RASPBERRY PI BASED DRIVER STATE ANALYSIS USING AI TO AVOID ACCIDENTS

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Abstract

Today the main problem faced due to accidents are driver state analysis and condition of driver. Drowsy Driving can be extremely dangerous.A lot of road accidents are related to the driver falling asleep while driving and subsequently losing control of the vehicle. However, initial signs of fatigue and drowsiness can be detected before a critical situation arises. Driver drowsiness detection is a car safety technology that helps to prevent accidents caused by driver getting drowsy. Therefore, this article aims to design and develop driver drowsiness detection using image processing for detecting whether the driver is feeling fatigued or sleepy, where it first detects the eyes of the person and computes how much time the eyes are closed. If the eyes are closed for a while, thenthe system will produce buzzer alert which wakes him up immediatelyand preventsfrom an accident. In addition, this proposed systemimplements seat belt alertthrough blinking of red led andit also automatically alerts the drive through a vibration motor.

Keywords: Raspberry Pi, driver drowsiness system, Camera module, artificial intelligence.

1. Introduction

Driving- and road safety are current and growing problems with global dimensions. According to the global status report on road safety conducted by the World Health Organization (WHO) in 2013, 1.24 million traffic-related fatalities occur annually worldwide, currently the leading cause of death for people aged 15–29 years [1]. As a result of the increased need for mobility in developing countries the continuous expansion of vehicle manufacturing is evident. The evolution of the global vehicle fleet causes an infrastructure backlog [2], which in turn is responsible for increased traffic safety risks and accident prevalence. Driver assistance and safety awareness programmes have been an area of focus to minimize road safety incidents, and since the WHO launched their "Decade of Action in Road Safety (2011–2020)" programme, a remarkable improvement in road safety has been noticeable [3]. Despite the growth of 15% in the annual number of registered vehicles from 2007 to 2013, the annual fatalities remained stable in the region of 1.2 million over the same period [4]. However, a saturation in the number of fatalities is not good enough and a reduction should be observed instead. High priority is given to traffic safety improvements by government agencies and major automobile manufacturers across the globe to address this problem, and innovation in driver assistance is currently in demand.

The contribution of human behaviour towards traffic accidents is an important area of interest in the remedial attempts to address the global road safety problem. A clear distinction needs to be made between errors and violations to ameliorate traffic accidents, due to the different psychological originsof these components of human behaviour, as well as the dissimilar forms of remediation [5]. The Driver Behaviour Questionnaire (DBQ) is a metric widely used in driver behaviour studies over the past few decades and focus falls on the correlation between the sub-components of both violations and errors, and the degree to which these components are related to crash involvement [6]. Around 12,000 novice drivers were tested repeatedly with the DBQ in the first six months after they passed their driver's licence tests and analysis of the data accumulated from this experiment proved the trustworthiness of the DBQ as a driver behaviour measure in traffic accident prediction [6]. The integrity and validity of the DBQ has been confirmed [7]. The statistical correlation between driver behaviour and crash involvement is particularly related to individual variability associated with numerous parameters such as age, gender and geographic locations [8]. Interestingly, DBQ results shown that violations declined with age as opposed to errors and the prevalence of violation is higher in men than in woman [5,7]. Results obtained using the DBQ are used as predictor of self-reported traffic accidents, but the question regarding the trustworthiness of the metric is raised due to the reporting bias and the non-real-time recording of the measurement, which serves a remedial instead of a reactive purpose, and therefore real-time evaluation of driver behaviour information and patterns are investigated as a solution to mitigate risk through driver assistance and early warning of predicted dangerous situations.

One of the primary focusses of this investigation is to analyse research in the area of driver behaviour solutions in order to address road safety problems. This is achieved through the identification and understanding of the relationship between driver behaviour and road safety, and the classification of drivers using their propensity to risk [9]. The relationship between the driver and the vehicle control, and the sensitivity of the driver to complex driving environments or situations (e.g., weather, traffic) are major contributing factors towards traffic accidents [10]. According to [11], traffic accident involvement is more closely related to human judgement and decision-making than the mere inability to control the vehicle, and therefore, the focus of driver behaviour and decision-making patterns became a popular research area in road-safety applications. The authors in [11] approached the study of decision-making in two different ways: To analyse the beliefs and values that constitute the decision process, and to evaluate the style of decision-making based on individual habits and personality traits. The second approach proved to be representative and measurable in applications through the classification of drivers into predefined driving styles.

2. Related work

Driver and Road Safety Concerns in Developing Countries Driver and road safety improvement programmes, for instance remedial driver education programmes, are more actively pursued in first-world countries with specific reference to available driver behaviour and driver style information. Although results from the UK Department of Transport's report for road casualties in Great Britain for 2011 indicates that the decrease of 5% in road accident injuries and fatalities from the previous year is attributed to driver awareness campaigns [14], strong evidence opposing this claim is given in [15] in which trial reviews indicated that no impact exists of driver education on the reduction in traffic crashes or injuries. Other possibilities should therefore be investigated.

Third-world countries especially struggle to address road and vehicle safety concerns due to infrastructural and economic challenges. These challenges are introduced by the rapid growth of vehicle fleets, increased driver carelessness and neglected law enforcement in these countries. The Ministry of Works of Malaysia provides evidence of this statement in research findings, attributing 41% of vehicle collisions as the direct result of driver carelessness [16]. More evidence is described in [17], that although vehicles cater for human convenience and mobility, bad driving practices, traffic congestion and vehicle maintenance negligence threaten peoples' lives and property. The International Transport Forum's (ITF) annual road safety report for 2013 ranked South Africa as the country with the highest number of road fatalities, from the 37 countries evaluated, with a roadfatality ratio of 27.6 deaths per 100,000 inhabitants in 2011, as opposed to developed countries such as North America with 10.4, Australia with 5.6, and the UK with 4.1 [18]. The result for this sample is shown in Figure 1. It is apparent that an immense void exists in the market in South Africa and other developing countries, with ample opportunity to introduce and implement driver and road safety enhancement solutions through driver behaviour applications.

Vehicle accidents and road damages greatly affect economic growth. The International Road Traffic and Accident Database (IRTAD) also mentioned in the road safety report that the estimated economic cost of South Africa's Road accidents amounts to approximately 24.38 billion US dollar annually [18]. This economic burden is not limited to a single country but has become a general problem worldwide, with accident-related costs in 2011 in the US estimated to be 299.5 billion US dollar [9]. Occupational fatalities are another area that greatly influences economic growth, and according to [19] work-related accidents are the topmost individual cause of occupational fatalities in Australia. It is evident that road safety improvement is an essential responsibility of developing countries world-wide.

3. Proposed methodology

The proposed block diagram of raspberry pi-based driver state analysis system is demonstrated in Figure 1, which comprises of a processor, camera module, seat belt switch, vibration motor as main components and additionally, it has regulated power supply (RPS), LCD and red LED.It first detects the eyes of the person using the camera module interfaced to raspberry pi processor and computes how much time the eyes are closed. If the eyes are closed for a while, then the system producesa buzzer alert which wakes him up immediately and prevents from an accident. In addition, this system implements seat belt alert through blinking of red led and it also automatically alerts the drive through a vibration motor.

Hardware components

- Raspberry pi 3B+
- LCD
- Vibration motor
- RPS
- SD card
- Camera
- Seatbelt switch
- Red LED

Software

- Embedded Python programming.
- Python IDE for compiler, dumping code into Micro controller.

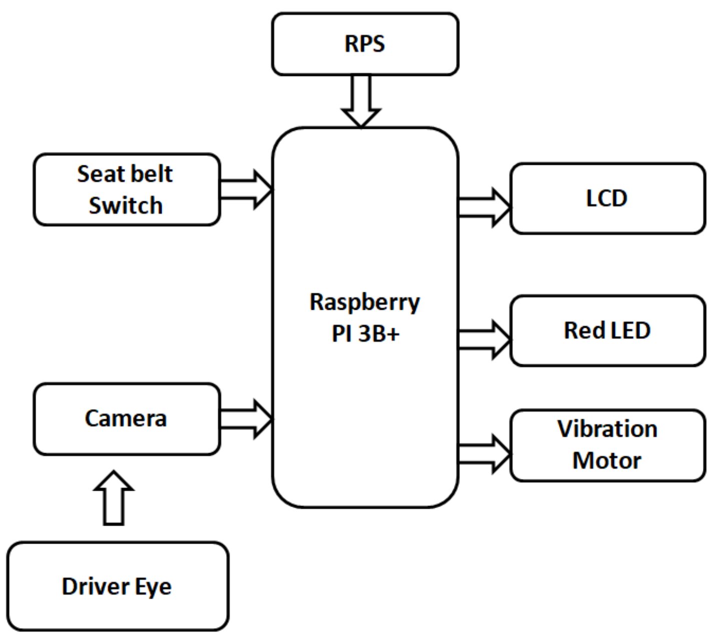

Figure 1: Proposed block diagram of driver state analysis system.

4. Hardware description

4.1 Raspberry-Pi Processor

The Raspberry Pi 3 Model B is the third iteration of the Raspberry Pi microcomputer system. This powerful single board computer, which is the size of a credit card, may be used for a variety of applications and replaces the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B. The Raspberry Pi 3 Model B, while preserving the popular board style, provides you with a more powerful processor that is 10 times quicker than the original generation of Raspberry Pis. In addition, it has wireless LAN and Bluetooth connection, making it the right alternative for strong linked designs that need connectivity.

Since its introduction, the Raspberry Pi has generated a great deal of excitement. The credit-card-sized computer is capable of doing many of the functions of a desktop computer, such as spreadsheets, word processing, and gaming, among other things. It is also capable of playing high-definition video. In addition to being able to run many variants of Linux, it is being used to teach programming to children all around the globe, and it accomplishes all of this for less than $50.

Figure 2: Raspberry-Pi 3 model B+ processor.

4.1.1 Components

The Model B+'s FOUR built-in USB ports are plenty for connecting a mouse, keyboard, or anything else you think the R-Pi requires, but if you want to add even more, you may do so by connecting the Model B+ to a USB hub. It is advised that you utilise a powered hub in order to avoid overstressing the on-board voltage regulator of your computer.

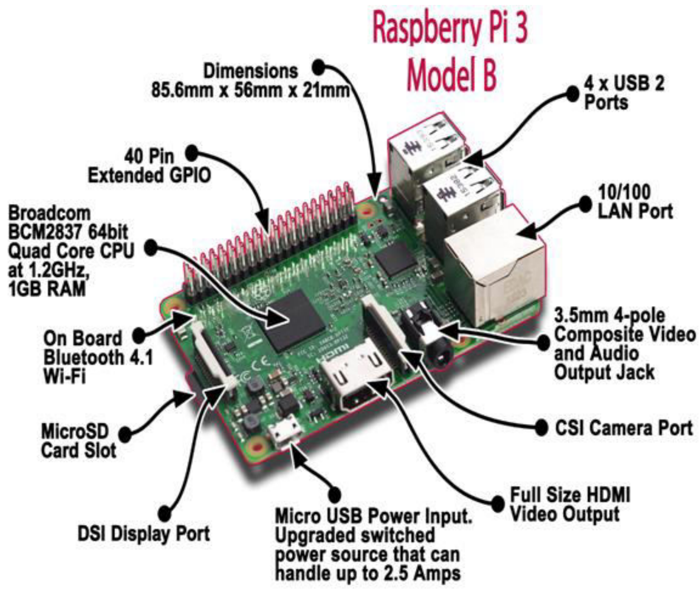

Figure 3: Components of the raspberry-pi processor.

The Model B+'s FOUR built-in USB ports are plenty for connecting a mouse, keyboard, or anything else you think the R-Pi requires, but if you want to add even more, you may do so by connecting the Model B+ to a USB hub. It is advised that you utilise a powered hub in order to avoid overstressing the on-board voltage regulator of your computer. Powering the Raspberry Pi is simple; just connect any USB power source to the micro-USB connection on the board. The lack of a power button means that the Raspberry Pi will begin to boot immediately after being powered on, and to turn it off, just unplug the power cable. The four built-in USB ports can even provide up to 1.2A of electricity, allowing you to connect more power-hungry USB devices to your computer (This does require a 2Amp micro–USB Power Supply).

4.1.2 Processor – specifications

- BCM2835 ARM v7
- Single Core
- 1GHz (same as B/B+ and A/A+)
- Memory: 512MB RAM uSD slot to run OS
- Video: mini-HDMI PAL or NTSC via pads HDMI capable of 1080p
- USB microB for power microB for OTG
- Audio from HDMI port only
- Wireless 2.4GHz 802.11n
- Bluetooth 4.1/BLE

4.1.3 General purpose I/O (GPIO) pins

The term "GPIO" refers to a generic pin on an integrated circuit or computer board whose functionality, including whether it is an input or an output pin, may be controlled by the user at run time. GPIO pins have no specified function and are thus left unoccupied by default. The notion is that a system integrator who is designing a complete system may sometimes need a small number of extra digital control lines, and having these accessible from a chip eliminates the need to design and build additional circuitry to supply these lines.

- GPIO pins may be set to be either input or output;
- GPIO pins can be enabled or disabled.
- Input values are readable (usually high or low).
- Output values are writable/readable.

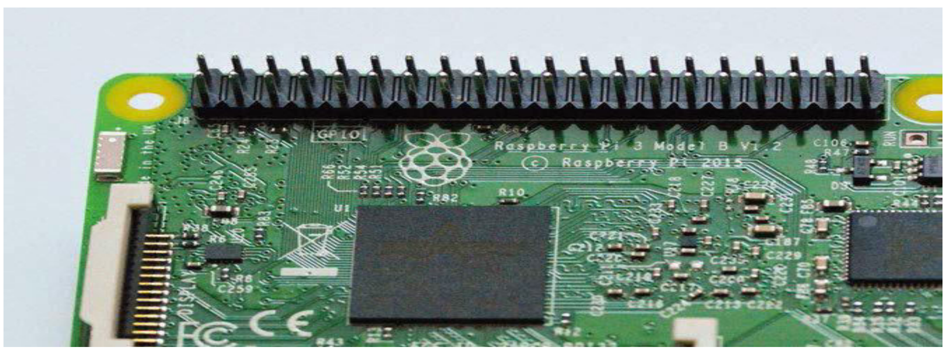

Figure 4: GPIO pins of raspberry-pi.

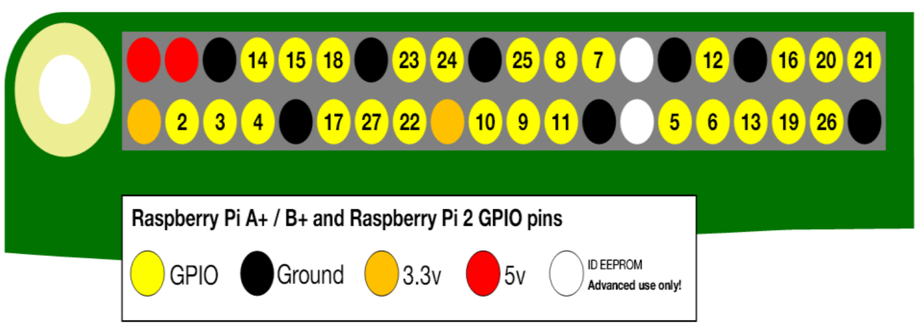

Figure 5: Physical layout of GPIO pins.

The GPIO peripherals are quite diverse. For example, in certain circumstances, they are just a group of pins that may be switched to either the input or the output as a group. Each pin may be configured to take or supply multiple logic voltages, with drive strengths and pull ups/downs that can be adjusted as needed in others. In most cases, but not always, the input and output voltages are restricted to the supply voltage of the device that contains the GPIOs, and higher voltages may cause harm to the device.

4.1.4 Key benefits of raspberry pi

- Low cost.
- Consistent board format.
- 10x faster processing.
- Added connectivity

4.1.5 Applications of raspberry pi

- Low-cost PC/tablet/laptop
- IoT applications
- Media centre
- Robotics
- Industrial/Home automation
- Server/cloud server
- Print server
- Security monitoring
- Web camera
- Gaming & Wireless access point
- Environmental sensing/monitoring (e.g., weather station)

4.3 LCD Display

LCD modules that show information about the current condition of the proposed system. 16*2 LCD module was utilised, with 16 characters each row and 2 rows total, for a total of 32 characters to be shown on the LCD module. This module will provide the current status of all irrigation factors like as temperature, humidity, and pump status.

Figure 6: 16X2 LCD.

4.4 Buzzer

A buzzer is a tiny speaker that serves as both an audio signaling device and a speaker of limited volume. Piezoelectricity is one of the effects that is employed in this experiment, and it is the only one in which the crystals will change form when electricity is given to them. As a result, the buzzer emits a sound when the electricity is delivered at the right frequency. Buzzers are employed in a variety of applications, including alarm devices, timers, and other similar devices.

The buzzer operates in the following manner: when a tone is present, it delivers some frequency of 1KHZ to a specific pin that is utilized, and a delay is used to pause it for a certain number of seconds, after which the buzzer stops the signal. A brief beep sound from the buzzer is produced as a result of continuing this procedure. The output module for notifying the user of any parameter changes is the buzzer. In the event that any sensor exceeds the threshold value or grows, the microcontroller will notify us via the use of this system.

Figure 7: Buzzer

5. Conclusion

This article proposed a design and development of driver drowsiness detection using image processing, which detected whether the driver is feeling fatigued or sleepy. First, it detects the eyes of the person and computes how much time the eyes are closed. If the eyes are closed for a while, then a buzzer alert is produced to waken up the driver immediately, which prevents from an accident. In addition, this proposed system implements seat belt alert through blinking of red led and it also automatically alerts the drive through a vibration motor.

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