Wireless Vehicle Deceleration Speed System (WVDSS)

SULEIMAN Q. ABU-EIN
Department of Mechanical Engineering, Faculty of Engineering Technology,
Al-Balqa Applied University
Amman, JORDAN

Abstract: This work presents an analysis of the problem related to road safety, the idea is to introduce the importance of obtaining more seriousness with committing the traffic rules, and more safety for roads and vehicles. This work provides a system, that replaces the systematic road bump with a transmitter that sends a signal to the coming vehicle's Electronic Control Unit (ECU). Wireless connection will be between the vehicle and the transmitter placed at the bump's supposed position, to send signals or waves to be received by the receiver in the vehicle's ECU. It was found that this system will increase the commitment of drivers to traffic signals which control the speed of cars and limit their speed at the allowable speed limits.

1 Introduction

The main causes of accidents area unit vehicle over-speeding, driving once overwhelming alcohol, distraction throughout driving, non-adherence to traffic signals, non-wearing of seat-belts and safety gears, tailgating, poor lane discipline etc. However, in most of the countries dashing or excessive vehicle speed on the road is taken into account to be the only biggest issue for road accidents conducive to fatal injuries or perhaps death and monetary prices to society.

the main turning purpose in history is formed by indusrial revolution, and virtually every acpect of our way of life was influenced in a way. In a part, average financial gain and population began to exhibit unprecedented sustained growth [1].

After or through this industrial revolution as spoken before, it has effects, many things have been made in order to meets the human needs. Of course this revolution its influences continue many years after, one of the biggest noticed results from it were the cars founding. Humans have been using cars over many years, and this is why they are produced to service the humans, but it also as seen it has many effects on the human life, like increasing death percentage caused by driver vigilance which causes in traffic accidents, increasing in driving speed, and decrease the health level due to increasing in the percentage of the emissions in the air.

Deceleration of the vehicle's speed is very important to avoid collisions. The trafic system consists of vehicles with wide variation in their diminsions, weights characteristics, which affect treir deceleration behaviour. Drivers must decelerate their vehicles from their maximum speed to zero speed in shortest time [2].

Some technologies will shield folks in collisions solely to a precise extent, these technologies like pretension life belt, airbag, Anti-Lock brake, Traction system, and Electronic Stability Programs. They solved this drawback by causing a warning to driver once the driving force seems drowsy., Zutao Zhang, et al. [6].

This is a big problem, the expected solution is by follow laws and rules called the ''Traffic Rules'', like:

- The main and the most important rule is the sdie of the driving in the road, left or irght. Then the location of the signs according to the type of the road.
- High vegicle speed, more than the maximum limits at the roads, is one of the problems to avoid crash.
- The width of the road also take a place in reducing crashes, for example, single or multilane raod. Multilane street or road can accommodate more than tow vehicles, whereas single lan just one vehicle for each direction [3].

Depending on Kong W., et al. [4], and Li G., Lin W. [5] studies, a serious issue was the apparent decrease within

the driver's sensory activity senses, like feeling, recognizing, and dominant the vehicle's skills, once they became drowsy. Statistics show that the most explanation for deaths and injuries in traffic accidents is that the low level of driver alertness.

In many countries, roads are designed and organized on a specifec rules and shapes. One of the visual and touchable safety factors on the road is the bump or hump, which used to force the drivers to decrease vehicle's speed at some locations on the road. These bumps have a little high in the pavement layer, and constructed in specific way and made of asphalt of rubber.

Using such bumps commits the driver to the traffic rules and safety bases, has many disadvantages on the vehicle and on the passengers comfort and may causes serious mechanical faults.

To avoid these problems a wireless system will be designed to provied information to the vehicle's control unit to automatically slow down the speed if the driver will not response to speed limitations at the road.

2 Working principle of Wireless Vehicle Deceleration Speed System

The system composed of a sender or transmeter of signals and a receiver, the sender must be placed at the supposed pump location, and the receiver in the vehicle, the sender device distributes the signals to be detected from the receiver of the incoming vehicle, when the receiver starts to detect the signals from the sender, these signals provides information to the vehicle about the speed limit, and gives alarm to the driver in order to start reducing the speed, depending on the strength of the received signal, if it was strong that's mean the vehicle's speed must be reduced to the allowable speed. As the reciever detects the signal, it sends an order to the warning sign (lamp) at the dshbord to illuminate immediatly as shown in Figure 1.

Fig.1 Some warning traffic signs

If the driver does not response or made any action, then the WVDSS skips to the next step, which is responsiple to process the input signals and send a signal to appropriate actuaters to control and limit the speed. Wireless Vehicle Deceleration Speed System (WVDSS) Imagine, that you can avoid the breaking in traffic rules, and mechanical damage in car that caused by bumps, now it is possible using wireless vehicle deceleration speed system (WVDSS), which is based on wireless network that provide signal to the vehicle through alternate signals, used for alarm the driver.

Wireless vehicle deceleration system, the system formed from sender or distributor signals and a receiver, which the distributor must placed at the supposed bump locate, and the receiver in the vehicle, the sender device distributes the signals to be detected from the receiver of the incoming vehicle, when the receiver starts to detect the signals from the distributor, these signals provides information to the vehicle in order to start alarming driver or reducing it speeds, depending on the strength of the received signal, if it was strong that's mean the vehicle speed's must be reduced to the allowable speed.

If the driver does not make an action, WVDSS is skip to next step, which is responsible to process the input

Suleiman Q. Abu-Ein

signals that coming from different devices and sends a signal to different actuators to control the speed in gasoline engines Wireless vehicle deceleration speed system is focus of three main categories:

- Network.
- Road.
- The vehicle.

Many researcher discussed this issue, Sawalha (2015) created a system that aimed to regulate vehicle's speed in accordance with the road and road regulation. The system finds out the whereabouts of the vehicle then it identifies the allowed speed for that individual place. After this, it starts decreasing the speed bit by bit till it reaches the fascinating limit. once the vehicle runs, The GPS finds the placement of the vehicle then it sends the great circle and therefore the latitude to the management unit to spot the regulation of the road.

If it's found that the vehicle speed exceeds the permissible limit, a symptom is distributed to the brake to scale back the speed till it drops to the utmost limits. one in every of the foremost vital options of the system is that it senses the distances between 2 vehicles victimisation the inaudible sensing element, that permits a precise distance between them commensurate with their speed, which ends up in no accidents and accidents. All this can be evaded olympian the regulation of the streets. within the event of a system failure within the event of any malfunction, a warning message containing the vehicle range and knowledge concerning it'll be sent to the Traffic Department as a comment.[7]

Christy et al. (2019) presented a successful technique for automatically controlling the decelerating system by proactively recognizing accident-prone zones and avoiding accidents from occurring For effective operation of the decelerating system, this technology employs Arduino, L293d motor driver, and ultrasonic sensor, Machine Learning methods, RFID, and RFID protocols. This technology must be embedded in a vehicle's dashboard and backed by secure RFID and machine learning algorithms in order to properly operate the decelerating mechanism

To reduce the incidence of accidents, the driver's driving style in different situations is analyzed using the Car Trips data log and the terra acelerolinear dataset. The trained data is used to develop a mobile application which when installed in the windshield of the vehicle helps the driver to control the deceleration system thus avoiding accidents and reckless driving [8].

Zhang et al. (2016) projected a lively vehicle controller safety model supported driver alert detection, scattered illustration victimisation cheap , convenient and wearable medical instrument EEG sensors, and thin illustration. The projected system is split into 3 main steps: a wireless wearable EEG assembly, driver alertness detection, and a vehicle speed management methodology. 1st of all, a convenient, low-cost, wearable, home-made brain-computer interface (BCI) system with eight channels for collection the driver's EEG signal was designed. Second, wave form noise removal and sample bottoming algorithms square measure wont to improve the standard of EEG information, and a Fast Fourier rework (FFT) is adopted to extract the EEG Power Spectrum Density (PSD). At now, PSD is ab initio wont to assess the driver's attention level victimisation thin illustration classification plus k-single-value analysis (KSVD). Finally, to avoid major collisions and traffic accidents, a novel vehicle speed management safety strategy has been projected, that regulates electronic throttle gap and automatic braking once driver fatigue is recognized victimisation the preceding approach. Simulation and actual take a look at results show that the construct of active vehicle safety is feasible [9].

Markevicius et al. (2019) finding a good thanks to estimate the speed and length of a vehicle remains a challenge for engineers and scientists functioning on Intelligent Transportation Systems. The electricity sensors are created from polyvinylidene salt (PVDF) and used as a reference device. The ways applied within the analysis box live are well-known: the fixed threshold-based technique and additionally the adaptive two-extreme-peak detection technique. However, the improved accuracy of length estimation by mischief is one amongst the ways that depends on calculative the discriminant quotient for a time-discrete signal (representing changes within the magnitude of the Earth's magnetic flux), being determined. The obtained results, i.e. vehicle speed and length, are shown for various values with increment Δn used for numerical differentiation of magnetic flux size knowledge. The results were achieved in real traffic conditions once analyzing the M = 290 knowledge set of auto signatures. Accuracy was evaluated by calculative MAE (mean absolute error), RMSE (root mean sq. error) for various categories of compounds. MAE is within the range from zero.52 m to 1.18 m when an appropriate calibration factor is used. Results depend upon the

space between the sensors, vehicle speed, and also the applied signal process methodology [10].

3   Results and Discussion

General system operation is decribed here, the Wireless vehicle deceleration speed system composition which uses electronic circuitis shown in Figure 2 below. As discussed before, the signal has been received, and then the system will act to get the required response.
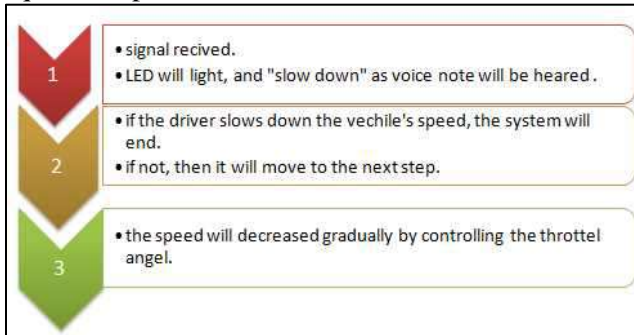

Fig.2 General system operation steps

First, receiving the signal:

Now, what will happen when the signal is received?

The next block diagram in Figure 3 shows the block diagram of the first step of which what happened to the vehicle.
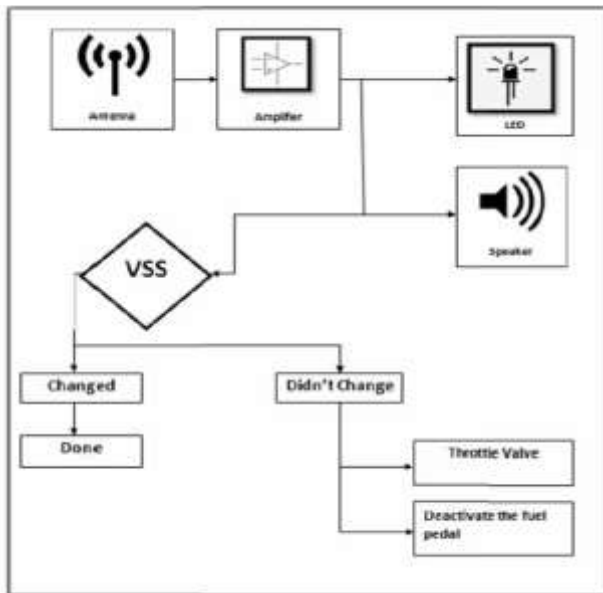

Fig.3 First step on the system procedure

4   The system flow chart

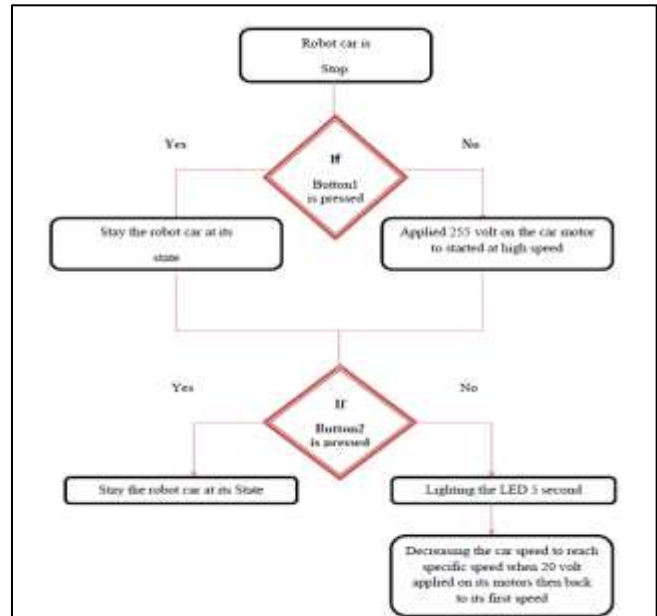It illustrates the principle of a system which applied on arduino. Figure 4.

Fig.4 System flowchart

Deceleration zone when the drivers make an action: It's a zone where the vehicle will travel from when the driver is alert to when it come to specific speed that the vehicle must passage the road.

4.1 Declaration time

Deceleration time is divided into several parts as follows:

4.1.1 The driver's reaction time:

The time required to alert the driver that there is bump, and determine what he/she can do about it.

This time it takes from 0.5 to 1 second for people with an average age, this depends on the age of the driver, state of mind, busy talking on mobile phone or alcohol drink.

On that period (driver's reaction time) the car is in motion at a constant speed, a vehicle speed follows to this physical law:

$$S = V \times T \tag{1}$$

Where: S is the distance during that time, in meter m, V is a vehicle speed meter per second (m/s) which is equal kilometer per hour divided on 3.6 ((km/ h) /3.6). T is the driver's reaction time (average 0.75 seconds).

The effect of speed on the driver's reaction distance, for an example: Vehicle's speed 108 km/h where:V= 30 m/s, and the driver's reaction distance will be:

S=V× T = 30 × 0.75 = 22.5 meters.

4.1.2 Time load brake:
When you press the brake, the work of the brake does not start by simply pressing the brakes, this time in the range of 0.1 to 0.2 seconds; this depends on the situations of the brakes.

4.1.3 Braking time:
With the continued pressure on the brake for working to slow down the wheels speed, this depends on the car's speed and mass, state of the art brake parts braking force, the design of the brake system, having a wheel anti-lock system, tire condition, road condition. As a result the total deceleration time can be calculated according to state of driver and car. Deceleration zone when the driver doesn't make an action: In this case when the driver doesn't make an action WVDSS is active.

The whole deceleration zone in this case is 150 meter according to signal range, this zone is dived to three main distances which are:

A) Alarming Zone
Start from 0 up to 50 meters, the main cause for existing this area to warn the driver
using warring lamp and sound order to slow down.
Physical law that used to calculate the time needed in this zone is: Time = Distance/Velocity

B) Activation Zone
In this zone, WVDSS is moving to the next step, which is starting to decrease the vehicle speed, while the vehicle reaches to a specific speed, it passive through 70 meter at specific time, this time and acceleration can be calculated by several speed relationships:

$$v = v_0 + at \qquad (2)$$

$$r = r_0 + v_0 t + 0.5at^2 \qquad (3)$$

$$r = r_0 + vt - \frac{at^2}{2} \qquad (4)$$

Where: r_o is the particle's initial position, v_o: is the particle's initial velocity, v is the particle's final velocity, a: is the particle's acceleration. By using the relationship number three we can find the time that need to reach to specific velocity and distance.

C) Constant Speed Zne
This zone the vehicle speeds it must stay constant before go through the bump, and this distance must be not more than 30 meters. We use the same relationship that used in alarming zone. For example let us take several car speeds and calculate the time needed from receiving the signal to reach the specific velocity (that

the car must pass through the bump in this velocity). If we take car with 50 km/h speed, and the speed must reach to 30 km/h (This speed represent the speed in traditional bump place), the total time can be calculated:

4.2 Alarming time:
By taking 50 meters alarming distance from detection the signal to the WVDSS start make a deceleration action, this calculation time is:50/13.88=3.6 s.

4.2.1 WVDSS action time:
This distance is 70 meter and the speed must reach to 30 km/h (8.33 m/s), the time can calculated is 6.3 seconds.

4.2.2 Constant speed time:
This distance is 30 m and the speed is 8.33 m/sec, the time is: T=7.7 sec.
The total time is (3.6+6.3+7.7)
=17.6 Sec
Table (1) shows the time to cross deceleration zone when the drivers doesn't make an action.

Table 1 Results of calcualtions

Car speed	Alarming time	Action time	Constant speed time	Total time
40	4.5	7.2	7.73	19.43
45	4	6.7	7.73	18.43
50	3.6	6.3	7.73	17.63
55	3.2	5.9	7.73	16.83
60	3	5.6	7.73	16.33
65	2.77	5.3	7.73	15.8
70	2.57	5.04	7.73	15.34
75	2.4	4.8	7.73	14.93
80	2.25	4.5	7.73	14.48
85	2.11	4.38	7.73	14.22
90	2	4.2	7.73	13.93
95	1.89	4.03	7.73	13.65
100	1.8	3.87	7.73	13.4

Figure 5 shows the relation between total time neede for the alarm system and car speed.
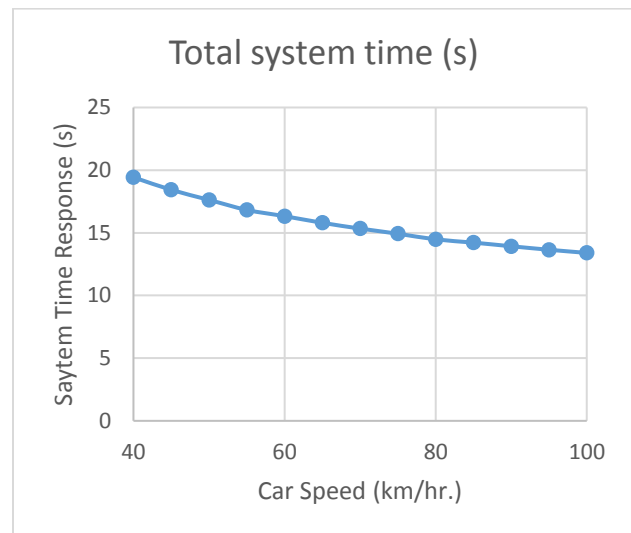

Fig.5 Total system time response calculations

It can be noticed that as the car speed increases the response time of the system increases.

As the results seen, the average total time that is needed from the vehicle received the signals is 15.7 sec. The system consists of the receiver, that captures the signal from the first system and then sends it to arduino which translates this signal to specific commands are applied to the robot that accordance to the signal received from the transmitter , that will be as:

 -If the Button (1) compressed the signal will be send by the transmitter it makes the robot started at high speed when the voltage applied on its motor 255 volt.

 -If the Button (2) compressed the signal will be send by the transmitter it makes the robot stopped.

 -If the Button(3) compressed the signal send by the transmitter it makes the LED on the robot lighting 5-seconde then the motors will be decreasing its speed by decreasing the voltage applied on its motor.

To controlling the robot according to signal received from RF (transmitter) through the receiver we are going to program the arduino board which connected with the receiver, which the

programming shown in the next Figures (6-8).

As the systems' programming is finished with the arduino programmer, applying this programming to the pieces used and connecting the parts together to get to the final result as shown in Figure 6.
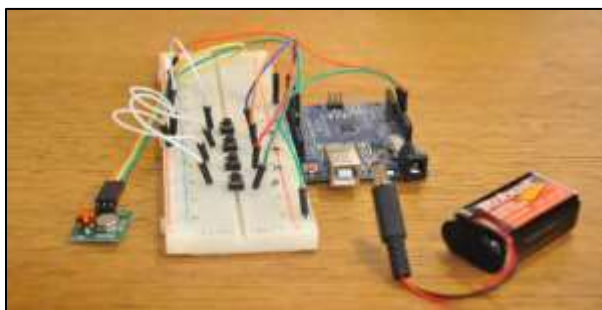
(a)

(b)
Fig.6 (a,b) System simiulation

After running the programming on the two parts, and as spoken before how first button pushed to active the DC motors to move the vehicle, then pushed the second button to active the transmitter and to be received by the moving vehicle, to start decrease its speed, once while it received the signal a warring or green light, the hole operation is attached with a CD with in a recorded video who everything works, while in Figure 7 shows the two systems together in active mood which is WDVSS.

Fig.7 The two systems together in active mood WDVSS

And the Figure 8 shows the vehicle first alarm, which is lighting the lightning emitting diode with a green color.
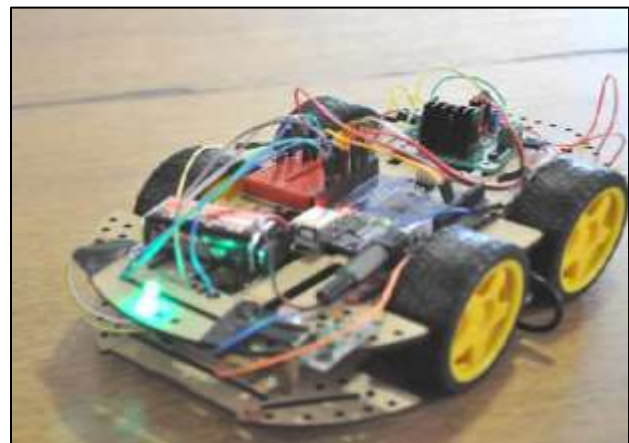

Fig.8 Vehicle first alarm

After showing how the system is applied on experimental vehicle driven by DC motor, decreasing the vehicle's speed when it receives the signal from the transmitter also and after lighting the LED, this application on prototype to clear the implementation

of this operation, and for expelling how the vehicle will deal with receiving the signal from the antenna it was cleared what steps the vehicle will do whether the driver do an action or not, and for sure the distance of deceleration has been taken into account, and also the time respond for different vehicle speeds from the time the receiver detects the signal due to its frequency and range, developing using technology and commenting traffic rules to get to main aim form this project to be the roads place more safety to drive or use. Holding back to what we took through studying about roads and what its demand a exact calculations and standards in designing it and what the allowable speeds in all cases, which has been controlling us in determinations that we used for speed distance of deceleration zone and in time need to decelerate, also how the mastermind of the vehicle the ECU works and how important the information from the different inputs are used in vehicles to decide what to do and what driver want and what vehicle want and the road too, all of this

provide for us a way to make an easy and more accurate controlling and reacts in right time with the right action, while without ECU we can also make an action on the vehicle when it received the signal , by connecting the throttle valve to a variable resistance and this resistance work to dived the current that will pass by it after the signal is received to let the current pass by to let the resistance do its function, and controlling the amount of opening angle of the throttle valve.

5 Conclusions

In this system, when the vehicle received the signal, and by connecting the throttle valve to a variable resistance and this resistance work to dived the current that will pass by it after the signal is received to let the current pass by which let the resistance doing its function, and controlling the amount of opening angle of the throttle valve, the speed of the car can be reduced uppon regulated speed and so the roads safety increases. This system increases the roads safety by controlling cars speed into acceptable values.

6 Acknowledgment

References

[1] Hawke, Gary. "Reinterpretations of the Industrial Revolution" in Patrick O'Brien and Roland Quinault, eds. The Industrial Revolution and British Society, (1993), pp 54–78

[2] Akhilesh Kumar Maurya, Prashant Shridhar Bokare. "Study of Deceleration behavour of Different Vehicle Types", International Journal for Traffic and Transport Engineering, (2012), 2(3),pp. 253-270.

[3] Heinrich Hertz. "Electric waves; being researches on the propagation of electric action with finite velocity through space", Cornell University Library Historical Monographs Collection. Reprinted by Cornell University Library Digital Collection, (1893)

[4] Kong W., Lin W., Babiloni F., Hu S., Borghini G. Investigating driver fatigue versus alertness using the granger causality network. Sensors. 15:19181–19198. doi: 10.3390/s150819181. [PMC free article] [PubMed] [CrossRef] [Google Scholar], (2015)

[5] Li G., Chung W.Y. Detection of Driver Drowsiness Using Wavelet Analysis of Heart Rate Variability and a Support Vector Machine Classifier. Sensors, 13:16494–16511. doi: 10.3390/s131216494. [PMC free article] [PubMed] [CrossRef] [Google Scholar], (2013).

[6] Zutao Zhang, Dianyuan Luo, Yagubov Rasim, Yanjun Li, Guanjun Meng, Jian Xu, and Chunbai Wang, A Vehicle Active Safety Model: Vehicle Speed Control Based on Driver Vigilance Detection Using Wearable EEG and Sparse Representation. Sensors MDPI, 2016, 16(2), pp. 242.

[7] Salameh A. Sawalha, Vehicle Speed Control Equipped with Special Combinations, Brake System and Safe Distance Measurements. IOSR Journal of Engineering (IOSRJEN), 2015, Vol. 05, Issue 05 PP 42-51.

[8] A. Christy, S.Vaithyasubramanian, Viji Amutha Mary, Naveen Renold J., Artificial Intelligence based Automatic Decelerating Vehicle Control System to avoid Misfortunes. International Journal of Advanced Trends in Computer Science and Engineering, 2019, Vol.8. No.6, 3129-3134.

[9] Zutao Zhang et al., A Vehicle Active Safety Model: Vehicle Speed Control Based on Driver Vigilance Detection Using Wearable EEG and Sparse Representation. Sensors 2016, 16, 242; doi:10.3390/s16020242

[10] Vytautas Markevicius et al., Vehicle Speed and Length Estimation Errors Using the Intelligent Transportation System with a Set of Anisotropic

Magneto-Resistive (AMR) Sensors. Sensors 2019, 19, 5234; doi:10.3390/s19235234.