National Center for Transit Research
Center for Urban Transportation Research
College of Engineering
University of South Florida

For more information,
contact: Robert L. Bertini, Ph.D.
NICR Director
Email: rbertini@usf.edu

Project: Smartphone-based Connected Bicycle Prototype Development for Sustainable Multimodal Transportation Systems

Authors: Achilleas Kourtellis, Ph.D.

Summary

Due to rapid developments in the automobile industry in the past several decades, the increasing use of vehicles has caused serious safety and operation efficiency issues in terms of traffic crashes, congestion, and loss of productivity. Therefore, a sustainable multimodal transportation system is considered address these traffic issues including considerations to bicyclists. Unfortunately, bicyclists suffer high crash and fatality rates dues to their excessive exposure to traffic compared to other modes. Because of this, with advancements in smartphone technologies, it is of practical importance to develop connected bicycle techniques. This research project proposed a pilot study to investigate the mechanism for bicycle-to-everything (B2X) technology. This report describes the selection, design, and testing of a smartphone application to alert bicyclists and drivers of imminent dangerous situations. The goal of this study was to develop a proof-of-concept prototype and test methods to broadcast basic safety messages (BSMs) via smartphones for connected vehicles and use them to alert users of imminent crashes in established scenarios relevant to bicycles.

The first step of this study was to review existing solutions for connected/autonomous vehicles and to identify the techniques that can be useful for bicycle/ vehicle interactions. The study determines useful parameters such as speed, acceleration, latitude, longitude, etc., and system requirements including GPS, Wi-Fi, etc. for communication between bicycles and vehicles. Using this information, the study developed a mechanism for information transmission for communication between the two using a smartphone-based system. The final goal was to establish a proof-of-concept prototype for a smartphone-based connected bicycle/vehicle using selected hardware, software, and other components to include sensors, smartphone, mobile applications, and a user interface.

Before designing the software, the research outlined the needs. These included the ability to collect information from user smartphones into a cloud server, provide a way to track users locations in relation to each other, and identify conflicts using specific thresholds and deliver messages. The study used an open source application for Android OS developed for location data collection to design the system prototype. After a user creates an account, the database will assign a unique to each user for identification. The user would be able to identity their use type: bicycle, vehicle, or pedestrian. Using an algorithm to determine if two users are on a collision course, the app sends them a warning that varies depending on the conditions they are in at the given the moment. The next step in this research effort was to test the application. The tests were conducted at closed road at USF with a bike and car. The test involved three scenarios: cyclist and vehicle traveling in the same direction along a roadway, in the opposite direction, and perpendicular to each other at an intersection. The results found that in the same direction test, both the driver and the cyclists received three warnings at equal intervals and stopped when it was detected that their distance was getting farther. In

the opposite direction test, the bicyclist received two warnings and the motorist received three warnings. In the intersection test, the driver received a warning and was able to come to a complete stop to allow the cyclist to cross the intersection. Further, the algorithm was able to deliver the first warnings when the users were approximately 30 meters (100 US feet) from each other in the directional tests and 24 meters in the intersection test. The results also found that the accuracy of a single CPS point cannot be trusted for accuracy due to GPS drifting. Ultimately, the proposed algorithm has the potential to warn both drivers and bicyclists of imminent dangerous situations that occur when the two types of users come near each other.

Future research can be expanded to develop an application compatible with Apple iOS. In addition, to avoid issues in handling large number of users simultaneously, the system can be improved by using a grid network, where calculations for user proximity are made in a small area, this keeping the detection of users localized. The accuracy of GPS can be improved using the new dual frequency GPS chips that can bring the accuracy to 1 meter. Low data frequency can be improved by interpolating points and filling in the gaps. Finally, the shape of the boundary can be improved by changing it to an ellipse rather than a circle, thereby reducing the time when a warning is provided but not needed by keeping true events at a maximum.

VIEW FULL REPORT: scholarcommons.usf.edu/cutr_nctr/7