Vehicle Speed Reduction Based on Authorized Speed Limits

Ali Fadhal Athab, Asaad. S Daghal, and Saif Ali Abas
Al-Furat Al-Awsat Technical University, Iraq
(E-mail: ifadhel1983@gmail.com , ad466kent@atu.edu.iq, saif.fp@v@gmail.com )

Abstract: - Keeping vehicle speed under control according to the speed limit is considered the main key to the traffic departments in the world to reduce vehicle accidents. This paper presents a prototype of a novel idea to control vehicle speed automatically according to the types of roads that the vehicle passes through without human intervention. The Micro-controller unit is interfaced with the RF receiver at the prototype, also with the RF’s transmitters deployed along the hypothetical pathway. The results show a valuable response for controlling a vehicle’s speed according to the speed limit of different types of roads.

Keywords Micro-controller, GPS, GIS, RF

1 Introduction

Nowadays, exceeding the speed limit for driving motor vehicles has become familiar and poses a real threat to people’s lives, as well as the life of the driver himself. Recent studies have shown that changes in the roadway, the presence of roadwork, unexpected obstacles in the roads, and excessive or inappropriate speed are the main reasons behind one-third of the number of fatal and serious accidents [1]. However, the reduction of the number of such accidents caused by exceeding the vehicle’s speed limits needs to be considered.

The smart roads have considered a promising way for a modern transport infrastructure, where it combines a software infrastructure like artificial intelligence and big data with physical infrastructures such as sensors and solar panels [2]. Furthermore, roads can connect to the internet of things (IoT), to collect traffic and weather data, where it can utilize from this type of connectivity to improve safety and traffic management. In general, several research attempts have made suggestions to limit overruns to reduce traffic accidents.

In [3], a smart display and controller (SDC) was designed to alert the driver when the speed limit zone is exceeded, where the information can be displayed on the vehicle. The author suggested placing a Radiofrequency identification (RFID) tag in different zones. When the information has been received from the RFID zones, the message of the speed limit zone will appear on the smart display to alert the driver with an alarm. If the driver does not reduce the speed in the speed limit zone, the SDC unit will automatically send a message through the global system for mobile communications (GSM) that include the details of the vehicle and speed limit zone to the traffic police system. In [4], the author suggested deploying radio frequency (RF) devices along with the work areas (construction areas) and maintenance areas, which send a voice message to the driver to reduce speed, stop or otherwise. The driver can hear that message through the radio channel or receiver device. In [5], sensors were installed in the vehicle to broadcast the collected data, such as car registration plate, car speed, and vehicle speed limit monitoring. The broadcasted data gathered and analyzed by the RF devices deployed along the streets, and the analyzed data would be sent to the traffic department through a special router. In [6], the author suggested to set up a Micro-controller with the car system to
receive a message from the traffic authorities to reduce the speed when the driver exceeds the speed limit. If the driver does not respond to the message, the Micro-controller will turn off the vehicle engine within 10 seconds without reducing the vehicle’s speed. In [7], a method to send a warning message through a protocol Zigbee was considered. The vehicle is tracked through a global position system (GPS), and the warning message would be received from the driver via protocol Zigbee to reduce the vehicle speed.

Basically, there is a standardization for the vehicle’s speed according to the zones or types of roads that vehicles pass through. However, from the literature, the reduction vehicle speed requires human intervention. Therefore, controlling vehicle speed automatically without human intervention is considered a big challenge technically. However, the prevention of vehicles exceeding the limit speed that is specified to each road is the main contribution of this paper.

The rest of this paper is organized as follows: Section 2 describes the methodology and system model. In Section 3, a prototype of the suggested system is explained. Results and discussions are presented in Section 4. Finally, the paper is concluded in section 5.

2. Methodology and system model

Dividing the streets with different speed limits is considered a basic solution to reduce street accidents. In this paper, we designed a prototype to control the speed of the car by gathering the data received from the geographical information system (GIS) and (GPS) or (RF), where the maximum vehicle speed has been divided by the traffic department according to different streets in different areas (see example Fig. 1).

Fig. 1: Different types of roads

Fig. 2: Engine speed control architecture

Generally, the speed of the motor vehicle can be changed by setting the accelerator pedal position (APP), where the variation in the (APP) is forwarded to the Electronic Control Unit (ECU) [8]. Depending on APP, and the data received from different sensors, the ECU has controlled the gate of the throttle [9]. The amendment of the throttle gate position causes the change in the vehicle’s speed. In this project, as shown in Fig. 2, we set a Micro-controller as linked between (ECU) and (APP), where it gathers the data speed of a vehicle from APP. According to the data collected from the APP unit, the Micro-controller will analyze it and compare it with the data that is saved. Then the Micro-controller will decide to stay at the same speed or decrease the vehicle’s speed and send its decision to the ECU unit. Depending on the decision of the Microcontroller, the ECU will turn to decrease or not the amount of spent fuel that affects the vehicle to reduce or stay at the same speed. Also, a proposed system is set to be compatible with the GIS map, where a prototype is connected to the GPS and Micro-controller. The Micro controller is programmed to determine the coordinates of certain areas, where the speed is to be reduced according to the speed restricted zone.
In this proposed system, the GPS coordinate device as shown in Fig. 3 always tracks the vehicle. The Microcontroller receives the data of the vehicle position and decides to reduce the speed level or stay at the same level depending on the specific speed that belongs to the type of street that the vehicle passes through. In addition, the authorities can receive the information of the vehicle’s status from the internet cloud via a Wi-Fi device, which will help them monitor the vehicle when an accident happens.

![Fig. 3: GPS system in vehicle](image)

Due to the high cost for us to implement this project, which needs financial funding. Therefore, for the sake of simplicity, we used a prototype with RF devices instead of a GPS model as shown in Fig. 4. The RF devices are deployed in a different area as transmitters, which sends signals to the vehicles. At the receiver, the signal will pass to the Micro-controller, which will decide to reduce the vehicle’s speed according to the speed limit in that area.

![Fig. 4: Suggested RF system model](image)

In the utilized design, the vehicle has two statuses
(2.1: Normal mode, 2.2: Active mode)

2.1 Normal Mode.

The pedal position value is passed to the Microcontroller unit in the vehicle via sensors and transfers the data to the ECU unit. In this mode, the vehicle’s speed will not be changed since it is below the allowed maximum speed.

2.2 Active Mode.

In this mode, the vehicle’s speed data is always passed to the Microcontroller unit. According to the received data from the RF transmitters, which are specified for each road, the Micro-controller would compare the data with that received from the APP unit. After that, if the driver exceeds the maximum speed limit, the Micro-controller will decide to reduce vehicle’s speed and passes this information to the ECU unit. Fig. 5 shows the flow chart of both normal and active modes.
3. Prototype

A prototype of the suggested system is designed and implemented. The system component consists of two parts. The first part consists of the NRF-24l01 transmitter, the dc power source (battery) and the Microcontroller, type Arduino pro mini (ATmega328). These pieces of equipment are placed in a plastic box as shown in Fig. 6. This part is set in a roadside and customized according to the types of the road through programming the Micro-controller. In the second part, the same components in the first part is compact with the car pattern as shown in Fig. 7. However, the NRF-24l01 is both used as a transmitter and receiver since it has the advantage of a fast connection recipient using the serial peripheral interface (SPI) protocol [10]. In addition, the Arduino pro mini is used in this project due to its small size. Therefore, it can be easy to use it with the small car’s prototype.
4. Results and discussions

In this section, the results from the tested prototype is illustrated. The prototype car is examined on the path of 500 meters, where the path is divided into different regions to emulate the real streets. The certain transmission units are named with an identifier, for example, C, D, etc. The Micro-controller is programmed by the open-source Arduino Software (IDE) version Arduino 1.8.12, where the code as shown in Fig. 8. The Microcontroller receiver part in the car pattern is also programmed via the same Arduino software, where each station is specific for a limited speed, where the receiver code is shown in Fig. 9.

```
#include <RF24Network.h>
#include <RF24.h>
#include <SPI.h>
RF24 radio(9, 10);
RF24Network network(radio);
const uint16_t this_node = 02;
const uint16_t master00 = 00;

void setup() {
  SPI.begin();
  radio.begin();
  network.begin(90, this_node);
  radio.setDataRate(RF24_2MBPS);
}

void loop() {
  network.update();
  //------ Sending -----\n  const char text[] = "СМ";
```
Fig. 9: The receiving station code

It is shown from Fig. 10; the vehicle starts to increase the speed gradually from zero points up to 42 Km/h during the period of 0 to 4 seconds (s) since the maximum speed in the first path is set to 45 Km/h. After that, the vehicle speed drops in the second region to 20Km/h and it stays almost stable at that speed of a period of 5.8 s to 14.2 s, where the vehicle enters a restricted region that set to 20 Km/h maximum speed. When the vehicle has passed the restricted area, it returns to increase its usual speed with the region of 45Km/h.

Fig. 10: Control speed reduction zone

5. Conclusion

In this paper, we tested a new idea to control a vehicle’s speed according to the types of different roads in which the vehicle passes through. It is concluded that the over-speed limit driving can be controlled; thereby serious accidents that cause fatal situations can decrease drastically. Since the maximum speed limit of vehicles depends on several conditions,
such as the speed limit that varies between day and night. Also, it depends on weather conditions, for example, rain, fogs, and dust. Thus, these conditions can be added to this project as future work.

References

1. H. R. TO and M. M. Barker, “White paper European transport policy for 2010: time to decide,” 2001.
2. A.-E. M. Taha, “An iot architecture for assessing road safety in smart cities,” Wireless Communications and Mobile Computing, vol. 2018, 2018.
3. N. Singh and R. Teja, “Vehicle speed limit alerting and crash detection system at various zones,” International Journal of Latest Trends in Engineering and Technology, (Jan. 2013), vol. 2, no. 1, 2013.
4. F. Qiao, J. Jia, L. Yu, Q. Li, and D. Zhai, “Drivers’ smart assistance system based on radio frequency identification: Enhanced safety and reduced emissions in work zones,” Transportation Research Record, vol. 2458, no. 1, pp. 37–46, 2014.
5. K. Kumarmanas, S. Praveen, V. Neema, and S. Devendra, “An innovative device for monitoring and controlling vehicular movement in a smart city,” in 2016 Symposium on Colossal Data Analysis and Networking (CDAN). IEEE, 2016, pp.1–3.
6. H. Gupta, A. Pundir, and O. Sharma, “Rf module based—and seatbelt detection system,” in 2016 Second International Conference on Computational Intelligence & Communication Technology (CICT). IEEE, 2016, pp. 504–509.
7. P. Kochar and M. Supriya, “Vehicle speed control using zigbee and gps,” in International Conference on Smart Trends for Information Technology and Computer Communications. Springer, 2016, pp. 847–854.
8. M. Abdelsalam and T. Bonuy, “Iov road safety: Vehicle speed limiting system,” in 2019 International Conference on Communications, Signal Processing, and their Applications (ICCSPA). IEEE, 2019, pp. 1–6.
9. R. Conatser, J. Wagner, S. Ganta, and I. Walker, “Diagnosis of automotive electronic throttle control systems,” Control Engineering Practice, vol. 12, no. 1, pp. 23–30, 2004.
10. A. Subero, “Usart, spi, and i2c: serial communication protocols,” in Programming PIC Microcontrollers with XC8. Springer, 2018, pp. 209–276.
