Performance Improvement of Circular Micro-Strip Patch Antenna for WCS

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Abstract: - The proposed a circular micro-strip antenna (CMSA) with a circular slot in this paper, that solves the current narrow bandwidth dilemma. The parametric analysis reveals that only with the right choice of parameters would wideband features be achieved with a smaller antenna. The proposed antenna is built at 27.5GHz with wider bandwidth and tremendous return failure. This antenna can also be used extensively for embedded applications with a large data rate. This antenna can be physically implemented with embedded devices that enable it to function in a broader variety of applications.

Keywords: - WCS, CMPSA, Reflection Coefficient, Gain and Radiation Pattern

1. Introduction

GPS (global positioning system) receivers are now commonly used predominantly for Wireless Communication System (WCS) such as automobiles, aircraft, ships, and cellular communication through satellite navigation. Patch and quad helix are the two most common antenna styles used in GPS receivers. Thanks to their light weight, ease of mounting, single hemispheric radiation pattern and low profile, micro-strip patch antennas are ideal for a GPS receiver antenna. This is focuses on the design and produce of a new form of circular micro-strip patch antenna (CMPSA) inset feed. Enhanced patch antenna characteristics can be accomplished by adding a circular slot at the middle of the ground plane. Focus has been put on optimizing the 1.8GHz antenna configuration by using CST-Microwave Studio simulation tools. It is observed from simulation and calculated outcomes that the proposed patch antenna displays better efficiency relative to a typical CMSPA [1]-[5].

One of the easiest ways to produce is the micro-strip line feed, since it is a conducting strip connected to the patch which may thus be viewed as a patch expansion. By manipulating the inset location, it is easy to model and quick to fit. Because the current at the end of a half-wave patch is low and rises in amplitude towards the middle, if the patch was fed closer to the centre, the input impedance (Z=V/I) could be minimized. Connection today plays an important position in global culture and the communication infrastructure is transitioning quickly from wired to wireless. Telecommunication is still seeking, at the lowest possible expense, to produce the highest results, reliability and productivity. In this domain, antennas constitute a fundamental element which enables electromagnetic waves to be transmitted in free space. We see many kinds of antennas that vary by cuts, geometric form, and transmitting power. A micro-strip patch antenna is a type of antenna that provides a low profile, i.e. small and simple to produce, which gives conventional antennas a great
advantage. In wireless connections and other microwave uses, patch antennas are flat antennas used [6]-[10]. The micro-strip approach is a planar technique used for generating lines that transmit signals and combining those lines and radiated waves with antennas. Usually, a patch is larger than a strip and its form and dimension are significant antenna characteristics. When use MSPA, micro-strip antennas are especially ideal for large losses and surface waves in the substrate layer, since losses can often arise in the radiation when the signals are emitted by the antenna. Because of their advantages such as light weight, low volume, low expense, compatible with integrated circuits and simple to mount on the rigid surface. MSPAs are perhaps the most frequently used type of antennas today. In addition, they can conveniently be built to function in quad-band, multi-band, dual or circular polarization applications. In several commercial applications, they are important. But for realistic purposes, MSPAs have inherently narrow bandwidth and bandwidth expansion is typically needed, so several techniques have been used to expand the bandwidth. Using the dielectric constant of substrate FR4 glass epoxy 4.4 with 50 micron copper thickness, FR4 epoxy for MSA at various frequencies such as 2GHz, 4GHz, 6GHz, 8GHz and 10GHz are design in the proposed CMSPA. Because of its low cost and easy availability, FR4 was selected for this analysis and can therefore be used for MSA array prototyping [11]-[13]. Wireless connectivity has been part of daily life in the last few years, together with its different ways. It was this focus on wireless technology that made it possible to find small-sized and lightweight antennas. Both these ones, all of this usage of microstrip antennas fulfils the demands in contact networks, microstrip antennas are used to due to systemic simplicity, low processing costs, modest development costs, small size and simplicity of installation. The circular microstrip antenna consists of a separated by a sandwich of two parallel conducting layers with single thin substratum dielectric. It is a plain ground plane and the upper conductor Patch circular. Due to the patch antenna, it is really common day after day. its simplicity of research and production, low expense, and light weight. Microstrip patch antennas have been commonly used lately satellite communications, aerospace, radar and biomedical communications [14]-[16].

2. Modelling of Circular Patch Antenna
There are various approaches to build and evaluate a MSPA, such as hollow prototypes for transmission line patterns. Since its start, wireless and smart phone interaction has come a long way. Miniature sized antennas such as the MSA are therefore necessary for efficient communication. In this article, an appropriate circular MSA with a broad band is suggested. In this build of a circular patch is placed on the FR4 substrate material with εr=4.4. To have broadband operation, a circular slot is engraved on the circular patch. The antenna was designed for 27.5GHz operation and the findings showed a broader 800MHz bandwidth and a low -24.8dB return loss and an antenna gain of 8dBi. The radiating patch is positioned around the axis of symmetry with an inset feed line spanning the middle of the patch. Through removing one spherical slot, the winding of the patch is modified and a pair of rectangular slots is merged to minimize the impedance mismatching losses for wireless contact device implementations, one of which is imprinted onto the patch's non-radiating core and two are combined.

\[ Wg = 6h+W \]  
\[ Lg = 6h+L \]  

The symmetrical design of the pair of slots is attributed to the fact that it eliminates cross polarization. The slits promote the present streak and decrease the activity of the frequency. The values of each of the variables used in the design model are given in the following Table 1. The antenna design consist substrate of a single layer of thickness 1.6mm. The dielectric constant of the substrate is 4.4 and antenna is designed on FR4 as shown in Figure 1.

\[ Wg = 6h+W \]  
\[ Lg = 6h+L \]
Table 1: Antenna Design Parameters

| Sl. No. | Parameter                  | Values         |
|---------|----------------------------|----------------|
| 1       | Operating Frequency        | 27.5GHz        |
| 2       | Radius of Circular Patch   | 8.96mm         |
| 3       | Substrate Dielectric Material | FR4 epoxy   |
| 4       | Substrate Dielectric Constant | $\varepsilon_r = 4.4$ |
| 5       | Substrate Thickness        | 1mm            |
| 6       | Feeding Technique          | Line feed      |
| 7       | Ground Plane               | 30mm*30mm      |

Figure 1. Proposed Structure of the Circular Patch Antenna

3. Results and Discussion
The FR4 dielectric substrate material with a relative permittivity ($\varepsilon_r$) of 4.4, loss tangent ($\delta$) of 0.02 and a thickness or height of 1.6mm is included in the proposed production model. As a mix of traditional forms such as round and rectangular, the concept layout consists of a novel rounded patch. At the middle of the patch, the spherical structure is positioned with rectangular shaped strips around it. Among such rectangular patch strips, one is used as a line feed for cooking. A circular ring-shaped defect found in the partial ground comprises the ground plane. The scale of the antenna is around 30mmx30mm. The reflection coefficient parameter of the simulated effects of the proposed antenna is given in Figure 2. The 800MHz bandwidth is calculated and the estimated reflection coefficient results are recorded at -24.8dB operating frequency at 27.5GHz. There is strong consistency between the simulated and calculated values of the coefficient of reflection.
In the CMSPA with a circular slot, the return loss is in the range of -24.8dB with a 3dB bandwidth of around 800MHz. The bandwidth is obtained with the above-mentioned patch and substratum dimension. The bandwidth obtained demonstrates that for embedded applications, the built CMSPA has high data rate applicability. The Gain Plot of the built antenna is shown in Figure 3. The benefit along the elevation plane of the proposed model is found to be almost 8dBi at 27.5GHz. HFSS is often used to simulate the gain of the proposed CPA and it is found to be about 8 dBi for the far-field pattern. Automatic GPS monitoring systems have allowed antennas to work in multi-frequency bands in recent years, including GSM, 3G, and modern LTE bands. Thanks to their light weight, ease of installation and less air-drag, several researchers emphasize it because MSPAs are ideal for GPS use.

A circular slot in the ground plane would be added to boost the characteristics of the circular patch antenna. The new distribution of the circular patch antenna's E-Field and H-Field is seen in Figure 4 and Figure 5. At 27.5GHz, this suggested CMSA only has one resonant frequency. Bandwidth, gain, beam width and the magnitude of reflection coefficient have increased with the implementation of the slot in the ground plane. There is a discussion of the calculated and assessed parameters of the proposed model. The features of the proposed model are simulated using high frequency structural simulator, such as reflection coefficient, gain, bandwidth, radiation trends, performance and current distribution.
4. Conclusion
Modelling and simulation of a Circular Micro-Strip Patch Antenna in the field of WSN is present in this article. The expressions of fields inside the cavity, far fields and resonant frequencies are thus obtained using the cavity model for the study of circular form of MSA. Using dielectric substrates with dielectric constant $\varepsilon_r = 4.4$ and thickness $h = 1.6\text{mm}$, a probe fed circular MSA is built at 27.5GHz. The radius of circular patch $a = 8.96\text{mm}$ at these parameters. The simulated effects of CMSPA indicate strong coefficient of reflection and value of gain. For the circular patch antenna, the reflection coefficient and gain are $-24.8\text{dB}$ and $8\text{dBi}$, respectively. However, to enhance the applicability of this patch antenna may also boost the antenna characteristics utilizing various technologies.

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