Acoustic Self-calibrating System for Indoor Smartphone Tracking (ASSIST)

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I. Abstract

In the past three years handheld computers and smartphones have become an important companion to many people. Context sensitive applications support the user in everyday life. One of the most important contexts is the location of the user.

In indoor areas, where GPS is not available, alternative technologies are required. Lately, a number of systems using the Received Signal Strength or Time of Flight (ToF) of WiFi communication were developed. These technologies are capable of navigating people with low accuracy. However, these systems are susceptible to errors in dynamic environments. High accuracy and robustness is required to navigate people for example between exhibition stands or to products in supermarkets.

In this paper, we present a novel smartphone indoor localization system (Fig. 1) based on high pitched acoustic chirp signals beyond the audible range. Using an Android "app" (Software) that we have created for commercial smartphones, generating these signals, the user is navigated with small effort, affordable equipment and with high accuracy in indoor areas.

The chirp signals are received by devices which identify the specific sound from each smartphone. The receivers are connected in a WiFi network, such that they synchronize their clocks and exchange the Time Differences of Arrival (TDoA) of the received chirps. In this way, using an iterative multilateration algorithm, the location of the smartphones can be calculated. As demonstrated previously the receiver positions are calibrated automatically by our approach.

The interface for the user is as simple as starting the Android app, which connects to a server and receives an ID using the usual smartphone internet connection. Specific parameters are assigned to each user, such that several devices can be distinguished by the appearance of the chirps. The position of the user is displayed on the smartphone in context of the environment, with a map and surrounding items.

We have verified our system in real-world indoor scenarios. In our experiments we compared the trajectory of several smartphones to reference positions of an optical tracking system, where we could locate the smartphones in a range of centimeters.

KEYWORDS: TDoA, chirp sounds, smartphone, indoor localization

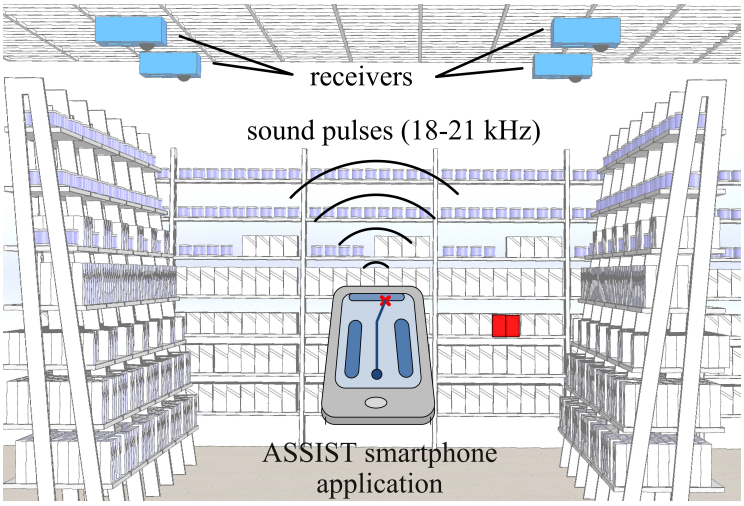

Fig. 1. System overview of ASSIST