TRI-BAND COMPACT MICROSTRIP ANTENNA WITH MULTI SLOTS FOR GSM/UMTS/WIMAX APPLICATIONS

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Abstract—In this paper, we presented a design and optimization of one compact tri-band microstrip patch antenna for multiband applications. This antenna is proposed to be used for GSM, UMTS and WiMAX wireless communications applications at 1.8 GHz, 2.1 GHz and 3.5 GHz, respectively. The multiband functionality was yielded by using E-shaped slot and cylindrical slot within the square radiating patch. The proposed antenna is basically a square microstrip patch and a partial ground plane fed from (4, 0, 0) point. It has a simple structure with overall size of 44 mm × 44 mm × 1.6 mm. After physical design, extensive simulations were accomplished using 3D full-wave FEM-based EM simulator. The performance of the antenna was analyzed in terms of gain, radiation pattern and s-parameters. The simulated radiation patterns at the desired resonant frequencies were shown nearly Omni-directional.

Index Terms—compact microstrip antenna, multi-band, slotted antenna, triple-band.

I. INTRODUCTION

Recent years mobile communication devices are required to operate in multi-frequency bands. Moreover, due to the preference for smaller devices, it is necessary for an internal antenna to be multiband as well as physically small. There have been various research works on designing the antennas [1-4]. The slot antenna was improved in 1995 by Huynh and Lee as a single-patch, single-layer linearly po-la-rized wideband antenna[5].

Actual studies indicate that the U-shaped slotted patch antenna can be designed both for wideband applications, and for dual-band applications [6, 7]. Single and multi-band antennas were accomplished by either modifying the shape or by in-ter-ting a single or double shorting walls to the antenna. Many researches were studied complex multiple slot loading for obtaining multiple-band. Characteristics of the tri-band U-shaped microstrip patch antenna which is somewhat complex to design has been verified by published results [8].

In this study, we designed a compact slot loaded microstrip antenna and optimized by simulating on 3D full-wave FEM-based EM simulator. The proposed antenna is designed more simple by using single E-shaped slot and cylindrical slot loading, in spite of previous complex designs. The operating bands were tuned by varying the lengths of patches. An extensive parametric study was made to determine the effects of the return loss varying dimensions of the patch E-shaped slot. Additionally, characteristics of an antenna were analyzed, radiation patterns and gain were identified.

II. ANTENNA CONFIGURATION
III. RESULTS AND DISCUSSIONS

Three-dimensional finite element analysis (FEA) models were developed in HFSS for proposed antenna. The parametric study results show a satisfactory convergence with the experimental results as discussed below.

A. Parametric Study

‘L1’ and ‘L2’ parameters, which were examined while designing the antenna, have considerable effect in determining the performance of the antenna significantly. The resonance frequency and bandwidth changes were checked by parametric study and all of parameters were optimized analytically. Variations of return loss with respect to frequency by taking the lengths L1, L2 parameters were seen on Fig. 2.

B. Changing the Lengths of Patch (L1, L2)

L1 and L2 were selected equal for the variations. When they are selected with the length 39 mm, return loss value is decreased. When L1 and L2 are selected as 44 mm, the results are obtained as best values. When the lengths are increased to 49 mm, the return loss is observed as greater than all previous results but the center frequencies are shifted.

IV. OPTIMIZED RESULTS

A. Return Loss

After examining the results of parametric study, proposed antenna design was optimized and improved with Ansoft HFSS software. Bandwidth and the return loss characteristics were optimized in desired bands with the patch lengths (L1 and L2) 44 mm. Optimized dimensions of the antenna, which is able to operate on 2G, 3G and 4G with corresponding resonance frequencies of 1.8 GHz, 2.1 GHz and 3.5 GHz as shown in Fig. 2, given in Table I. The corresponding bandwidth is obtained as 2.8%, 4.6% and 2.2% for 2G, 3G and 4G respectively.

B. Voltage Standing Wave Ratio (VSWR)

Minimum VSWR value, which means better performance, was obtained as given below. VSWR values of the antenna are approximately 0.69 at 1.85 GHz, 1.12 at 2.15 GHz and 2.33 at 3.56 GHz frequencies, which are really promising as seen on Fig. 3.
CONCLUSION

We proposed a compact microstrip patch antenna fed at (4, 0, 0) point with multi-resonance characteristics for triple frequency bands. We created it by etching E shaped and cylindrical slots within a square patch. The antenna was designed with a simple configuration and size of 44 mm \( \times \) 44 mm \( \times \) 1.6 mm\(^3\) and partial ground length of 29 mm. We modeled and designed the antenna on 3D full-wave FEM-based EM simulator.

We analyzed effects of major parameters on the antenna performance and optimized parametric and return loss characteristics. And we obtained nearly Omni-directional radiation pattern and better return loss value. So, proposed antenna is able to operate at 1.8 GHz, 2.1 GHz and 3.5 GHz, which make it promising for GSM, UMTS and WiMAX.

REFERENCES