TDOT Department of Transportation

Research Summary

Feasibility of Real-Time Infrastructure Driven Intervention for Improving Pedestrian Safety

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WHAT WAS THE RESEARCH NEED?

With the rapid advancement of intelligent transportation systems (ITS) and communication technologies, there is a growing focus on creating an infrastructure-driven, human-involved system to facilitate seamless and cooperative driving experiences for hybrid road users. For instance, pedestrians, who are among the most Vulnerable Road Users (VRUs), currently receive only passive protection due to the lack of real-time interaction between existing onboard and infrastructure-based sensing systems and non-connected road users. Despite the presence of reliable sensing technology and robust computational capabilities, effectively integrating, managing, securing, and disseminating critical traffic information to all road users, particularly those not connected to the network, remains a pressing challenge.

WHAT WERE THE RESEARCH OBJECTIVES?

Objectives included:

- Perform a comprehensive literature survey on the existing work on communicating information to non-connected road users.
- Explore communication options for non-connected vehicles and VRUs.
- Determine the use-case-specific feasibility based on communications delay/latency to VRUs.
- Demonstrate several use-case studies on the MLK Smart Corridor in City of Chattanooga.

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WHAT WAS THE RESEARCH APPROACH?

The design of V2P/I2P systems has been influenced using a variety of communication technologies. The research team approached the research by initially providing a brief overview of each communication technology and its specific characteristic. Delving into the performance evaluation of V2P communication. Finally, exploring the communication system established on the test bed and presenting the results derived from it.

WHAT WERE THE FINDINGS?

The performance of the communication system is heavily impacted by several factors such as wireless communication technologies, modulation type, bandwidth, antennas, local environment (topography, vegetation, weather, temperature, humidity, etc.), environmental electromagnetic noise, transmission power and receiver sensitivity and others.

It was necessary to perform the assessment of key wireless technologies, including LTE, and Bluetooth Low Energy (BLE) with a particular focus on gathering performance statistics and evaluating their applicability in ensuring safety and mitigating collision avoidance in Vehicle-to-Pedestrian (V2P) communications. To achieve our objectives, we have developed a cost-effective Software-Defined Radio (SDR) based testbed. Our primary emphasis lies in assessing the quality of service (QoS) and robustness of such a system to determine its suitability for supporting road safety applications and enhancing cooperative awareness in smart cities.

IMPLEMENTATION AT TDOT

Utilizing Software-Defined Radio (SDR) offers a streamlined approach to wireless technology evaluation, enabling cost-effective performance assessment of LTE, and BLE transceivers. SDR's software-based parameters simplify implementation, facilitating rapid prototyping and experimentation in real-world scenarios, ultimately enhancing V2P communications and smart city safety.

For future work, we recommend focusing solely on C-V2X and evaluating both LTE and 5G cellular-based implementations as well as PC5-based direct communication in real-world environments across diverse geographical areas, weather conditions, and obstacle densities.

We recommend developing a C-V2X enabled VRU collision alert system that leverages bidirectional communication between pedestrian user devices and interconnected roadside infrastructure to deliver real-time hazard warnings and improve situational awareness.

We also recommend that TDOT further research delivering warning messages to VRUs via personal devices like smartphones, tags, and helmets. Field studies should evaluate real-world behavior after receiving alerts, compare device effectiveness, study optimal warning modalities and frequency, and examine technical connectivity challenges.

MORE INFORMATION

Find the final report here: [link the final report].

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