A REVIEW ON VARIOUS ANTENNAS USED FOR USB DONGLE DEVICES

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Abstract: With the advancement in technology, there has been a keen interest in designing an antenna that enables maximum connectivity. In the field of wireless communication, an antenna that supports multiple frequency bands is required so that it occupies less space in various devices such as USB dongle, mobile phones etc. In this paper a conceptual study is performed on various antenna structures used for USB devices. These structures are compact in size, support multiband frequencies and provide high gain. Among them Planar Inverted F Antenna (PIFA) is considered the best as it reduces the size of antenna and can also be operated on multiband frequencies. These characteristics can be obtained by implementing various techniques to the basic structure of PIFA.

Keywords: Planar Inverted F Antenna, USB Dongle, Multiband Frequencies, Wireless communication.

I. INTRODUCTION

In February 2002, the Federal Communication Commission (FCC) allowed 3.1-10.6 GHz band for low power wireless communication [1]. Since then the Universal Serial Bus (USB) has gained much recognition. USB replaced separate serial and parallel ports and power chargers for various portable devices. USB devices provide large bandwidth to a number of applications over a short distance in order to utilize high speed wireless transmission.

While designing a USB system, the bandwidth enhancement and size of the antenna are the major practical constraints. Broadband antennas in the range of 3.1-10.6 GHz need to be designed to support radiation stability, impedance matching and ultra wideband performance to ensure that they can be used in various practical applications. Recently USB systems have been integrated with Ultra Wideband Antennas (UWB) in order to provide multiple service solution [2]. The high data rate wireless USB is considered as the most promising application among other UWB wireless communication systems. The primary requirement while designing a USB dongle is the compactness of the antennas that is to be fitted into it. The WUSB devices enable scanner, camera, and printer etc to be connected to PC without the use of wired cables [3].

Earlier the USB devices provided plug functionality in various communication systems such as laptops, PCs, Mobile devices etc. With the advancement in technology, Wireless USB devices have been incorporated to provide better data rates for several applications [4]. However, the limited space available in Wireless USB devices is the major constraint. In WUSB devices multiple antennas are placed inside a single USB dongle that share a common ground plane, therefore good isolation between the antenna elements should be maintained as there can be strong coupling between them due to current distributed on the ground plane.

Recently, many antennas have incorporated various techniques such as U-shaped Slot coupling [5], loop type[6], Planar Inverted F Antenna (PIFA) [7] to reduce the size and achieve wideband characteristics for designing Wireless Universal Serial Bus (WUSB). These techniques aim to improve the isolation between various antenna elements. The Universal Serial Bus (USB) technology has a number of applications in electronics and mobile market. The existence of cable was the biggest limitation of this technology. Therefore in order to remove this constraint Ultra wideband (UWB) helped unwiring USB devices.

In this paper various structures such as Inverted L Antenna; asymmetrical Triangle shaped slot; Planar Inverted F Antenna; meandered monopole; printed monopole etc used for designing USB dongles are discussed. These antennas have reduced size, provide multiple bands and improves radiation and gain pattern. Also it is observed that these antennas are suitable for Wireless Universal Serial Bus (WUSB) devices and other RF circuits.

II. TYPES OF ANTENNAS USED FOR USB DEVICES

A. Fractal Inverted-L Antenna

The Inverted-L Antenna has been designed using fractal geometry that allows the ground plane and the antenna element to be printed on the same side of the substrate. This technique is widely used in designing antennas for portable devices. The antenna is designed for WLAN USB dongle application using Roger 4003 having thickness of 0.8mm. The overall size of the antenna is 20mm × 60mm × 0.8mm. The designed antenna has no copper on the bottom of the ground plane rather the ground plane and the antenna element are printed on the same side of the substrate. It is observed that enough space is left to mount other hardware components on the same ground plane. The designed antenna shows a wideband from 2.25-2.60 GHz and 5.06-5.62 GHz, high radiation efficiency and moderate gain. In this paper studies are also conducted while connecting the proposed antenna to a laptop. It is seen that the resonant frequencies are affected and radiation patterns are also changed. This can be controlled by resizing the fractal element. The low input impedance can also be overcome reducing the antenna element with respect to the ground. Figure1 shows the design of fractal Inverted L Antenna [8].

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To design Wireless USB device, an asymmetrical triangle UWB antenna is used. The antenna is composed of triangle radiator. The proposed antenna consists of different side lengths to achieve wide band and reduced size. It has small size and can be easily integrated in WUSB dongles and other RF circuits. The dimensions of the proposed antenna are 12mm × 38mm × 1.6mm. In this design FR4 having relative dielectric constant of 4.4 is used as a dielectric substrate. The proposed design shows a wideband from 2.77 GHz to 10.64 GHz that covers almost whole UWB spectrum. The radiation pattern shows omni-directional radiation at low frequencies and directional radiation at high frequencies due to asymmetrical shape of the antenna. Furthermore the peak gain greater than 2.63dB is observed for the total field. The designed antenna is easy to fabricate and can be used in devices where less space is available. Figure 2 shows the design of Asymmetrical Triangle UWB Antenna.

The USB dongle used for WLAN and WiMAX with small ground plane is analyzed. The antenna uses FR4 as a substrate of thickness 0.8mm. WiMAX and WLAN are considered the most popular networks for using the high speed internet network. In this paper, the size of the antenna has been reduced to great extent with an aim to cover WiMAX and WLAN bands and to be fitted in the USB dongle. The size of the antenna is 30mm × 15mm × 0.8mm and covers a frequency band from 3.27 GHz to 6.32GHz. Further the antenna shows an omnidirectional radiation pattern and provides good gain and VSWR.

The monopole antenna used a simple architecture for WLAN 2.4 GHz. In this proposed design pair of L-shaped strips is introduced on the antenna for impedance matching. A bent structure is used on the top of the antenna to minimize the size of the antenna. The design resembles to that of fractal monopole antennas. It is observed that the overall size reduces to 35mm × 12mm. The antenna resonates at 2.4GHz and 2.5 GHz and 3.35-5.98GHz covering frequency bands of WLAN, WiMAX 3.5GHz and WiMAX 5GHz. The radiation pattern in Y-Z plane is omnidirectional. It is concluded that the antenna is suitable for practical applications in USB devices. Figure 4 shows the design of printed monopole antenna for USB devices.

The Planar Inverted F Antenna (PIFA) is used for USB devices due to their low profile structure, low SAR value and omnidirectional pattern. The proposed antenna consists of irregular shaped main radiator, shorting plate and a rectangular slot. The antenna is very thin and small in dimensions. It covers a wide frequency band of 1.5-6.8 GHz and can be used for various bands such as WLAN, m-WiMAX, UMTS. One major challenge was to change the dimensions of the radiator while not disturbing the current distribution on other radiators. The radiation pattern of the proposed antenna is omnidirectional and provides a good gain and VSWR graphs. Figure 5 shows the geometry of Planar Inverted F Antenna used for USB devices.

Figure1. Fractal Inverted L Antenna [8]

Figure3 shows the design of printed antenna used for USB devices [10].

Figure2. Asymmetrical Triangle UWB Antenna [9]

Figure4. Printed Monopole Antenna [11]

Figure5 shows the geometry of Planar Inverted F Antenna used for USB devices [12].

Figure3. Design of Printed Antenna [10]

E. Planar Inverted F Antennas

The Planar Inverted F Antenna (PIFA) is used for USB devices due to their low profile structure, low SAR value and omnidirectional pattern. The proposed antenna consists of irregular shaped main radiator, shorting plate and a rectangular slot. The antenna is very thin and small in dimensions. It covers a wide frequency band of 1.5-6.8 GHz and can be used for various bands such as WLAN, m-WiMAX, UMTS. One major challenge was to change the dimensions of the radiator while not disturbing the current distribution on other radiators. The radiation pattern of the proposed antenna is omnidirectional and provides a good gain and VSWR graphs. Figure 5 shows the geometry of Planar Inverted F Antenna used for USB devices [12].
III. CONCLUSION

The review paper describes various antennas used for Universal Serial Bus (USB) devices. The antennas designed by various researchers have aimed for low profile structures and multiband characteristics. It is also concluded that the Planar Inverted F Antenna structures shows multiband/wideband characteristics, reduces SAR and has much better scope when compared to other antennas. Therefore researchers can make better designs of several antennas in terms cost, implementation and easy integration with various wireless communication equipments.

REFERENCES