**Wireless V2I Communication Protocols for Driver Assistance**

Conor Power1, Scout Case2, Daniel Collins1, James Tompkins2

1 School of Science and Computing, Waterford Institue of Technology, Waterford, Ireland

2 College of Science and Engineering, Central Michigan University, Mt. Pleasant, USA

**Abstract:**

The project presents an application of Bluetooth low energy beacons as a wireless vehicle to infrastructure V2I protocol. An Arduino will be programmed to transfer from different light states periodically and a circuit will be set up displaying the state of traffic lights visually using red, yellow and green LEDs. The light systems states will be pushed to a cloud server. The Bluetooth low energy beacon will send the URL of the page hosting the data to the Raspberry Pi onboard the vehicle which will be connected to the internet. The Raspberry Pi reads the URL and interprets the state of the lights.

**Introduction:**

The main purpose of the project is to assist the driver when approaching traffic lights by notifying the driver in advance of the state of the of the traffic lights ahead. The proposed concept is applicable in an inner-city area, where speeds are lower allowing for Bluetooth low energy beacons to be more effective.

For a visual display of the traffic lights we will use an Arduino circuit connected to red, yellow and green LEDs. The Arduino will also be programmed to control the states of the traffic lights system changing periodically to mimic an actual traffic light system. The traffic light states will be pushed to an online cloud-based server.

The Bluetooth low energy beacon will search for a device to connect with. When it finds the Raspberry Pi onboard the vehicle it will send a URL in its message. The Pi, which will have access to the internet, will read the URL and interpret the state of the traffic lights. The vehicle can be sent a signal to slow down or continue depending on the state of the lights.

An RC car could serve as a substitute for a vehicle for testing. An accelerometer could be attached to the RC car. The motors of the car can then be signaled to slow down or stop if the lights ahead are amber or red. If the lights are green the car can be notified to continue.

**Scope:**

For the successful completion of this project, there are some key areas to focus on. Connecting the Arduino to a Cloud Platform and pushing the state of the LED’s to a Document. The data pushed to the document will also be in a format that is readable for the Raspberry Pi.

Once the data is on the Cloud platform, accessing the Cloud via a URL that will be stored on the BLE will the next objective. When the Raspberry Pi comes within range of the BLE, the BLE will send the URL to the Pi which needs to access this web page and pull down the relevant data.

When the data is parsed, relevant corrective action needs to be taken with respect to the state of the light. Using the speed calculated by the accelerometer, if the car is deemed to be travelling too fast, the motors will be slowed down by the Pi.

**Rationale:**

The conceptualization of this project was based around the conversion of the typical car from manual to autonomous, while also trying to lower human error as a cause of car crashes. This idea could be easily manipulated to include all forms of traffic signs/signals.

Another motive for choosing this project is the crossover between the Computing students from WIT and the Engineering students from CMU. By constructing an RC car, we are bringing in the skills of the Engineering students to link the pi to the motors and accelerometer and using the Arduino board and cloud hosting brings in the skillset of the Computing students.

**Goals:**

There are three main goals in conducting this project. Firstly, we would like to evaluate the usefulness of Bluetooth as a V2I communication protocol and to highlight its potential strengths and weaknesses. One example of a weakness from a previous study being “in several tests at higher speeds Bluetooth devices could connect, but they were unable to exchange any correct message” [1]. The success of this goal will be determined by our ability to establish a connection and transmit a beacon.

Another goal of conducting our project is to circumvent or limit the time-consuming effect of the handshake protocol. “Measuring handshake time between devices is an important test when it comes to implementing a communication technology in a vehicular environment characterised by a small window in time in which a vehicle can transmit and receive data to/from road infrastructure equipment. As in many applications the amount of data that is to be transmitted is not high, the communication handshake appears to be the main parameter to be considered in deciding the proper communication technology to be implemented in vehicular environment”[2]. We can evaluate the success of this goal by the ability of our Raspberry Pi to connect to the web page and interpret the data in time.

Lastly, we have the goal of successfully implementing an accelerometer onboard an RC car which will measure the acceleration of the car, using the car as a model replacing a real car in our testing process. Considering the speed measured by this sensor we could slow down or stop the motors in the RC car in accordance with the state of the traffic lights.

**Anticipated Challenges:**

The challenges we anticipate facing during the process of developing our project are numerous and vary in degrees of difficulty. These include but are not limited to:   
(i) designing the Arduino circuit, (ii) hosting the traffic light state data on a live web page,   
(iii) sending beacons containing the URL to the Pi, (iv) interpreting the data from the web page on the Raspberry Pi, (v) constructing an RC car with motors and an accelerometer and (vi) using the data to send messages to the driver and stop or slow down the motors if necessary.

**Referenced Literature Reviews:**

[1]Iordache V., Gheorghiu R.A., Minea M. & Cormos A.C. (2017), “Field testing of Bluetooth and ZigBee technologies for vehicle-to-infrastructure applications”. [Online] Available at: https://ieeexplore.ieee.org/document/8246274

[2] Gheorghiu R.A., Iordache V. & Cormos A.C. (2017) “Analysis of handshake time for bluetooth communications to be implemented in vehicular environments”. [Online] Available at: https://ieeexplore.ieee.org/document/8075955

