StreetBit: A Bluetooth Beacon-based Personal Safety Application for Distracted Pedestrians

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***Abstract*—The safety of distracted pedestrians presents a significant public health challenge in the United States and worldwide. An estimated 6,704 American pedestrians died and over 200,000 pedestrians were injured in traffic crashes in 2018, according to the Centers for Disease Control and Prevention (CDC) [1]. This number is increasing annually and many researchers posit that distraction by smartphones is a primary reason for the increasing number of pedestrian injuries and deaths. One strategy to prevent pedestrian injuries and death is to use intrusive interruptions that warn distracted pedestrians directly on their smartphones. To this end, we developed *StreetBit*, a Bluetooth beacon-based mobile application that alerts distracted pedestrians with a visual and/or audio interruption when they are distracted by their smartphones and are approaching a potentially-dangerous traffic intersection. In this paper, we present the background, architecture, and operations of the StreetBit Application.**

I. Introduction

Almost everyone can attest to witnessing pedestrians interact with their smartphones by engaging on social media, talking, or listening to music while crossing roads and intersections. However, behavioral science repeatedly proves that using smartphones while walking on road may distract pedestrians from the complex cognitive-perceptual task of engaging in traffic, and therefore may lead to pedestrian injuries and deaths [2], [3]. Distracted pedestrians face impaired attention in at least three ways. If their vision is directed partially or fully to the smartphone while they walk or cross a street, they suffer from impaired visual attention. Similarly, if they listen to music or a telephone conversation on their smartphone when engaging in traffic, they suffer from impaired aural awareness [4]. Finally, a distracted pedestrian suffers from reduced cognitive attention. One effective strategy to reduce distracting behavior to intrusively alert pedestrians via smartphone as they approach street-crossings [5]. Such a system would necessitate alerting pedestrians in real time when they approach an intersection while being distracted by their smartphones. In order to alert such distracted pedestrians, we have developed *StreetBit*, a Bluetooth Low Energy (BLE) beacon-based intervention application. StreetBit works with off-the-shelf BLE beacons and smartphones to provide an inexpensive solution for preventing distracted pedestrian injury that we have developed, deployed, and tested in a real urban environment [5].

This paper presents an overview of the architecture and functionality of the *StreetBit* smartphone application that detects distracted pedestrians at traffic intersections and gives a warning in real-time. *StreetBit* uses Estimote[1] proximity beacons (Figure 1) for localization and Amazon Web Services (AWS)[2] to store the data collected from users.

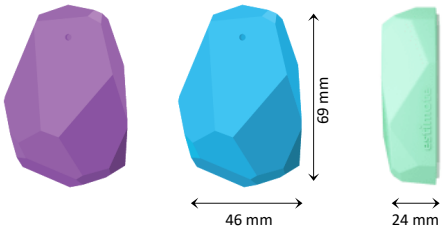

Fig. 1: Bluetooth low energy proximity beacons

The rest of this paper is organized as follows. In Section II, we describe the architecture of StreetBit, and in Section III, we present an overview of the demonstration.

II. StreetBit Architecture

A. Localization

We calculate pedestrian locations using BLE beacons in an urban environment. A beacon broadcasts a signal to all nearby devices that can receive the Bluetooth signal (i.e., smartphone, smartwatch, smart car, etc.). The StreetBit smartphone app receives these signals and calculates the approximate distance based on the signal strength (Received Signal Strength Indicator or RSSI). Beacons broadcast some other values (i.e., UUID, Major, Minor, etc.) to uniquely identify them. Figure 2 shows the simplified architecture of StreetBit.

If the StreetBit app identifies multiple beacons at the same time, then distances from all of them are used to determine the current zone and accurate location of the pedestrian. The application stores the distance from the nearest beacons for future reference. The same calculation is performed in each iteration of the signal update. StreetBit only starts calculation near an intersection (within beacon radius). We divided the beacon radius in two areas, the *activation zone (20 meters)* - Streetbit initiates sensors and start the calculation, *alert zone (8*

[1]https://estimote.com
[2]http://aws.amazon.com

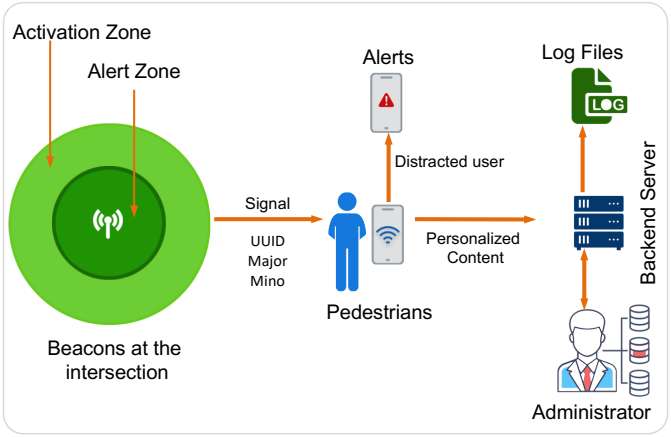

Fig. 2: StreetBit architecture

meters) - pedestrian receives an alert within this radius if they identified as distracted. Figure 3 displays the characteristics of the beacon based on their position. The Streetbit app starts to collect data when users enter the *activation zone* and ends data collection when they depart the zones of all beacons.

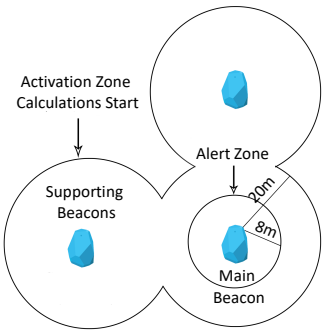

Fig. 3: Beacon characteristics based on their position

B. Mobile Application

We developed the StreetBit mobile application for both Android and iOS platforms. The Android version is compatible with Android 6.0 (Marshmallow) or newer; the iOS application supports iOS-12.1 or newer. The mobile application calculates the distance, identify the pedestrian distraction, and gives warning to the pedestrian based on their conditions. Users are considered distracted if they are actively using the phone, listening to music, or talking to someone on the phone. StreetBit collects data from pedestrian movement, phone status, and phone position near the intersection in real-time to gives alert efficiently. The application runs as a background service; to reduce the battery consumption, it only starts sensors at the intersection. Figure 4 shows the StreetBit application interface and sample visual warning from the system.

III. Demo Overview

The demonstration consists of the following steps: firstly, we set up a testbed like a traffic intersection by installing BLE beacons. There are two types of beacons; the main

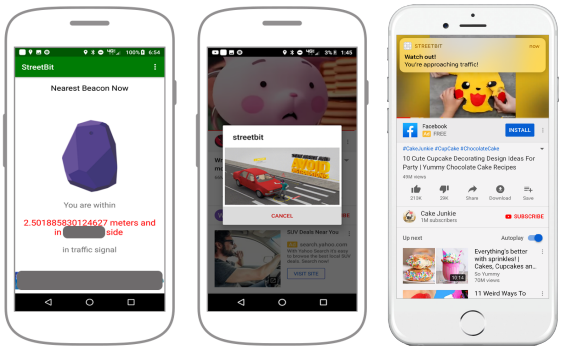

Fig. 4: StreetBit mobile application. (a) shows the app calculating the distance from the nearest intersection corner. (b) overlay alert from StreetBit while the distracted pedestrian using youtube on an Android phone. (c) alert on the iOS platform.

beacons are responsible for the alerts and supporting beacons are used for better positioning. Secondly, the StreetBit mobile application; the audience could download both Android and iOS versions from the corresponding app store and tests the system. For both platforms, only some benign permissions are required (i.e., Bluetooth, music status, phone state, etc.). Thirdly, the backend server collects various sensors data (i.e., light sensor, accelerometer, etc.) to give the customized warning. We developed a backend server using AWS Elastic Computer Cloud (EC2) and AWS Relational Database Service (RDS). In the demo, we will also provide a video walkthrough of the use of StreetBit in various scenarios involving distracted and non-distracted pedestrians.

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References

[1] Centers for Disease Control and Prevention [CDC], "Injury prevention & control: Data & statistics (wisqarstm)." https://www.cdc.gov/injury/wisqars/index.html, 2020. [Online; accessed October 30, 2020].

[2] J. L. Nasar and D. Troyer, "Pedestrian Injuries Due to Mobile Phone Use in Public Places," *Accident Analysis & Prevention*, vol. 57, pp. 91–95, 2013.

[3] K. Ralph and I. Girardeau, "Distracted by "distracted pedestrians"?," *Transportation Research Interdisciplinary Perspectives*, vol. 5, p. 100118, 2020.

[4] D. C. Schwebel, D. Stavrinos, K. W. Byington, T. Davis, E. E. O'Neal, and D. De Jong, "Distraction and pedestrian safety: How talking on the phone, texting, and listening to music impact crossing the street," *Accident Analysis & Prevention*, vol. 45, pp. 266–271, 2012.

[5] R. Hasan, A. Hoque, Y. Karim, R. Griffin, D. Schwebel, and R. Hasan, "Smartphone-based Distracted Pedestrian Localization using Bluetooth Low Energy Beacons," in *Proceedings of the IEEE SouthEastCon 2020*, March 2020.