innovations are constantly transforming agriculture to increase efficiency as well as revenue. The agriculture has changed, from conventional farming to Agriculture 4.0, which use technology based on data to enhance farming processes. The possibility of Agriculture 5.0 is then looked at, which intends to use even more advanced technology to raise the efficiency, long-term viability and competitiveness of the agricultural sector. The applications of IOT in smart/intelligent/digital agriculture is shown in the Figure 2.The most widely used IoT applications for agricultural technology include intelligent irrigation management, which optimizes the use of water in agriculture through tracking the state of the soil and effectively managing sprinklers. Large-scale and small-scale agricultural human and autonomous vehicles surveillance and control, as well as testing of soil for diseases and pests. In Agricultural animals and livestock their well-being: this includes tracking movements to identify and stop ailments like lameness, tracking dietary preferences, and monitoring beehives. Measuring ecological variables in greenhouses and urban gardening to preserve ideal conditions for growth all year long [7].

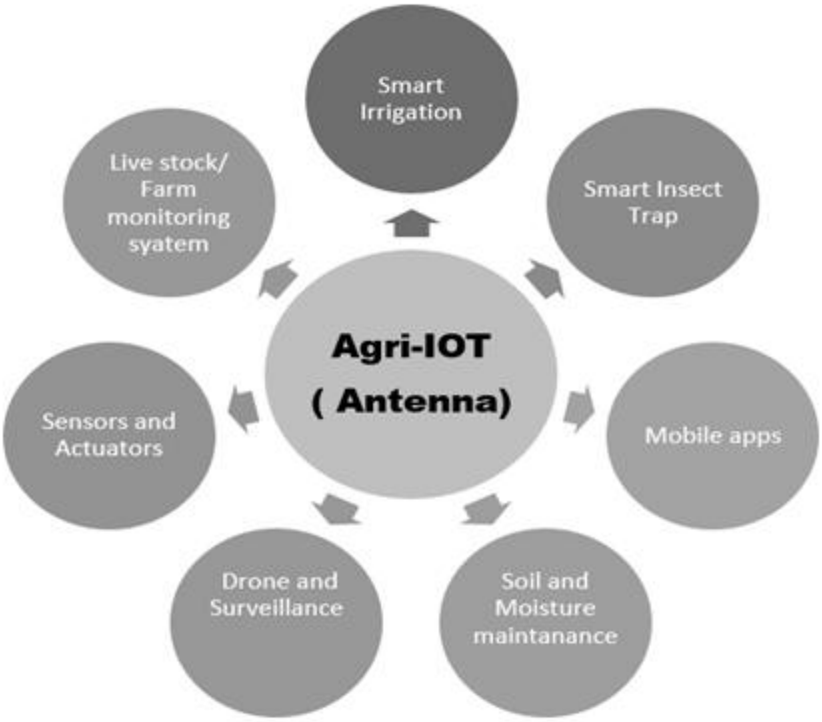


Figure 2: Agricultural IOT applications

In the area of intelligent farming, sophisticated management techniques are offering workable answers. In addition, even though certain farmers have years of experience in farming, technologies might provide an organized system for identifying unforeseen issues that are hard to identify via infrequent vision examination [12]. Younger farmers, who can combine their modest practical knowledge with fresh inputs for analytical approaches, are therefore more optimistic about employing contemporary technological advances in farming than older farmers [13]. Basically, the above said are the research's main fundamental contributions: First, we describe the study area known as "Agriculture 5.0," that is an advancement above the accuracy of farming practiced now. We indicate that fresh research possibilities may develop that could significantly broaden the study field through integrating and accepting present agricultural precision ideas and integrating them with new developments like period detecting, automation, developed mobile phone service, and artificial intelligence (AI) [11].This section is followed by designing antenna suitable for IOT and their result discussions.

II. DESIGN OF BICONE STRIP ANTENNA WITHOUT HAT

Initially developed 10 element bicone strip antenna without hat design produces an isotropic radiation pattern with moderate gain. The proposed antenna has a strip width of 6.75mm and a cone height of 30mm. To achieve high gain and directivity, the radius from wide to narrow was designed to be less than 0.127mm. The number of antenna elements is gradually raised to 15, and ultimately 20. It works best with 16 elements. The Bicone strip was selected because of mainly its prominent features like light weight, less space requirement (since it is strip instead of complete antenna). The reflection coefficient obtained for various elements are mentioned in the upcoming sections.

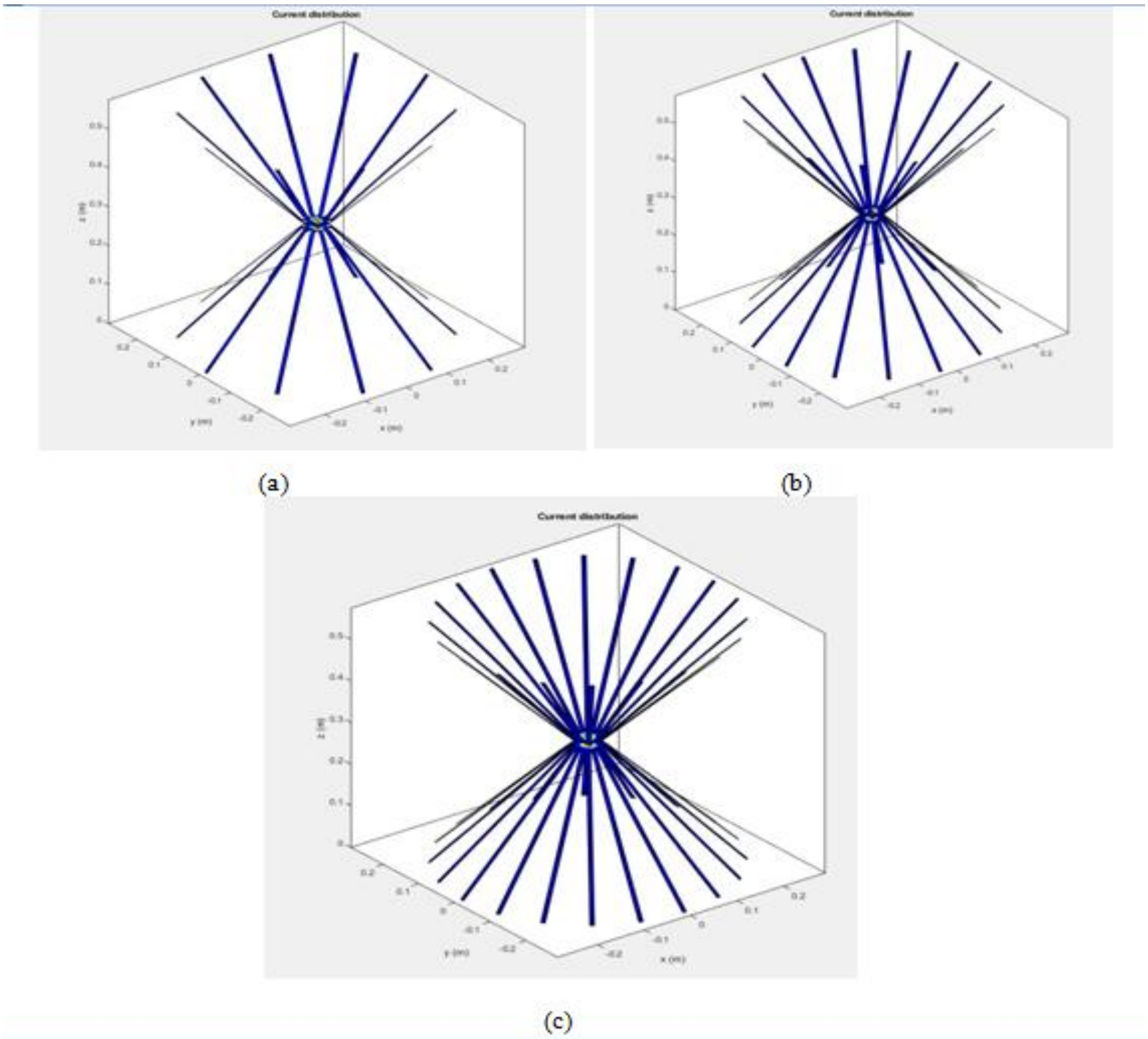


Figure 3: The current distribution pattern for (a) 10 element (b) 15 element (c) 20 element Bicone strip antenna without Hat.

The Figure 3 shows the schematic of antenna with current distribution. When we employ with 10 element since the spacing was sufficient the radiation was moderate. The reflection coefficient for 10 element Bicone strip is observed as -18 dB which is not sufficient for LoRaWAN long distance observation and maintenance. When we try to increase the element gradually from 10 element to 20 the reflection coefficient was maximum at 16 element Bicone strip. The reflection coefficient is maximum for 16 element Bicone strip antenna at 865 MHZ. The comparison for various number of Bicone strip elements is shown in the figure 4 and table 1.

Table 1: Reflection Coefficient for 10 Elements to 20 Element Bicone Strip Antenna at 865 MHz

S.No	Number of strips in Bicone	Reflection coefficient (dB)
1.	10	-15
2.	11	-12
3.	12	-13
4.	13	-15
5.	14	-12
6.	15	-10
7.	16	-18
8.	17	-5
9.	18	-4
10.	19	-3
11.	20	-6

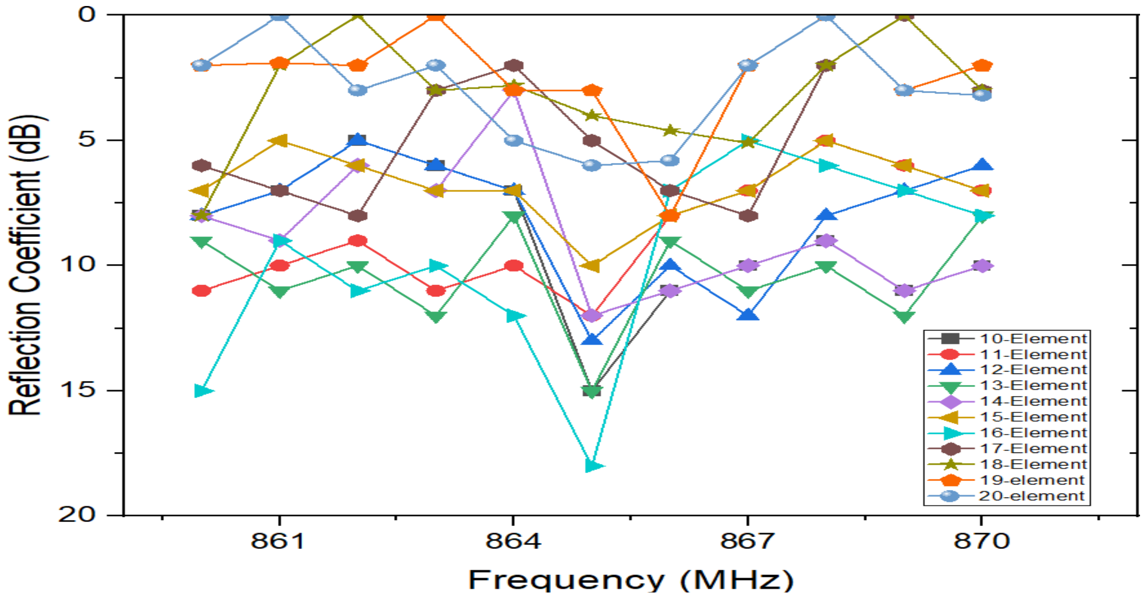
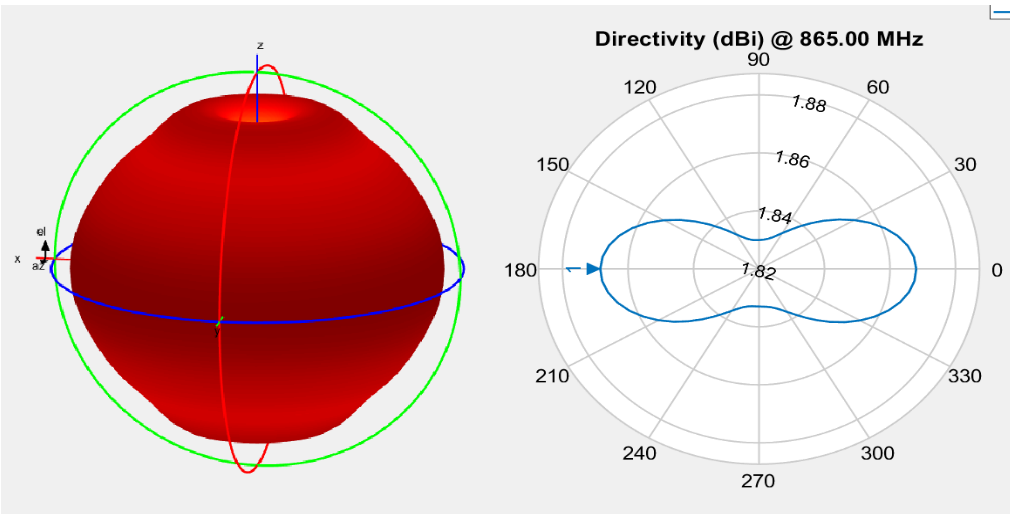


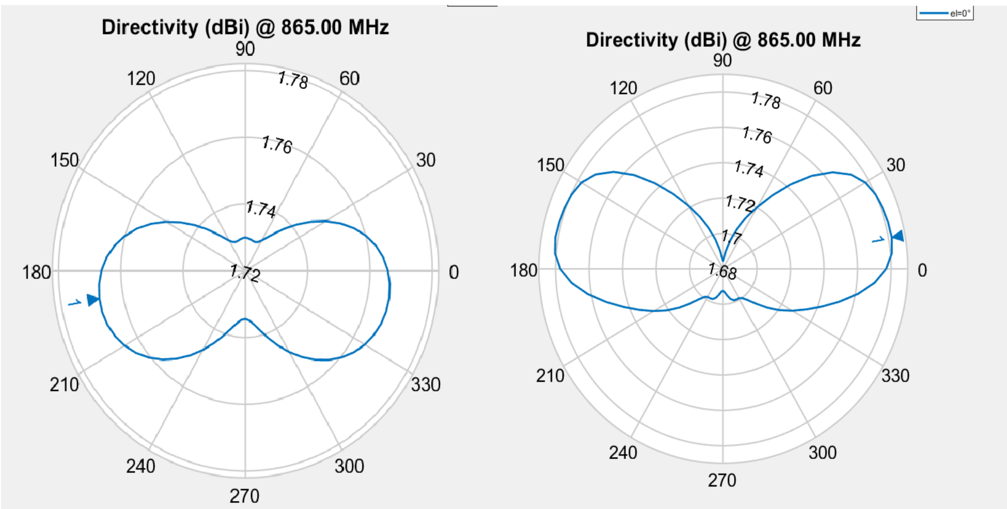
Figure 4: Reflection coefficient for various elements of Bicone strip antenna at 865MHz

The Figure 4 clearly shows the different element from 10 elements to 20 elements and their performance with respect to reflection coefficient. The maximum reflection occurs as -18dB at 865MHz and it gradually decreases when we increase the elements further. The range of tags equipped with RFID is governed by frequencies. The frequency at which this occurs controls interfering tolerance along with other attributes of performance [8]. The computer programme chooses the tag that is RFID to use as well as the frequencies. These two organizations are not entirely compatible because they are still in the early phases of growth [9]. To disregard the use of multiple radio frequency technologies, the majority of global communities are needed to adhere to ITU regulations [10].

For long distance IOT enabled agricultural, RFID, Surveillance and monitoring system this reflection coefficient and gain is not sufficient. Hence a modified shape of the existing antenna is made with a simple Hat closing at both the end. This will not only increase the performance but also reduces the shape, improves the directional properties of the antenna for high frequency applications. The directivity obtained for the current 16 element antenna is isotropic and non-directional pattern which is not suitable for all applications. Hence a Hat of size 5mm is made with the present design and the results are examined [11]. The Figure 5 shows the radiation pattern and Azimuth angle for 10, 16, and 20 – element bicone strip antenna without hat. The maximum reflection coefficient achieved is -14.6 dB at 865MHz and directivity of 4dB. Since to improve the antenna performance the proposed design is alter in the next section.



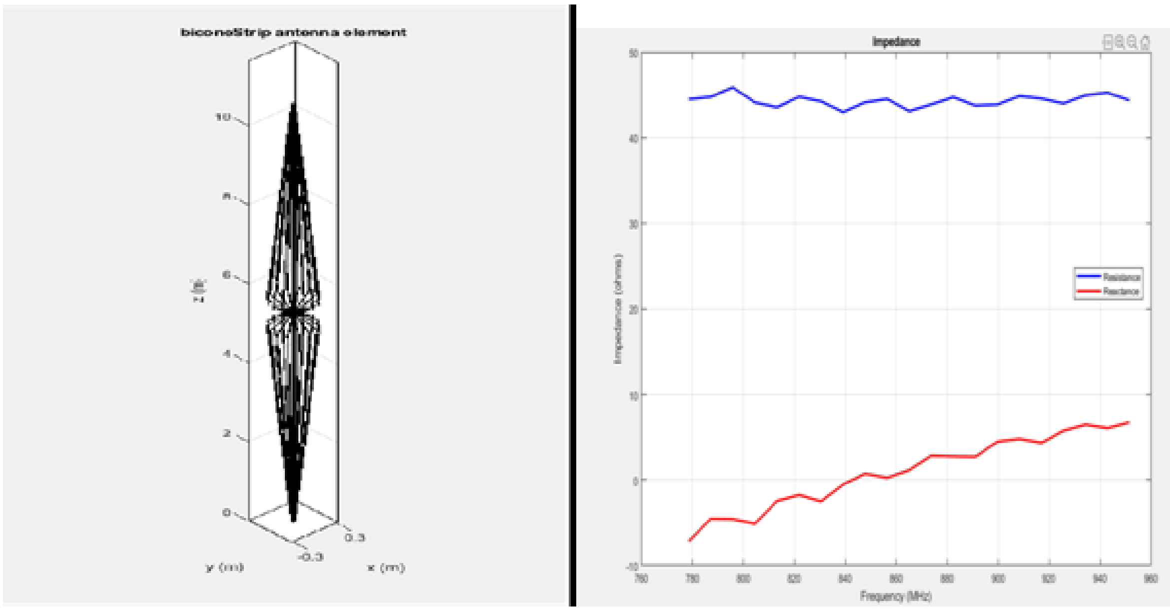
(a) (b)



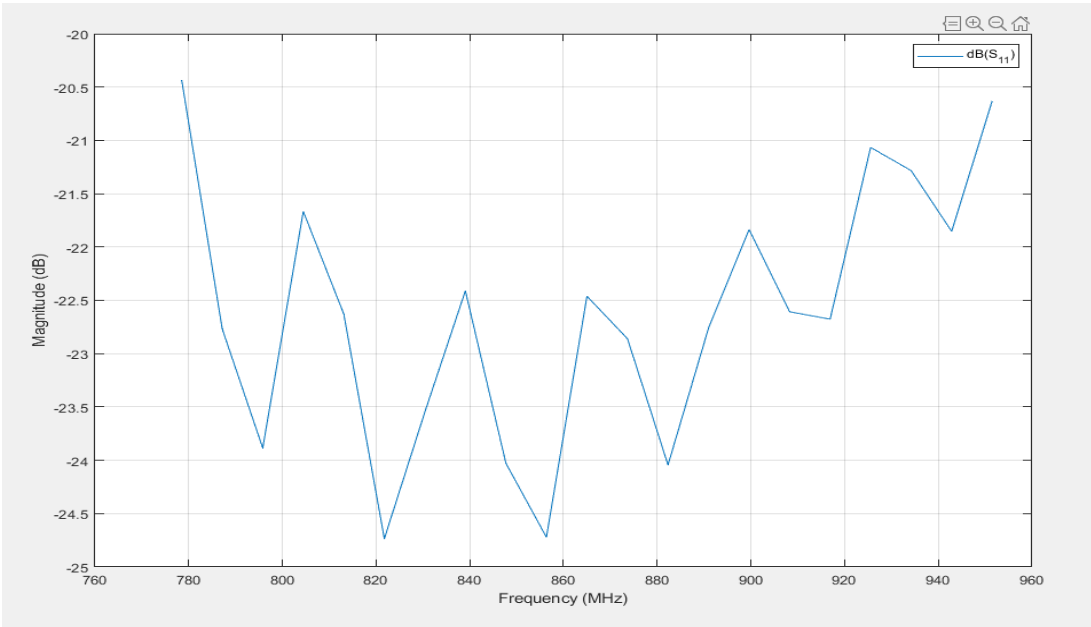
(c) (d)

Figure 5: (a) Radiation pattern of 16- element bicone strip antenna without Hat (b) Azimuth radiation pattern for 10 -element (c) Azimuth radiation pattern for 16- element (d) Azimuth radiation pattern for 20 – element

III. DESIGN OF BICONE STRIP ANTENNA WITH HAT



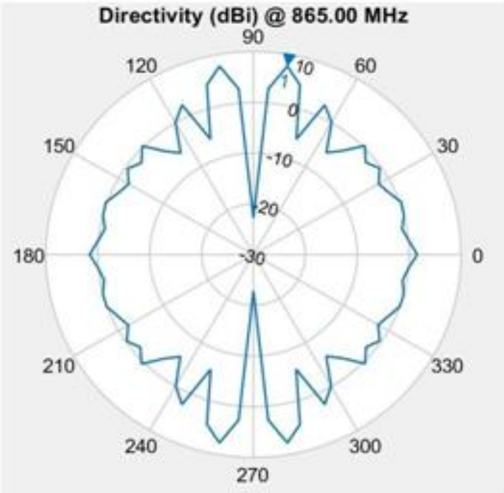
(a) (b)

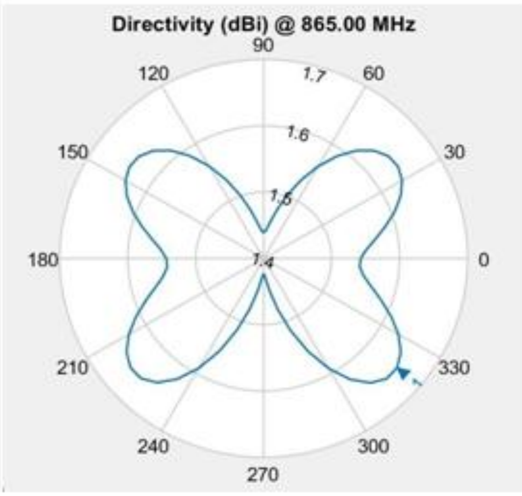


(c)

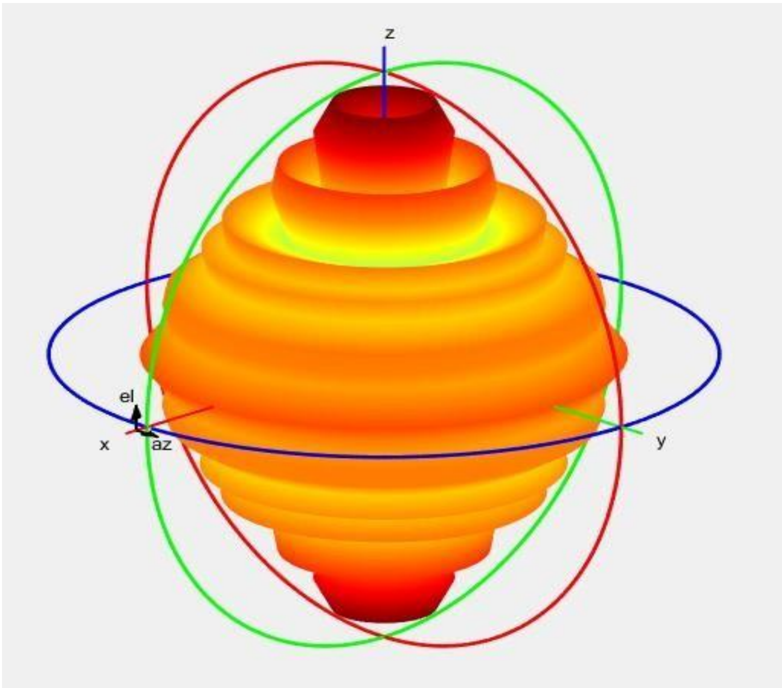
Figure 6: (a) Design of 16 - element Bicone strip antenna with Hat (b) Impedance vs. Frequency graph (c) Reflection coefficient for the proposed antenna

The Bicone antenna is closed at both the ends with a Hat height of 5.675mm to improve the antenna parameters. The Figure 6 (a) shows the antenna design of 16-element strip bicone with top hat while (b) shows the impedance graph. The figure 6 (c) shows the reflection coefficient of the proposed system.





(a) (b)



(c)

Figure 7: (a) Azimuth angle for 16-element Bicone strip antenna with Hat (b) Elevation angle for 16-element Bicone strip antenna with Hat (c) Radiation pattern for 16-element Bicone strip antenna with Hat

The directional pattern of the Hat covered Bicone strip antenna is differing from the uncovered antenna and the covered antenna is highly directional. The elevation angle is butterfly shaped for Hat applied antenna and it is ground nut for uncovered antenna. The advantage of the Sharp antenna in Figure 6 (a) is it covers multiple frequency band such as 795 MHz, 822 MHz, 855 MHz, 882 MHz, 918 MHz, 942 MHz at -23.9dB, -24.75dB, -24.74dB, -24.2dB, -22.7, -21.7 respectively.

IV. CONCLUSION

By using an innovative design, the novel antenna proposed in this study can raise the performance level of IoT applications. Using simulations and performance optimization, the antenna was created for real-world use in IoT applications for agriculture that operate between 780 and 945 MHz. A novel Bicone strip antenna was developed for IOT agricultural applications with iron as conducting substance.

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