CHAPTER 7

CONCLUDING REMARKS

The development of various wireless systems has created a high demand for wideband and low profile unidirectional antennas to accommodate several wireless communication systems with good electrical characteristics, such as low cross polarization, low back lobe radiations and stable gain across the operating frequency range. Among many categories of antennas, MPA and dipole antennas are the most favorable antenna due to their attributes like-easy design, ease of fabrication and low cost. However, they do suffer from disadvantages like narrow impedance bandwidth, significant variation in gain and beam width across the entire operating band, asymmetrical radiation pattern in the E-plane and H-plane and high back lobe radiations. To overcome these challenges, the concept of exciting electric dipole and magnetic dipole simultaneously to produce equal E-plane and H-plane radiation patterns was first revealed by Clavin, under the name complementary antenna [52]. Since then, several investigations have been made to demonstrate the same concept [150-154]. In 1974, Clavin proposed a new and simplified structure of complementary antenna, having two parasitic inverted-L wires, placed beside a slot antenna [54]. The two parasitic inverted-L wires acted like an electric dipole, and the rectangular slot acted like a magnetic dipole. Recently, a wideband complementary antenna re-designated as the ME dipole has been proposed [4-6]. The antenna comprises of a vertically oriented quarter wave shorted patch and a planar dipole, which are equivalent to a combination of a magnetic dipole and electric dipole respectively. Good electrical characteristics, such as low back radiation, stable antenna gain cross the frequency band, symmetric E-plane and H-plane radiation patterns are the most salient features of this antenna.

A novel wideband antenna with end-fire radiation pattern was presented in Chapter 2. This new designed antenna has many advantages, including simple structure, wide bandwidth, low cross polarization, symmetrical radiation pattern, and in particular, extremely low back radiation. The gain and bandwidth of the antenna are almost constant over the operating band. The proposed antenna is simply actualized by constructing Z-shaped feed with two Γ-
shaped feeds. Such architecture gives an advantage for forming a vertically oriented shorted patch antenna and a planar dipole. With the presence of the shorted patch, a magnetic dipole can be excited, while an electric dipole can be existed simultaneously through the planar dipole. In this proposed design, the antenna has a wide impedance bandwidth due to the Γ-strip coupled line and the double resonance from the planar dipole and the shorted patch antenna. Antennas with end-fire radiation pattern have been widely adopted in numerous applications due to its excellent characteristics like simple structure, ease of fabrication, low cost and low aerodynamic profile. The proposed antenna exhibits low profile, 23.9% impedance bandwidth, stable peak gain of 8.5dBi, end-fire radiation pattern, antenna efficiency greater than 80%, identical E-plane and H-plane radiation pattern and good radiation characteristics in the frequency range 12.2GHz - 15.5 GHz. The antenna has a wide potential to be used in airborne radar applications.

In the second stage of the research, an intensive study on the shape of feed is carried out to achieve an UWB and is presented in Chapter 3. A differentially-fed ME dipole antenna has been proposed as differential circuits have achieved popularity in RFIC and MMIC because of their good performance characteristics like common mode rejection, low mutual coupling, less noise, great harmonic suppression and high linearity. But most antennas has been designed for single ended circuits. Baluns are required for the transition between differential signals and single ended signals, when they are to be integrated with differential signals. Here, a simple and easy to design differentially-fed ME dipole antenna has been designed and fabricated and the measured results indicate that it possesses wide impedance bandwidth of 133.3% in the frequency range 0.5GHz - 2.5GHz. A stable unidirectional radiation pattern, peak gain of 7.5dBi and low cross polarization level less than -30dB has also been reported.

In Chapter 4, ground folding technique has been used to increase the gain of a wideband antenna. As high gain antennas are widely in demand, changing the shape of ground plane, is one of the technique by which the gain can be increased. High gain antenna results into sharp and concentrated main lobe beam radiations. A novel and simple E-shaped ME dipole antenna with novel feed design, inserted in a rectangular cavity, has been designed, fabricated and analyzed. Parametric analysis on various parameters has been done successfully to quantify the measured and simulation results, which indicate that the antenna
possesses wide impedance bandwidth of 68.8% in the frequency range 2.0GHz - 4.1GHz. A stable unidirectional radiation pattern with more than 90% antenna efficiency has also been observed. The antenna also exhibits equal E-plane and H-plane radiation patterns with stable peak gain of 10.45dBi and low cross polarization level, less than -30dB. The antenna is suitable for various wireless communication applications in S-band.

A novel planar ME dipole antenna with an ability to provide circular polarization in X-band has been described in Chapter 5. Here, an inverted U-shaped feed element has been embedded into the antenna. A special technique to form magnetic dipole has been used and various parametric analysis has been performed to bring concrete results. The measured and simulation results indicate that it possesses 21.1% impedance bandwidth, in the frequency range 8.9GHz - 11.0GHz and provides 3-dB ARBW of 9.52% covering the frequency range 10.0GHz - 11.0GHz. The antenna also exhibits stable omnidirectional radiation pattern with almost equal E-plane and H-plane radiation pattern and provides a peak gain of 6.2dBi. The antenna is an excellent candidate, suitable for satellite and radar communication in X-band.

A further study of the bandwidth enhancement and overall size reduction of the antenna using a modified twin Γ-shaped feed, to excite the wideband antenna composed of a planar monopole and a vertically shorted magnetic monopole, has been introduced and presented in Chapter 6. Here, a ME monopole antenna has been designed, fabricated and discussed. A series of parametric analysis along with the study of simulation analysis, has been performed to obtain wide impedance bandwidth of 61.5% impedance bandwidth, in the frequency region 4.5GHz - 8.5GHz. The antenna exhibits stable omnidirectional radiation pattern with almost identical E-plane and H-plane radiation patterns and provides a peak gain of 7.4dBi. Due to its good electrical and radiation characteristics, the antenna has wide potential to operate in C band to overcome the challenges of multi-frequency applications.

7.1 Scope of Future Work

Different designs of ME dipole antenna have shown excellent performance in terms of electrical parameters. In particular, their low back lobe radiation characteristic makes them highly attractive for the development of various kinds of indoor and outdoor base station antennas for modern cellular communications as the interference between different cells
operated at the same frequency would be reduced substantially. Due to their wideband characteristics and desirable radiation patterns, they can easily find conceivable applications for the recent wireless communication systems like 3G, 4G, 5G, Wi-Fi, WiMAX, ZigBee etc. Moreover, the proposed designed antennas are simple in structure and low in manufacturing costs. Therefore, they have a great potential as a basic element for the design of low cost high performance antenna arrays.