Design of Zipper Antenna for Women Safety

Jasmine Vijithra A , Deepeka B, Sri Vaishnavi E, Srivani K, Gattu Bindhu

ABSTRACT: The suggested system utilizes an inverted F metal zipper to act as an antenna. Here we have proposed an antenna which is designed using HFSS software in order to assure safety of women. The antenna design is carried out in three layers namely Ground plane, substrate and patch. Copper is used as ground and patch and substrate is made of FR4 material. The feeding point is identified at the bottom of the zipper, nearby one of the teeth. Simulations and measurements are made with HFSS. Changes in the radiations styles and the reflections coefficients happens when there is any disturbance in the teeth. The zipper constantly remains closed. The antenna will function even if the zipper is partially opened or closed. The suggested model remains as reconfigurable, particularly for radiation styles and also possess high gain value. The measured values give proper results based on simulations in terms of matching functionalities and radiation properties for the designed zipper, which acts as a good wireless product for women safety. This antenna design can be used in various applications when it is interfaced with some embedded system devices like GPS in order to find the location of the affected person and the material onto which it is going to be placed can also be made flexible that is, it can be used as Zip in dress material, hand bag, or can also be worn as an ornament.

Keywords - Zipper antenna, ground plane, FR4, reconfigurable.

I. INTRODUCTION

The word SMART in wireless communication signifies “World in Finger Tips” which can be referred to as IOT. The attracting ability of this technology connects human world to the technological world via virtualization. The Internet of Things (IoT) has a tendency to develop both technical and other areas of management industry. So, we can further investigate its uses since it is very fascinating [1]. Now-a-days, a variety of instructional progresses together with some exciting products are presented [2], [3]. The interconnection of antenna with IOT provides a wide variety of applications in the field of wireless communication, telemedicine, and satellite communication, remote sensing, RADAR etc., As an advancement, the antenna nowadays is used as a safety tool by coordinating wireless communication and wireless biomedical sensors. By using these sensors, a communication link is established in the human body using any one among the three formats such as a link along the surface or a link via the vicinity of the periphery or an interior connection establishment. The existing WBAN system trusts WLAN and Bluetooth at a frequency of 2.4GHz. The MICS (Medical Implant Communication System) is a short range, low power, high-data-rate network for communication [8]. In contrast the antennas with UWB applications with operating frequencies in the range up to 10.6GHz provides better results when merged with WBAN. The indirect contact (aperture coupling and proximity coupling) and direct contact (microstrip line feed and coaxial probe) are the two different types of feeding methods. Single component fix reception apparatuses have a few confinements, for example, restricted data transmission, low addition and low proficiency. Nonetheless, numerous applications in remote correspondence needs wide band and so high addition of it cannot be accomplished using a solitary component receiving wire, thus these hindrances might be overwhelmed by utilizing patch array antennas. The headway in remote correspondence frameworks incited to make smaller and little size gadgets. Be that as it may, the reception apparatus will in general be enormous in size when contrasted with different parts. So, fix reception apparatus have been created to diminish the size of the radio wire (antenna). The fix reception apparatus (antenna) has numerous focal points like little size, ease, simplicity of establishment, low profile, light weight, mechanical power and adaptability when made on tough surfaces it had high similarity with microwave solid coordinated circuit structure and so forth. This sort of receiving wire generally utilized in remote correspondence applications, for example, telemetry and interchanges, avionics, maritime correspondences, modified heading of canny weaponry, satellite, radar, GPS frameworks, biomedical. The application utilizes metal zipper as an antenna since it is a decent product to be used. Here, in second section of this article we shall discuss about configuration and structural design of the metal antenna (zipper antenna). Then, in third part we shall discuss about the parameters and simulations of the antenna along with its performance. At last, the effect of measurement of the designed antenna is provided in the fourth paragraph. This article is arranged as given below. Section II explains the related work which is already performed, Section III describes the configuration and structure.

Revised Manuscript Received on June 30, 2020.

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II. RELATED WORK

In this design we have selected a fixed set of format parameters that will provide better results at higher fields and an upward push instances than what is provided by using the H3. In order to have minimum dispersion, we make use of coaxial zipper with small diameter. The 2.4 GHz ISM band is ideal for performing this design since it supports low-power communications (like ZigBee). This band is widely used in many industries since it offers a trade-off among many key factors and power consumption.

The distance of the antenna from the head affects its efficiency a lot, since the body tissues possess high losses nearly 2.4 GHz because of the presence of more water content. It is necessary to make a note that important antenna design parameters like VSWR should have a minimum value below 2. National and international organizations give us some suggestions which includes some facts like 1 g of tissue in human body should have a SAR value less than 0.08W/kg and it must not be greater than 1.6W/kg. In Europe, 2 W/kg is the utmost SAR value acceptable for 10 g of tissue.

III. STRUCTURAL DESIGN

Generally, the designed metal zipper runs through a duration (length of zip) of about 20 to 50 cm and contains 50 to 150 teeth on both the sides. Since the zipper antenna has many small parts, the model of it has to be made with care.

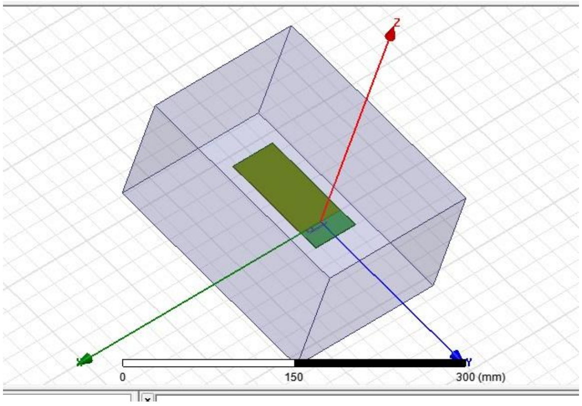
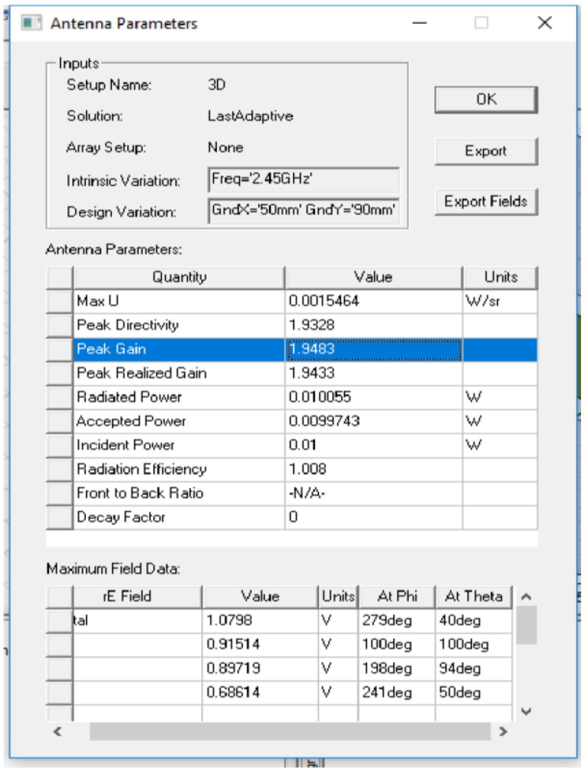


Figure 1 Antenna Structure



Antenna Parameters

Inputs

Setup Name:	3D
Solution:	LastAdaptive
Array Setup:	None
Intrinsic Variation:	Freq='2.45GHz'
Design Variation:	GndX='50mm' GndY='90mm'

OK | Export | Export Fields

Antenna Parameters:

Quantity	Value	Units
Max U	0.0015464	W/sr
Peak Directivity	1.9328	
Peak Gain	1.9483	
Peak Realized Gain	1.9433	
Radiated Power	0.010055	W
Accepted Power	0.0099743	W
Incident Power	0.01	W
Radiation Efficiency	1.008	
Front to Back Ratio	-N/A-	
Decay Factor	0	

Maximum Field Data:

rE Field	Value	Units	At Phi	At Theta
tal	1.0798	V	279deg	40deg
	0.91514	V	100deg	100deg
	0.89719	V	198deg	94deg
	0.68614	V	241deg	50deg

Figure 2 Antenna parameters

We have utilized an IFA (inverted F antenna). This variety of antenna is predominantly used for wireless communication. It has a monopole antenna which is grounded at one end. This antenna runs parallelly along a ground plane and it is fed at a particular point which is located at some distance away from the end which is grounded. We have made use of FR4 (epoxy) as substrate. The dimension of the substrate is as follows- l=110mm, b=50mm, thickness=0.8 mm. The ground and antenna are made by using Copper. The dimension of ground is as follows - l=90mm, b=50mm. The algorithm for creating a zipper antenna design is given below.

STEP 1: Create a new project file.

STEP 2: Create the xyz axis by clicking "insert HFSS design" option.

STEP 3: Place the ground plane by clicking "draw rectangle" option according to our design dimensions l=90mm, b=50mm.

STEP 4: Place the substrate above the ground such that it extends beyond the Ground. The dimension of substrate is as follows - l=110mm, b=50mm, thickness=0.8mm.

STEP 5: Finally place the inverted F type antenna above the substrate and also provide appropriate feeding point.

STEP 6: The feeding point is provided from the antenna to the ground via Substrate.

STEP 7: Click "validate check" from HFSS option then if no error appears click option "analyze all" and wait till the project runs completely.

STEP 8: Now click on results in order to generate the required graphs.

IV. RESULTS

From the performance, we infer that simulations are done with the help of HFSS. Related assessment on the bang of numerous variables can be furnished.

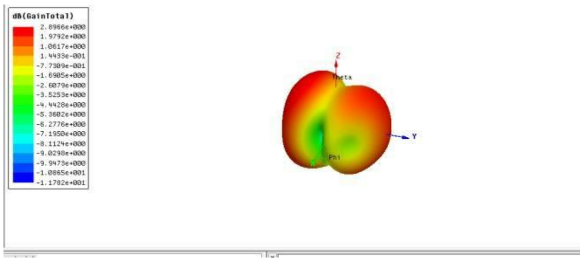


Figure 3 3D polar plot

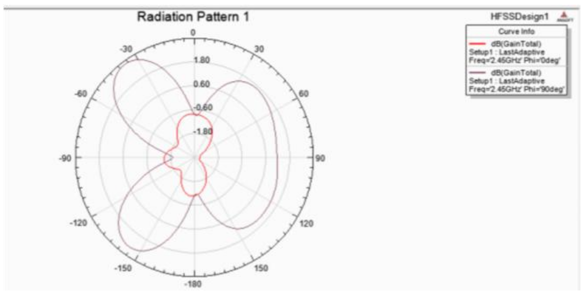


Figure 4 Radiation Pattern

In Figure 3, it denotes that we obtain a gain of 1.94 dB when it is operated with frequency of 2.45 GHz. When it is operated with frequency of 1.575 GHz, we obtain a gain of about 1.47 dB.

As pointed in Figure 4, the numerous connections along the teeth and the probe of zipper provides minor variations in reflection coefficients. With the help of loose links or tight links from the lowest and side of the enamel the connections between the two contact points are made. From the curves in the three scenarios the frequency range for the operation is determined. Unfastened contact from the facet has operating frequency of 2 GHz with S value less than -10 dB.

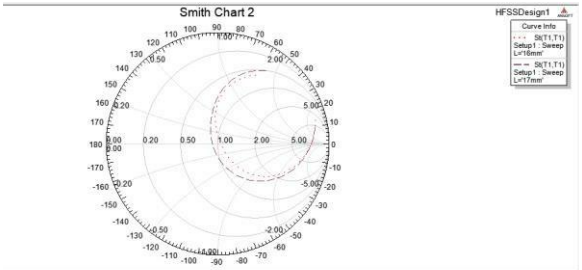


Figure 5 Smith Chart

Certainly, the precise probe interrelates might impact the antenna losses as demonstrated. From figure 8, the feeding point locations are computed that is 2.75 ,3.75 and 1.75 mm, and another value of 1.75 mm along right side of feeding area and left correspondingly. The antenna output is calculated when binding component moves towards outer side from the center. The S parameters are (0.035, -28.9), Y parameters are (0.018, 1.95) and Z parameters are (53.174, -1.95). The three-dimensional pattern of the antenna directivity in both the landscape and portrait orientations of the similar and different models at 2.45GHz is visible in the Fig. 4. It is clearly understood that the lowest radiation efficiency at 2.91GHz frequency is 97.2% and the overall best efficiency is obtained at 2.92GHz frequency as 97.5%. The radiation efficiency is given by the formula as gain divided by directivity or in other words it is given by the ratio of radiated energy to the accepted energy as a source by the antenna input.

$$\text{Efficiency} = \frac{\text{Power radiated by antenna}}{\text{Power restored by antenna}}$$

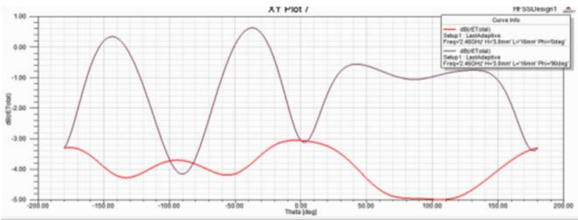


Figure 6 S-Parameter

When the area of feeding is flown along the X direction path, a variation in the radiation pattern is observed. In fig. 7, the two- dimensional radiation styles of the antenna at 2.45 GHz are placed at x= 34.6mm, x = 93mm and x = 193 mm correspondingly. The plot implies the enormity values of the electrical properties of antenna. Furthermore, for the next radiation styles, the configurations are far identical. The reduced curve has theta changing from zero to 360°then it changes to 90° and phi is initially zero then it changes from zero to 360°. Reduced curve is found to be equilibrium in xoz plane in line with edifice and shows prominent directivity in alternate curve also.

Figure 4 gives the 3-D broadcast of the main setup of the overhead mentioned, where the essential projection (primary node) may be noticeable in the higher path.

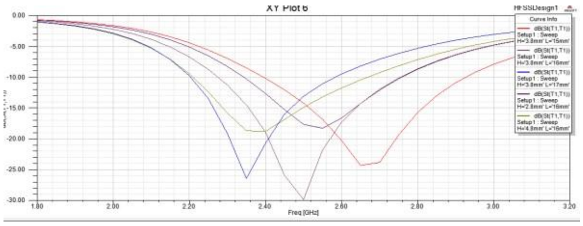


Figure 7 XY plot

The electric field dispersion is taken care of port 1 is demonstrated in Figure 7, counting completely the qualities and the general voltaic subject. For genuine uses, the zipper might be unlatched to a couple of degree. The radiation designs incorporate bends underneath the circumstances wherein the zipper is shut, periodically unlatched or partially unlatched, the frequentness of which is 2.4, 2.34 and 2.46 GHz, separately. By relatively doing few adjustments inside the xoz plane, and broadcast course inside the yox plane could extend because of the formation adaptations while zipper is unlocked, and this can be viewed at the bends.

By the length of zipper veneer, we can examine the frameworks by taking clash into the account. They give the radiation designs according to the teeth duration from 3 mm to 6 mm, whose frequency is 2.29, 2.44, and 2.53 GHz, respectively. The benefit of antenna improves barely by the help of teeth extensions because of the increase of electrifying dimensions. An example for a comparative amplitude is 5.79 dB, 4.74 dB and 4.72 dB similar to the three extensions at 72, 74, and 82 might be viewed.

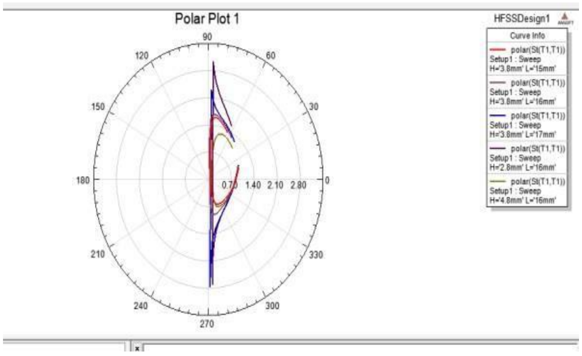


Figure 8 Polar plot

The mirrored image coefficients range with the teeth period because of the changes of the shape dimensions. It is visible that the resonance frequency gets shifted to elevated dots despite of the tooth duration changing from 4.4 to 3.1 or to 6.1 mm. The voltage standing wave ratio is affected by the width of the teeth in the zipper antenna. All the three configurations reap resonance factors within the band of 2.1-2.7 GHz. The modifications of resonance frequency from 2.17 - 2.45 GHz to 2.18 - 2.49 GHz when the variation in the width ranges from 1.1 to 1.6 mm. Thus, there is a decrement in frequency of about 2.16 - 2.41 GHz due to decrement in the width of the teeth by a factor of 0.6 mm.

There are not many differences took place consistent with the change in the width of the teeth from 0.6 to 1.1 and 1.6 mm (agreement with 2.32, 2.29, and 2.5 GHz), because of this parameter weighs little inside the performance of the antenna. This indicates an application scenario of the zipper antenna. The effects of simulation at 2.43 GHz suggest that the distinction is predictable however no longer very high. A break of no longer extra of 1 dB in the essential lobe might be discovered.

V. CONCLUSION

The simulation output and the values measured proves the effectiveness of the zipper antenna which is designed. Gain which is nearly 1.98 dB that is approximately equal to 2 dB is achieved at 2.5 GHz. The main advantages of the discussed method are: wider miniaturization and better operating frequency bandwidth, simple and easy to design. When certain frequency bands or values are expected, extra impedance transforming structure can be modelled. It is bigger in size when compared with the other varieties of body-centric network and wearable antennas that shows the advantage of high gains and the radiation patterns. No additional area for installation is required to mount over or to approach the body or can be attached to any material. The designed antenna can be operated at various frequency ranges by just adjusting feed position. Also, numerous radiation pattern pointing towards various directions can be obtained by pulling the zipper knob either by closing or opening it. Thus, we have simulated our antenna design with the parameters and dimensions as mentioned in the above passages and obtained good results. In the future scope of our design, we are going to trace the location of the person who is having this type of antenna using GPS and embedded system devices. This can be exclusively achieved by interfacing the antenna wirelessly with embedded modules.

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