Enhancing Road Safety with Cost-Effective Wireless Technologies

Tharaka Samarasinghe[1], Roshan Sandaruwan2, Kasun Hemachandra[3], Isuru Alagiyawanna[4]
Sameera Sandeepa[5], Suyama Dias[6], Tilan Wickramarachchi[7],
Nayan Dharmaraj[8] and Dileeka Dias

Abstract

Intelligent Transport System (ITS) applications are imperative for improving safety and efficiency on the road; for instance, accidents at railway and pedestrian crossings with fatal outcomes are frequently reported. According to the Department of Railways, more than 200 deaths due to railway accidents have occurred every year since 2018, and the Ministry of Transport statistics reveal more than 3000 deaths reported annually in road accidents, most of which are due to negligence of drivers and pedestrians. To address this problem, we present Active Road Signs (ARS), a system that delivers roadside alerts to the interior of vehicles in the vicinity, for the immediate attention of drivers. Alerts may include information such as a signal light about to turn red, a train approaching a level crossing, a dangerous bend, or pedestrians waiting to cross a road. We also demonstrate that ARS can be implemented with low-cost, off-the-shelf components. ARS consists of two components; sensing for the acquisition of dynamic roadside information, and communication, to relay the sensed information to relevant road users. The sensed information can be used locally, for example, to control signal timing for pedestrians at an intersection. Similarly, the information may also be conveyed to alert vehicles, for example, at a railway crossing. To illustrate ARS, we present a pedestrian safety application based on a novel use of the ubiquitous WiFi technology. Pedestrians are detected through a wireless mechanism, and alerts are conveyed to approaching vehicles. WiFi Channel State Information (CSI) processed through a Deep Neural Network (DNN), is used to estimate up to12 waiting pedestrians with 92% accuracy. Our communication technique is capable of relaying the sensed information to a vehicle at a distance of approximately 150m in under 50ms, satisfying the relevant performance standards for ITSs. This allows a vehicle travelling at 50 km/h, a minimum of 2.6s to come to a complete stop at the crossing. The current standard for vehicular communications in ITSs is Dedicated Short Range Communications (DSRC). DSRC is still a costly technology with a low penetration rate even in modern vehicles. Thus it is prohibitive for retrofitting older vehicles, and for three-wheelers and motorcycles. However, WiFi and DSRC standards have a common root. Accordingly, our design and experiments show that WiFi is able to function effectively in ITS applications such as ARS. Traditionally, pedestrian detection is achieved via vision-based techniques which cost approximately 130USD for equipment per installation, while DSRC will add a further 700USD for communication. However, our proposed system with off-the-shelf WiFi components will only cost 76USD for detection and 18USD for delivering warnings to end users. ARS is suitable for suburban or rural settings to reduce the risk of accidents, particularly those involving vulnerable road users. The components of ARS overcome privacy concerns and have no dependency on lighting and weather conditions associated with vision-based techniques. The vehicle-mounted equipment in ARS is affordable to be used even in three-wheelers and motorcycles, statistically the most susceptible to road accidents.

Keywords: *ITS, DSRC, WiFi, CSI, pedestrian, road signs*

Authors Details;

1. Senior Lecturer, Department of Electronics & Telecommunication Engineering, University of Moratuwa, 160020R@uom.lk

2. Undergraduate Student, Department of Electronics & Telecommunication Engineering, University of Moratuwa, tharakas@uom.lk

3. Senior Lecturer, Department of Electronics & Telecommunication Engineering, University of Moratuwa, tilan.c.w@gmail.com

4. Undergraduate Student, Department of Electronics & Telecommunication Engineering, University of Moratuwa, kasunh@uom.lk

5. Undergraduate Student, Department of Electronics & Telecommunication Engineering, University of Moratuwa, 160556N@uom.lk

6. Undergraduate Student, Department of Electronics & Telecommunication Engineering, University of Moratuwa, 160552A@uom.lk

7. Research Assistant, Department of Electronics & Telecommunication Engineering, University of Moratuwa, 160017N@uom.lk

8. Research Assistant, Department of Electronics & Telecommunication Engineering, University of Moratuwa, 160556N@uom.lk

9. Professor, Department of Electronics & Telecommunication Engineering, University of Moratuwa, dileeka@uom.lk