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Abstract

This paper aims to analyse radiation pattern for horizontally polarised dual band Yagi-Uda antenna (900/1800 MHz) with the presence of real ground. Simulations were performed at 920 MHz and 1780 MHz and antenna were placed in different distance from the ground. Simulation results of radiation pattern are calculated in the H-plane of the antenna. A simulation without the ground plane are compared with the result from the one with the real ground. The result shows that the ground plane greatly influences the radiation pattern and increases the gain of H plane significantly.

Keywords: antenna, dual-band antenna, Yagi-Uda antenna, non fixed base station, real ground.

Introduction

The basic part of any communication system is the communication channel. This is the physical medium that carries information bearing signals from the source of the information to the sink. In mobile communication, the means of signal transmission is through wireless and antenna is the device act as transducer to send and receive the information. In practical environment the base station is fixed, and the users are mobile. In some special cases, an additional non fixed base station will be used to solve the communication congestion problem. For example, when there are many more people gathered than usual (such as World Expo and Olympics), the channel capacity may be inadequate, thus leading to the communication congestion and influencing the normal communication. In this case, the non-fixed base station is usually used. To improve the channel capacity, we consider using the guard bands of GSM communication for the non-fixed base station. The backhaul from the non-fixed base station to the fixed base station is point-to-point communication, so a directional antenna is needed. The Yagi-Uda antenna is one of the most popular and widely used antennas because of its simplicity, low cost, directional radiation, and relatively high gain, and simply its directional antenna it gives advantage to be used as the backhaul[1]. Analysis of propagation pattern is of important before the deployment of any antenna. Propagation patterns of wireless systems may be affected by outside influences such as vegetation, solar radiation, climate conditions, interference from other RF sources, and ground reflection. As the RF waves propagate though space signal tend to reflect or absorbed in nearby objects and surfaces. Some RF waves would reflect off the ground surface while some would be absorbed by the ground. The amount of RF reflection and RF absorption depends on the earth's ground dielectric(ε_r) and ground conductivity(σ) properties[2].Thus, in this work, we desire to analyse the effect of ground in a dual band Yagi-Uda antenna. The guard bands of GSM are 915–935 MHz for GSM900 and 1760–1805 MHz for GSM1800.

Antenna Configuration and Placement

There are no simple formulas for designing Yagi-Uda Antenna due to its non-linear relationships between physical parameter such as element length, diameter and position and electrical characteristics such as input impedance and gain, but performance can be estimated by computer simulation [3-5] .In this paper we adopt the design of dual band antenna as was suggested by [1, 6], Figure 1 shows the configuration of antenna and table 1 shows optimum parameter dimensions . The dual-band Yagi-Uda antenna is composed of the director, driver and reflector. The Driven Element is a dipole which consists of two 1/4 wavelength elements. The Reflector is slightly bigger than the driven element and reflects the signal back towards the driven element. The directors are slightly smaller than the driven element with each one being slightly smaller again as they move away from the driven element, the directors help to focus the signal giving it a higher gain. For simulation we assume a ground has the relative

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permittivity of 10 and ground conductivity ($\sigma = 1e - 3$)

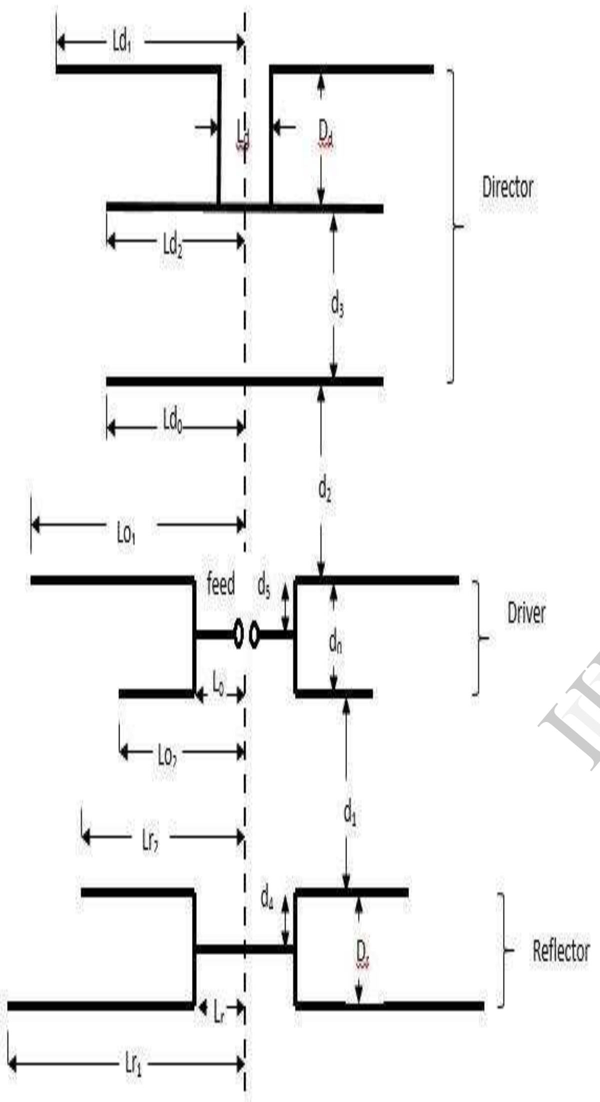

Figure 1: Configuration of Dual band Yagi–Uda

Table 1: Antenna optimal dimension

Parameter	Dimension (cm)	Parameter	Dimension (cm)
L_{r1}	8.19	L_{do}	3.33
L_{r2}	4.32	D_r	0.51
L_r	1	d_o	2.41
L_{o1}	7.16	D_d	4.11
L_{o2}	3.52	d_1	3.41
L_o	1.05	d_2	1.82
L_{d1}	7.03	d_3	6.65
L_{d2}	3.53	d_4	0.41
L_d	1.09	d_5	1.23

The ground plane was varied from 0.1m to 3m; figure 2 shows the 3D configuration of the antenna when placed in distance (d) from the ground

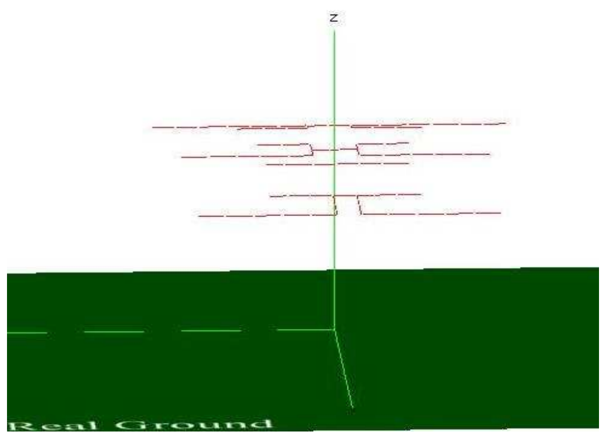

Figure 2: A 3D view of the Dual band Yagi-Uda antenna suspended over a real ground

Simulation Result

Figure 3 and 4 shows the antenna pattern at frequency of 920Mhz and 1780Mhz respectively when simulated with the presence of real ground at distance 3m from ground and without real ground at distance 3m from the (0,0,0) axis. The antenna patterns below show that the antenna gain increased when they are placed close to the real ground, and antennas become more directive in the presence of a ground plane as it seen from the figure 5 and 6, they also shows the effect of lowering the antenna from 1m to 0.1m high .while at 1m high antenna shows high variation of gain and the smooth curve result when placed near the real ground. This suggests that if you want more general coverage off antenna the lower distance yields a better result. (Note that the graph is a vertical polar plot of the gain in dB for the both cases)

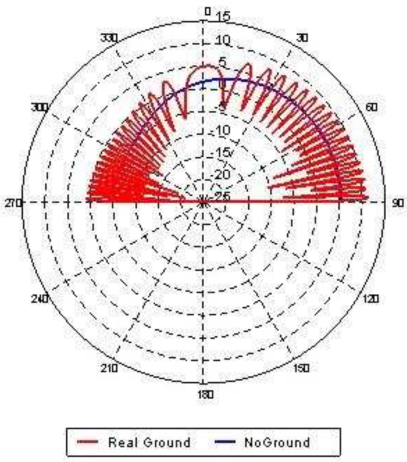

Figure 3: Directivity pattern at 920 MHz over a real ground and without any ground

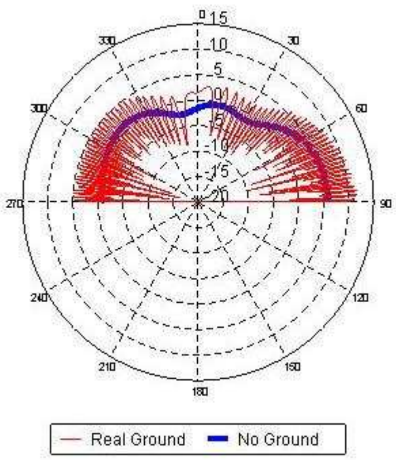

Figure 4: Directivity pattern at 1780 MHz over a real ground and without any ground

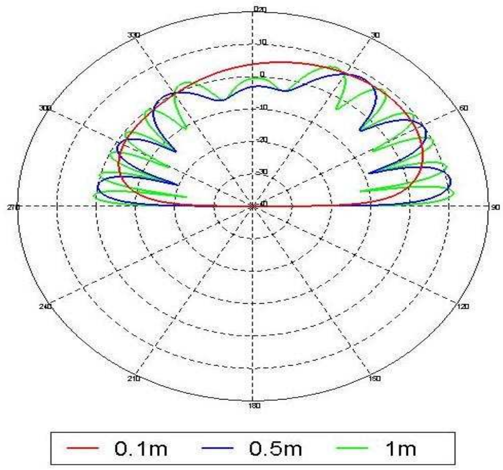

Figure 5: Directivity pattern at 920 MHz with variation of distance

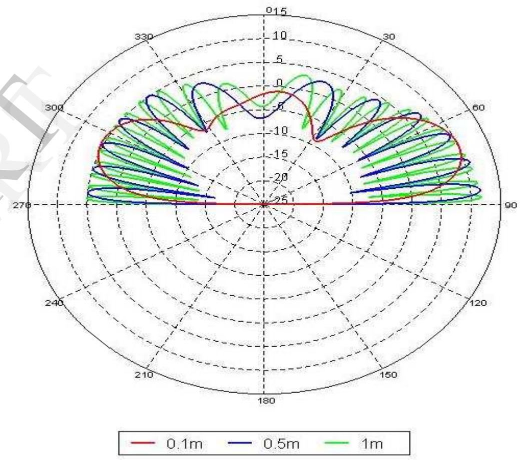

Figure 6: Directivity pattern at 1780 MHz with variation of distance

Summary

A Yagi-Uda Antenna has many advantage in the modern wireless application due to its characteristics such as simple structure, easy fulfilled, and thus low cost. In this paper we provide simulation result of the dual band Yagi-Uda antenna when is suspended to the real ground and radiation pattern was analysed in H-plane. Simulation results show that the ground has significant effect on which the gain was increased. However we don't get something for nothing in other way the reflected wave will be 180° out of phase and the waves will cancel completely when phase is at 180°, since the two signal will be anywhere from 0 to 180 out of phase which will account for a whole range of gain variations.

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