Chapter 78
A Domain Independent Pedestrian Dead Reckoning System Solution for Android Smartphones

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ABSTRACT

In this chapter we propose a domain independent Pedestrian Dead Reckoning System that can be applied to any indoor environment. We describe the entire solution and adopted architecture. The user can create new indoor spaces, define reference points in it, positions for future access and also track his current location. In order to track the user's position, we solve several walking detection false positives including a common problem with most pedometers. We present results of conducted tests that show a 98% accuracy of the system. Finally, we present the developed prototype.

INTRODUCTION

Location-based services (LBS) became an emergent area for mobile applications since most smartphones allowed to track the user's location. Outdoor location is currently very accurate using the Global Positioning System (GPS) and one of its most common applications is car or pedestrian navigation systems. However, tracking user´s location is also necessary in indoor environments and the lack of GPS makes this an active research area as providing an accurate indoor location is yet challenging (Vidal & Marron, 2014). One common approach is the use of Access Points (AP) and a map of Received Signal Strength

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Indication (RSSI) which has as main disadvantage the need to recalculate the entire map when AP´s physical location is changed. RFID tags can also be used but this approach demands an innumerous number of tags throughout the building with the correspondent costs associated. Another important aspect to bear in mind when choosing the technology is the control we will have on the indoor space. If a school board decides to provide track and navigation abilities to provide its students with important functionalities such as locating classrooms or teacher´s offices, then the school board has the power to acquire the necessary hardware to implement such a system. However, there are innumerous places we, as end users, would like to have indoor tracking and navigation abilities but we have no access to the system to perform the necessary changes. Examples are supermarkets or libraries where users could benefit from location services to track products or books. In these scenarios, programmers' can´t depend on APs or RFID tags (because they would not have access to them even if they existed) which automatically exclude these options. A suitable alternative is to use smartphone sensors namely the more common ones such as acceleration, gravity or the gyroscope that are present in almost all smartphones. This method is known as Pedestrian Dead Reckoning (PDR) (Kang & Han, 2014), where the current position is obtained based only on a reference position and data from sensors. Current PDR proposals have a detection method that tries to capture the walking swing. This approach is followed by many pedometer applications and the main problem is that a false positive is obtained when the user is standing still and shaking the phone up and down. Another issue with the majority of current proposals is the use of the indoor environment floor plan. While it produces a friendlier interface, it limits the applications of the system as sometimes (as we referred earlier for the cases of supermarkets or libraries) we don´t have access to that information which shouldn´t exclude the possibility to provide location and tracking services in such environments.

In this chapter we provide an extension to the previous work we developed (Paiva 2015) where we introduced a domain independent PDR system for indoor tracking and location that assumed no hardware exists in a given indoor environment. The system is able to provide users with the capability to mark a position for future access in the indoor space such as a given product´s location within a supermarket or a book in a library. With the proposed system, each user can create several indoor environments (each one representing a particular indoor space he attends) and mark positions so he can easily find them later. The representation of the indoor environment does not use any floor plan so the system doesn´t become dependent of a specific space/domain. We use the Android Operating System for the application development and its sensors to track user´s location and help him find a previously marked position. In concrete, in this paper we extended the description of the architecture of the solution and detail/improve two modules of the system.

In the next section we present some related work and then we briefly introduce Android sensors, a fundamental component of our proposal. Next we introduce the developed solution, namely the architecture and supporting database as well as each of its modules along with the developed algorithms. We present an evaluation of the conducted tests and achieved results and finish with conclusions and future work.

BACKGROUND

Several PDR systems are continuously being proposed to solve several situations where GPS cannot be used. One such example is proposed in (Constandache et al, 2010) where the users propose CompAcc, a simple and practical method of localization using phone compasses and accelerometers. For the user´s tracking, the authors record a person's walking patterns and match it against possible path signatures