Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 113 (2017) 621–626

Procedia Computer Science

www.elsevier.com/locate/procedia

International Workshop on IoT, M2M and Healthcare (IMH 2017)

GPS Signal Channel Modeling and Verification

Olcay Yiğit[a,*], Havva Esra Bilişik[b], Eren Demir[c], Radosveta Sokullu[d], Korkut Yeğin[e]

Department of Electrical and Electronics Engineering, Ege University, 35100 İzmir, Turkey

Abstract

Global Positioning System (GPS) is a technology that is used not only for military purposes but also for general positioning in civilian applications. It is often used in applications of Internet of Things (IoT), which have gained popularity in recent years, for example, tracking the daily activities of elderly people, and monitoring vital signs etc. The GPS signal which is extremely weak is affected by several types of errors in the course of its propagation. This situation becomes much worse particularly when the GPS receiver is located in dense urban areas where multipath effect is strongly pronounced. The received signal strength of a GPS satellite at a given location can be predicted by analyzing the propagation characteristics of the channel with an appropriate propagation model. In this paper, we propose a simple MATLAB model to estimate the received signal strength of a GPS signal in varying urban environment based on experimental measurements of the propagation characteristics of GPS signal taken in the city of Izmir, Turkey.

Peer-review under responsibility of the Conference Program Chairs.

Keywords: GPS; Channel Modeling; IoT; Multipath

1. Introduction

The use of navigation technologies has been steadily increasing in civil and military applications in recent years[1]. Among the positioning technologies, the most commercialized is the GPS, but there are still issues that need to be solved[2]. GPS is not suitable to be used indoors due to signal lost within contact of building walls. Alternative techniques can also be explored for indoor positioning systems. Some indoor positioning systems are based on the application of Wi-Fi access points found abundantly in smart phones and in buildings[3]. On the other hand, GPS behaves brilliant in the open outdoor area, but as a result of the low satellite signal power, the signal attenuation

* Corresponding author. Tel.: +902323111817 ; fax: +902323115243.
E-mail address: olcayyigitcon@gmail.com

1877-0509
Peer-review under responsibility of the Conference Program Chairs.
10.1016/j.procs.2017.08.311

phenomenon becomes very serious in the dense urban environment or under the bad weather condition. Therefore, modeling and studying the GPS propagation in urban environments and some closed areas is still an open research issue.

A GPS receiver calculates its position by the signals sent by several satellites. Each GPS satellite transmits two spread spectrum pseudo random noise (PRN) ranging codes along with 50 bps navigation data message at two frequencies L1(1575.42 MHz) and L2(1227.60 MHz)[4]. The accuracy of the computed position depends on the received signal strength. However the received signal may be degraded due to several reasons, such as travelling long distances through vacuum, dense clouds, dust particles etc. In general, GPS signal variations can be classified into two types; large-scale variations and short-term variations[5,6]. The large-scale variations in a signal are mainly due to path loss and shadowing. The average value of the signal strength at any point depends on its distance, carrier frequency, type of antenna used and atmospheric condition and so on. The second type of variation is due to multipath reflections and is illustrated in Fig. 1. In urban areas or dense urban areas, there may not be any direct line of sight path between a satellite and a receiver antenna. Therefore, the signal may arrive at a GPS receiver over a number of different paths after being reflected from tall buildings, towers, and so on. Because the signal received over each path has a random amplitude and phase, the instantaneous value of the received composite signal can vary quite randomly.

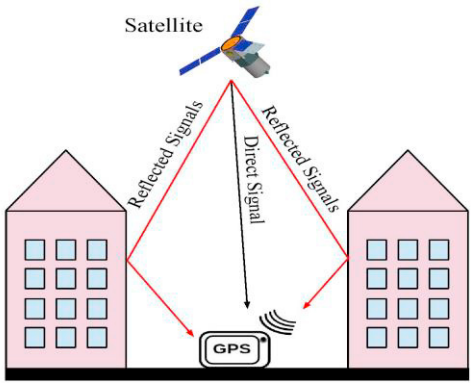

Fig. 1. Multipath configuration

It is known that using GPS in very dense urban settings (high-rise urban, dense urban).is inefficient due the weakness of the signal emitted by the GPS satellites as well as to due to shadowing, scattering, and other effects caused by man-made structures. Due to these reasons, localization may not be accurate. In this paper, we address the problem of modeling the multipath fading wireless channel for using GPS in dense urban areas. Since positioning systems are also used in many Internet of Things (IoT) scenarios, the simple model proposed in this paper can also be used for evaluating a wide variety of different IoT applications from healthcare to transportation safety and event tracking.

The remainder of this paper is organized as follows: in section 2 we present an overview of some recent work related to use of GPS especially for healthcare applications. Then, we present our experimental scenarios and measurements in section 3, and describe the proposed model for the received GPS signal and simulation results in section 4. Finally, we conclude the paper in section 5.

2. Related Works

Remote are many examples of GPS usage in healthcare applications[7,8,9]. In one of these works, authors proposed a new hybrid mobile-based location technique that uses GPS and cellular mobile network infrastructure for location tracking[7]. This technique has been integrated into Patient Tracking Location System (PTLS) to aid caretakers and family members to locate their patient's specifically in emergency situations. Another work conducted a study with seven people diagnosed with different levels of Parkinson's disease[8]. The aim is to determine whether there is a