IOT—Eye Drowsiness Detection System by Using Intel Edison with GPS Navigation

Auni Syahirah Abu Bakar, Goh Khai Shan, Gan Lai Ta and Rohana Abdul Karim

Abstract The number of traffic accidents continues to increase due to the driver's fatigue has become a serious problem to the society especially for the driver who drove for long distance. Technology in digital computer system allows us to create a drowsiness detection system. Studies for drowsiness detector system have focused on development of computer vision algorithm and lack of Internet of Things (IoT) and notification system, either awake or sleep or might involve in accident, and current location. Thus, we decide to develop a drowsiness detection system with notification of accident and the location by using Global Positioning System (GPS) navigation. In this system, if the driver's eyes are closed about more than 4 s, the driver considers as drowsy and an alarm system will be activated to warn the driver and notify the status and location to relative for further action via message (SMS).

Keywords Eye drowsiness · Intel edison · GPS navigation · IoT
Smartphone setup

1 Introduction

Nowadays, a safe driving is a major concern of societies all over the world. The percentages of car accident also keep increasing year by year. Malaysia also has the highest road fatality risk (per 100,000 populations) among the ASEAN countries that cause by car accidents [1]. There are also some factors that contribute to the car accident which caused by the vehicle problem itself and human behavior. Drowsiness is one of the famous caused in Malaysia which the drivers falling asleep at the wheels.

Normally, after long hours of driving journeys or in absent of alert mental state, the eyelids of driver will become heavy due to fatigue. The attention of the driver starts to lose focus, and that creates risks for accidents. These are typical reactions

A. S. Abu Bakar · G. K. Shan · G. L. Ta · R. Abdul Karim (✉)
Faculty of Electrical & Electronics Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
e-mail: rohanaak@ump.edu.my

Z. Md Zain et al. (eds.), *Proceedings of the 10th National Technical Seminar on Underwater System Technology 2018*, Lecture Notes in Electrical Engineering 538,
https://doi.org/10.1007/978-981-13-3708-6_42

of fatigue, which is very dangerous. Usually many exhausted drivers are not aware that they are falling asleep even for a moment (microsleep). Unfortunately, accident might happen anytime, less than one second. Besides, there are cases of death due to the absence of rescue. No report and emergency call to authorized person due to unknown occurrence and location of the accident by people around there [2, 3]. As a result, injuries become worse and the chances to death are increase.

Therefore, it is essential to develop a real-time safety system for drowsiness detection system which able to monitor eye condition and notify the responsible person (relatives/parent) by sending message and current location that the driver might get into accident. Fast action could be taken to save golden lives of the accident victims, even for a few seconds. By leverage the advancement of internet and communication technology, this project aim to propose a preliminary system of eye drowsiness detection with GPS navigation.

2 Related Works

A lot of studies for drowsiness were focused on development of robust features and algorithm for drowsiness detection such as bio-features [4], yawning [5], skin color [6] and etc. Besides, there also have several studies focused on integrated hardware and software for drowsiness system. Results proved the studies successfully integrated hardware and software elements, but lack of IoT implementation for automatic notification system [5, 7, 8]. As a result, rescue failed arrived as soon as possible.

In-vehicle webcam is commonly installed to realize the possible reasons of car accidents by detection of drowsiness [9] behavior. Recently, smartphone camera have been used widely to replace the webcam due to high-speed (3G, 4G) data transmission [10]. However, studies [5, 7, 8, 10] does not considered setting of smartphone for data acquisitions during the experimental design.

3 Proposed Modelling

3.1 System Design

The overview of the proposed system is illustrated on Figs. 1 and 2. The system involves real time processing and detection of drowsiness are processed by evaluate eye blinking using image processing analysis which is Open Source Computer Vision (OpenCV) [11]. The smartphone camera is attached on the windshield of the car and used as a sensor to capture video. The video are sent to cloud for analyze eye condition either sleep or awake. Synchronously, the GPS navigation module is activated to trace the current location data of the driver. All the captured data of eye analysis and

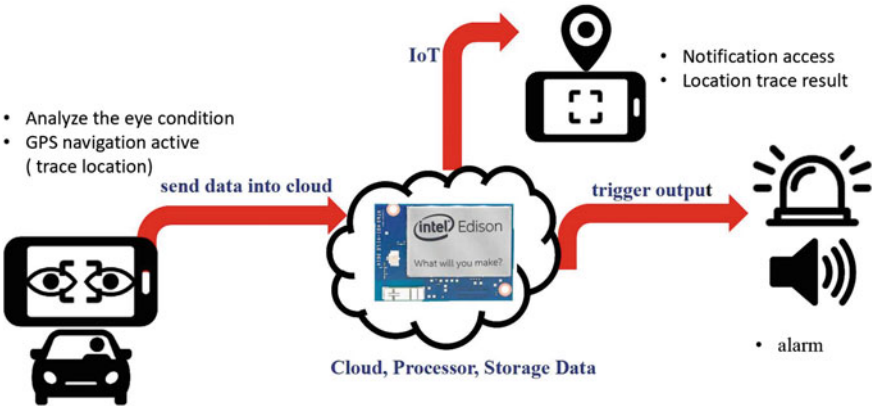


Fig. 1 Overview of the purposed system

location will be send to the cloud storage. Then, the information that has been stored into the cloud will be sent to Intel board for communicating with hardware. Intel processor will trigger the output system via LCD, LED, buzzer and Global System for Mobile (GSM) notification.

The Internet of Things (IoT) also has been implemented into the system, by connecting it using a network wireless connection (WiFi). This system will identify the eyes state of the driver and an alarm system will be activated to warn the driver whenever the driver's eyes is closed more than 4 s [12] and it will send notification message to driver's family members when eyes is closed for another 8 s for further action. According to [12], 4 and 12 s are a blink patterns and lid-contact times in dry-eye for normal subjects.

3.2 Hardware

The system basically consists of Smartphone Camera, Intel Edison board, GSM module, buzzer, LEDs and LCD. Circuit diagram of the proposed system is shown in Fig. 3. Details functions of hardware are explained in Table 1.

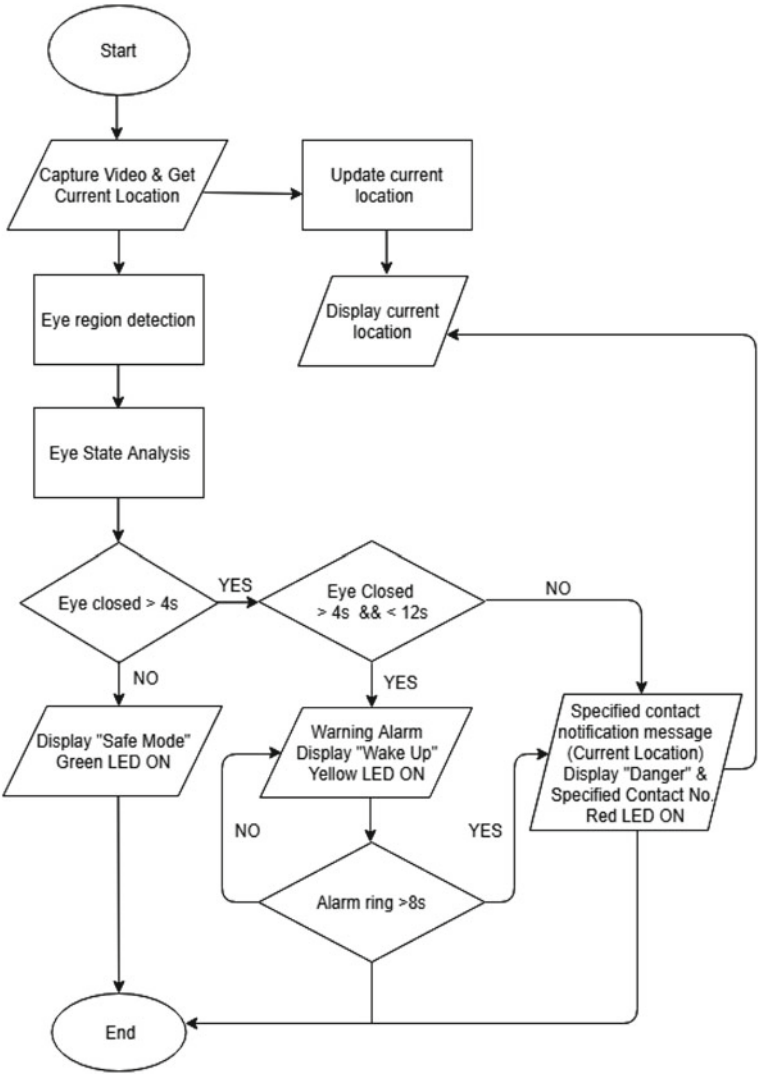


Fig. 2 Flowchart of the purposed system

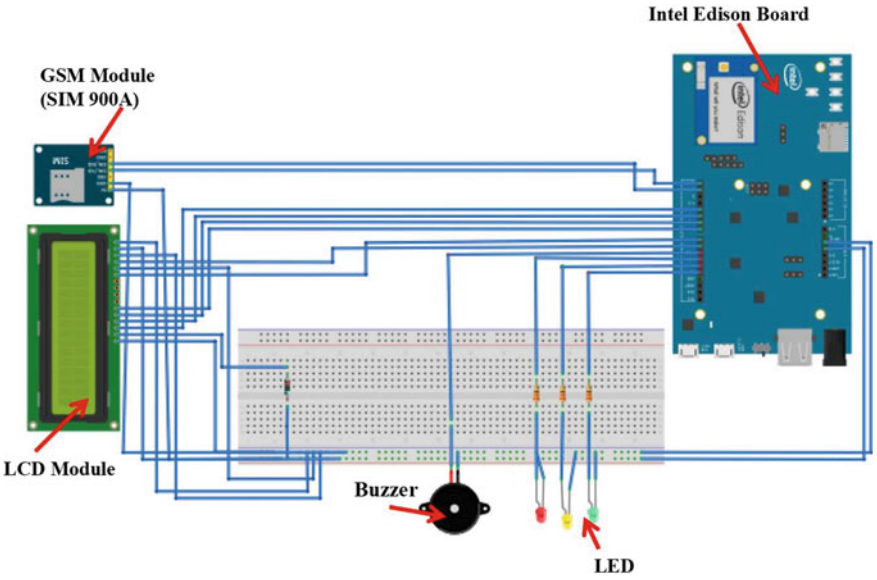


Fig. 3 Circuit diagram of the system

Table 1 Hardware functionality

Item	Function
Intel Edison Board	Intel Edison acts as a microcontroller. It is used to perform various functions and operations throughout the system
GSM module (SIM 900A)	GSM is used in this system for alerting and messaging system to notify the family members or emergency agency by sending message (current location) when the driver is suspected to involve in accident
LCD module	The I2C 1602 LCD module is a 2 line by 16 characters display interfaced to an I2C daughter board. LCD module is used to display the eyes condition of the driver
Buzzer	Buzzer acts as alarm to wake the driver up, three different led light (Green, Yellow and Red) which is the indicator to show the fatigue of the driver where green led indicates safe mode, yellow led means alarm is ringing due to eyes is closed more than 4 s and red led represents danger mode and message is ready to be sent
Smartphone Camera	A smartphone camera is a video camera that feeds its image in real time by install an IP camera which uses a direct connection using Ethernet or Wi-Fi. This camera will use to capture the eye condition of the driver

Table 2 Image resolution and processing delay measurement

Image resolution (pixel)	Delay (s)	Drowsiness detection
1920 × 1080	15	True
1440 × 1080	12	True
720 × 480	9	True
640 × 480	6	True
480 × 320	3	True
352 × 288	0	True

4 Results and Discussion

4.1 Experimental

4.1.1 Setup Image Resolution (Video)

Experiment to identify the best image resolution was conducted. Table 2 illustrated the experimental results. The lowest image resolution (352×288) performed accurate result with 0 s delay compared to the highest image resolution with 15 s delay. Internet image transmissions for high-resolution video were noisy and prevent the detection from working effectively. This indicates that the lower image resolution is best suited for the proposed system.

4.1.2 Smartphone Placement

The effectiveness of smartphone placement between windshield car and driver was evaluated by varying the distance of smartphone from driver as shown in Table 3. Experimental results found out that the suitable distance of a driver from smartphone camera was 25 cm to less than 100 cm. Distance 100 cm and above shows unstable results between sleeping and not sleeping. It is because when the eyes was located far away from a camera, the image of eye were getting smaller and opened eyes is seemed like closed eyes.

Table 3 Different distances between driver and phone

Distance (cm)	Drowsiness detection
25	True
50	True
70	True
100	True/false

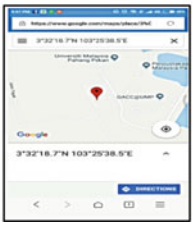
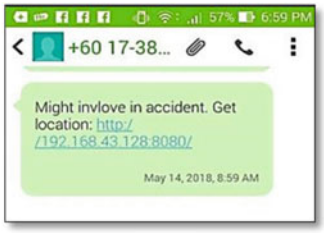
Condition	Result	
The eye is open		
	Not Sleeping is detected	Safe mode on LCD display
The eye is close for >=4s and <12s		
	Sleeping is detected	'Wake up' on LCD display and Yellow LED is ON.
The eye is close for >=12s microsleep		
	'Danger' on LCD display and Red LED is ON.	related/responsible person contact number on LCD display
		
	GPS navigation of driver location	Screenshot of messages sent

Fig. 4 Result hardware and software integration

4.2 Simulation Results

We have successfully detected the drowsy condition of the driver's eye and alert the driver by giving alarm and send the notification to responsible or related person. During this process, when the eyes is not closed more than 4 s then Green LED is ON and LCD will display 'Safe Mode' while the eyes is closed more than 4 s then Yellow LED and Alarm are ON together with LCD display 'Wake Up'. If the driver's eyes are opened after the alarm is rung then the system will go back to the first stage

where Green LED is ON and 'Safe Mode' is displayed. When alarm is rung for more than 8 s, Red LED is ON indicated it is in 'Danger Mode' and at the same time the notification message in terms of current location of the driver will be sent out to the specified contact and emergency agencies. During this stage, the system will continue to display contact number of family members of the driver for the people around the accidents place to call the driver's family members. Figure 4 illustrated visual results of hardware and software integration.

5 Conclusion

Eye Drowsiness Detection system was successfully built as proposed. The phone camera able to capture the eye of the driver and managed to analyze the eye condition i.e. open or close by embedded the information into the Intel Edison board. Besides, output integration of hardware successfully showing the Green/Yellow/Red LED, LCD and buzzer as a signal to indicate and display the condition of the driver as proposed design. The best setup for smartphone placement is between 25 and 99 cm. Meanwhile, for image resolution is 352 × 288 pixel. In addition, this study also successfully implemented Internet of Things (IoT) into our system by developed a sending notification system and GPS navigation access.

Acknowledgements We would like to acknowledge funding provided by Universiti Malaysia Pahang (RDU1703233).

References

1. Ruxyn, T.: Says.com. Retrieved from http://says.com/my/news/malaysia-sroads-among-the-world-s-most-dangerous-and-deadliest. Last accessed 01 Sept 2018
2. https://www.hmetro.com.my/mutakhir/2018/03/324770/derita-kereta-terhumban-dalam-gaung. Last accessed 01 Sept 2018
3. http://www.sinarharian.com.my/mobile/semasa/dua-kanak-kanak-maut-dalam-kemalangan-di-lpt-1.406312. Last Accessed 01 Sept 2018
4. Ghazali, K.H.B., Ma, J., Xiao, R.: Driver's face tracking based on improved CAMSHIFT. Int. J. Image Graph. Signal Process. **5**(1), 1 (2013)
5. Omidyeganeh, M., Shirmohammadi, S., Abtahi, S.: Yawning detection using embedded smart cameras. IEEE Trans. Instrum. Measur. **65**(3), 570–582 (2016)
6. Ramzi, S.: Proactive driver alert system (PDAS) for drowsy drivers. J. Soc. Sci. (COES&RJ-JSS) **5**(1), 42–55 (2016)
7. Das, P., Pragadeesh, S.: A microcontroller based car-safety system: implementing drowsiness detection and vehicle-vehicle distance detection in parallel. Int. J. Sci. Technol. Res. **4**(2) (2015)
8. Kulkarni, A.S., Shinde, S.B.: A review paper on monitoring driver distraction in real time using computer vision system. Int. J. Comput. Sci. Eng. **5**(6) (2017)
9. Kulkarni, S.S., Harale, A.D., Thakur, A.V.: Image processing for driver's safety and vehicle control using raspberry Pi and webcam. In: 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), pp. 1288–1291 (2017)

10. You, C.-W., et al.: CarSafe: a driver safety app that detects dangerous driving behavior using dual-cameras on smartphones. In: Proceedings of the 2012 ACM Conference on Ubiquitous Computing. ACM (2012)
11. https://github.com/tahaemara/sleep-detection. Last accessed 01 Sept 2018
12. Ousler 3rd, G.W., Abelson, M.B., Johnston, P.R., Rodriguez, J., Lane, K., Smith, L.M.: Blink patterns and lid-contact times in dry-eye and normal subjects. Clin. Ophthalmol. (Auckland, NZ) **8**, 869 (2014)