External Antenna Design for GPS Signal Reception Enhancement

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***Abstract*—The working paper explains the detailed analysis of the low-cost design and implementation of 53.0 × 41.0 mm Single Microstrip Patch Antenna (SMPA) for handheld Global Positioning System (GPS) receiver external use. A Computer Simulation Technology (CST) microwave studio technique was applied, using the dielectric of 5.0 and substrate thickness of 1.6 mm. The SMPA designed for data acquisition application operating on a single frequency on 1.57542 GHz. The antenna gain enhancement and the signal reception have improved the receiver line-of-sight (LOS) for an indoors experimental usage. However, the external antenna gain overcomes raw data quality degradation caused by the internal antenna due to low elevation angle and results in non LOS.**

Keywords-GPS receiver; patch antenna; SNR; dielectric; CST studio

I. INTRODUCTION

An electromagnetic device that uses for radiating or receiving electromagnetic wave signals in free space, mostly antenna work as a medium between the transmission line and open space. An antenna rejects any message that is operating beyond the desired operating frequency. Antennas can be explained as a critical part of most Global Positioning System (GPS) receiver design, and their importance cannot be stated enough. Therefore, the best receiver will not bring back what has been lost in signal strength due to a poor antenna design, radio frequency (RF) board design or in signal jamming. GPS signal are considerably weak and present unique demands on antennas. The selection and implementation of GPS receiver antenna will greatly play a significant role in GPS performance.

GPS portable receiver were used for experimental research by Azlan *et al.*, Pai *et al.*, Abba *et al.* and Volker [1–7] using the propagation sentences from the received signal. They found out that the signal strength was low at lower elevation angle below 15 degrees. The effect is due to receiver antenna gain and bandwidth. However, handheld GPS receivers normally come with built-in patch antenna or helix type [8] and due to environmental factors such as rain, temperature, trees and terrains these receivers perform less expected. Therefore, there is a need for propagation data for experimental purposes in the less developed countries such as Africa, Latin America and Asia, in order to encourage studies on GPS satellite performance in these regions. Therefore, a cost economical system for data acquisition was proposed.

The aim of this study is to improve and enhance the signal reception of the portable device for the acquisition data. Therefore, an external, low-cost and easy to build antenna is proposed, which it would be suitable for the research purposes. Single Microstrip Patch Antenna (SMPA) design, optimization and fabrication were implemented in this paper.

GPS receiver needs to receive a signal from as many satellites as possible, whereby an optional performance will not be available in a narrow street and underground parking lots or if some object covered the antenna. However, poor visibility may also result in position draft or a prolonged Time-To-First-Fix (TTFF) as it applies to reliability and maintainability theory [9–11]. Open sky with good visibility is an important advantage for a handheld GPS receiver, and almost all handheld receivers were equipped with built-in patch antenna. However, the need for an external antenna with a good high gain to boost the receiver signal reception for indoors application. GPS receiver can only achieve its threshold performance if the average signal to noise ratio (SNR) for the strongest satellite reaches at least 44 dBHz [1, 4, 5, 12, 13]. The standard design system for the average SNR of high elevation satellite signal strength should be within the value range of 44 dBHz and about 50 dBHz, using the standard off-the-shelf active antenna [12].

The design of linearly polarized patch were demonstrated by Baskar *et al.* [14] and an array combination of Microstrip Patch Antenna (MPA) using quarter half wavelength transformer feeding line obtained. The designed differed from our approach of single frequency patch antenna that operated externally for portable receivers. Probe-fed and linearly polarized was achieved using dielectric of 4.7 for the FR4 material which is contrary differs from current design done by us that employs the dielectric value of 5.0 for FR4 board [15]