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Motor Vehicle Driver Monitoring System to Prevent Traffic Accident

M. Taufiq Tamam, Arif Johar Taufiq, Anis Kusumawati

Abstract*: Traffic accident data shows an upward trend. One of the contributing factors is the condition of the driver who is tired or sleepy due to decreased oxygen saturation in the blood (SpO_2). If the oxygen saturation in the blood (SpO_2) decreases, the oxygen supply to the brain also decreases, which causes the driver to feel tired or sleepy, even to shortness of breath. By using a pulse oximeter sensor mounted on the wrist, oxygen saturation in the blood (SpO_2) can be detected. The results of the sensor readings are then sent using blue tooth technology to the microcontroller and displayed on the monitor. If the driver is tired or sleepy, there will be a warning that the driver should take a rest immediately. Based on the results of trials that have been carried out, the average error in measuring blood oxygen saturation (SpO_2) is 0.52%.

Keywords: Traffic Accident, Driver, Blood Oxygen Saturation (Spo_2), Pulse Oximeter, Blue Tooth.

I. INTRODUCTION

A traffic accident is an incident on the road that is unexpected and unintentional involving a vehicle with or without other road users resulting in human casualties and/or property loss. Traffic accidents can result in victims, both minor injuries, serious injuries or death. Statistical data shows that during the period 2015-2019, the number of traffic accidents increased by an average of 4.87% per year [1]. There are many factors that cause traffic accidents. The biggest factor is the human factor as much as 61%. This is related to the ability and character of the driver. In addition, the physical condition of the driver, such as a tired or sleepy driver, can also lead to traffic accidents. The next factor is the vehicle factor (9%) and the infrastructure/environmental factor (30%) [2]. Pulse oximetry is a non-invasive method to measure the percentage level of hemoglobin (Hb) saturation with oxygen in the blood. This method uses the different wavelengths of red light (660 nm) and infrared light (940 nm) which are captured by the detection sensor after passing through the veins and capillaries at the tip of the index finger [3]. Pulse oximetty serves to manage long-term patients on oxygen therapy and for the identification of patients with congenital heart disease. Pulse oximetry has high accuracy for detecting congenital heart disease in newborns [4]. Photoplethysmography is an optical technique for detecting cardiovascular (heart) pulse waves from the fingertips. By utilizing the reflection of the optical sensor, the area around the skin is heated, as evidenced by the increased pulse of the photoplethysmography component [5]. Smart home system by utilizing blue tooth technology as a medium of communication between android devices and microcontrollers that control objects. Relays are used instead of switches that will turn the lights on and off [6]. The use of blue tooth modules in wireless sensor network (WSN) applications controlled by the ATmega328p microcontroller for building security can replace human labor to monitor buildings. The observed parameters (smoke, temperature, vibration) are displayed on an LCD display [7]. Car control using blue tooth technology connected to an android device can be done within a distance of about 10 meters. As long as the Android device on the system is connected to Bluetooth, the car can be controlled wirelessly [8]. Embedded systems are currently applied in almost every electronic equipment such as robotics, medical equipment, building security, industrial automation, commercial, military. In the field of robotics, blue tooth technology can be used as a communication medium in sending and receiving data from remote devices [9]. The use of machine vision and Adaboost algorithms to detect driver fatigue levels by detecting faces efficiently by classifying the front face and the turned face. Then trained eye open and eye closed classifiers are used to quickly and accurately detect eyes in the candidate region. An index consisting of the PERCLOS and the duration of the closed state is extracted in the video frame in real time. This device is connected to a smartphone or tablet device so that it can be accessed in real time [10].

A new approach for the detection of hypovigilance drivers (fatigue and distraction) based on symptoms present in the facial and eye regions. This method is carried out by matching the face template and the horizontal projection of the facial image and the eye area. The extracted symptoms were the percentage of eye closure, changes in lid spacing and degree of eye closure. Fuzzy expert system is used to combine symptoms to estimate the driver's condition [11]. By using a charge-coupled-device camera with active infrared lighting capabilities to obtain the condition of the driver. The detected cues are eyelid movements, steady movements, head movements and facial expressions. This driver fatigue monitoring system can be accessed online [12]. By using a video camera aimed directly at the driver's pupils and yawning to detect fatigue.

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***** Correspondence Author (s)
M. Taufiq Tamam*, Department of Electrical Engineering, Universitas Muhammadiyah Purwokerto, Jawa Tengah, Indonesia. Email: tamam@ump.ac.id, ORCID ID: https://orcid.org/0000-0002-7993-2382
Arif Johar Taufiq, Department of Electrical Engineering, Universitas Muhammadiyah Purwokerto, Jawa Tengah, Indonesia. Email: arifjt@gmail.com, ORCID ID: https://orcid.org/0000-0001-8023-8796
Dr. Anis Kusumawati, Medical Faculty, Universitas Muhammadiyah Purwokerto, Jawa Tengah, Indonesia. Email: dokteranis@yahoo.co.id, ORCID ID: https://orcid.org/0000-0002-1218-5634

The illuminator is used in environments with low light levels. The Adaboost method is used to find the face and eyes through the driver's image. Driver status is monitored with the PERCLOS algorithm [13].

II. MATERIALS AND METHODS

A. Material

Blood oxygen saturation sensor, microcontroller, bluetooth module, arduino software and nRF connect software.

B. Method

In general, the research diagram is shown in Figure 1 which provides a visual explanation of how the research concept, information flow and infrastructure are involved or needed. The sensor is mounted on the driver's wrist. Communication between sensor devices with microcontroller module using blue tooth media. The sensor sends reading results and is received by microcontroller module and then displayed on the display monitor.

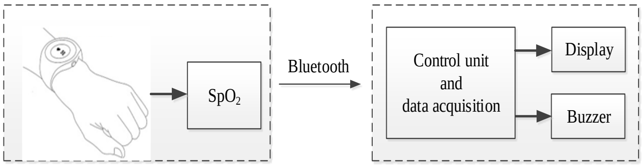

Fig. 1. Block diagram

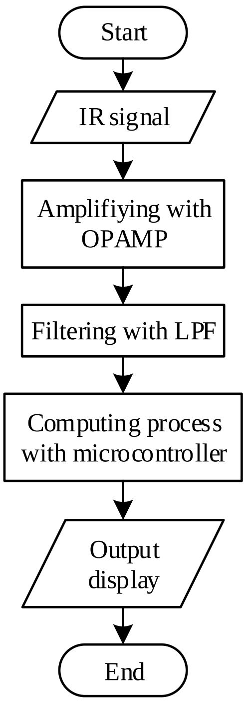

Fig. 2. System flow chart

Figure 2 shows a flow chart of the research process. The sensor is a photo diode that will read the intensity of light absorbed by the blood. The results of sensor readings that are still too small are strengthened by using an operational amplifier (OPAMP). Low pass filter (LPF) is used to remove noise. Once amplified and filtered, the next process is computing using the FFT (Fast Fourier Transform) algorithm and the results are displayed on the monitor display. The measurement results that appear on the monitor display are the heart rate and percentage of oxygen saturation in the blood (SpO_2).

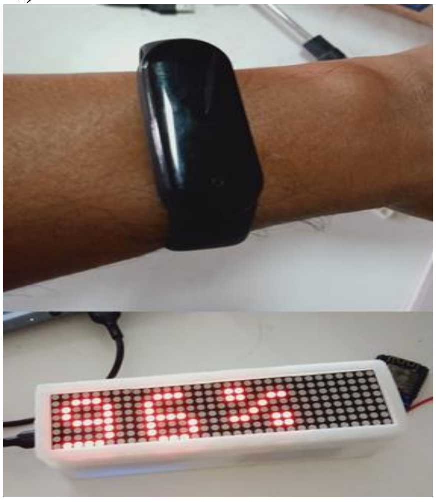

Fig. 3. System realization

The research that has been done is to build a measurement system for oxygen saturation and heart rate for monitoring the condition of motorized vehicle drivers. Measurement of oxygen saturation and heart rate using a non-invasive method, by measuring changes in blood volume or the presence of blood flow using a light sensor mounted on the wrist. Changes in light intensity are proportional to changes in blood oxygen saturation and heart rate. Information on blood oxygen saturation (SpO_2) measurement results and their status is displayed in a monitor display.

III. RESULT AND DISCUSSION

This system is used as a measuring tool for oxygen saturation in the blood (SpO_2) to detect the level of fatigue of motorized vehicle drivers in anticipation of traffic accidents. The oxygen saturation sensor is attached to the driver's wrist (like a watch) so it doesn't interfere with his activities. Before the computational process using the FFT (Fast Fourier Transform) algorithm, the signal from the sensor readings is conditioned by the signal conditioner by amplifying it with an operational amplifier (OPAMP) and filtering it with a low pass filter (LPF).

Table-I: Oxygen saturation measurement results

Respondent	Oximeter (%)	SpO_2 (%)	Error (%)
Respondent 1	96	96	0
Respondent 2	97	96	1.03
Respondent 3	97	97	0
Respondent 4	96	97	1.04
Respondent 5	95	95	0
Respondent 6	96	96	0
Respondent 7	94	93	1.06
Respondent 8	97	96	1.03
Respondent 9	95	95	0
Respondent 10	95	94	1.05

Table 1. shows the results of measuring blood oxygen saturation (SpO_2) for ten volunteer drivers. The measurement process is also carried out using a pulse oximeter as a comparison.

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Overall the measurement results show an error in the range of 0% – 1.06% with an average of 0.52%. The measurement results of respondent 7 read oxygen saturation of 93% and respondent 10 reads oxygen saturation of 94% as a tired category. Normal oxygen saturation values are in the range of 95% - 100%. Drivers who experience hypoxia (blood oxygen saturation < 95%) will have decreased driving concentration. Hypoxia occurs because the oxygen content in the blood is reduced. People who suffer hypoxia, the oxygen content in the brain will decrease. One of the characteristics is drowsiness or feeling tired. The measurement results are graphically shown in Figure 4.

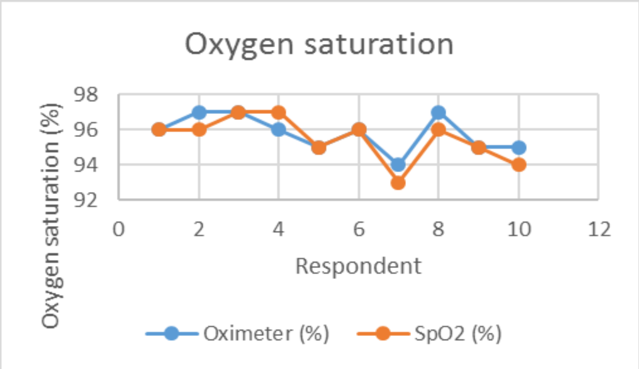

Fig. 4. Graph of oxygen saturation measurement result

Table-II: Heart rate measurement results

Respondent	Oximeter (bpm)	Heart rate (bpm)	Error (%)
Respondent 1	82	82	0
Respondent 2	87	86	1,15
Respondent 3	86	86	0
Respondent 4	83	82	1,20
Respondent 5	78	78	0
Respondent 6	86	86	0
Respondent 7	72	71	1,39
Respondent 8	77	78	1,30
Respondent 9	86	86	0
Respondent 10	65	64	1,54

Table 2 shows the results of measuring heart rate for ten volunteer drivers. The measurement process is also carried out using a pulse oximeter as a comparison. Overall the measurement results show an error in the range of 0% – 1.54% with an average of 0.65%. The measurement results are graphically shown in Figure 5.

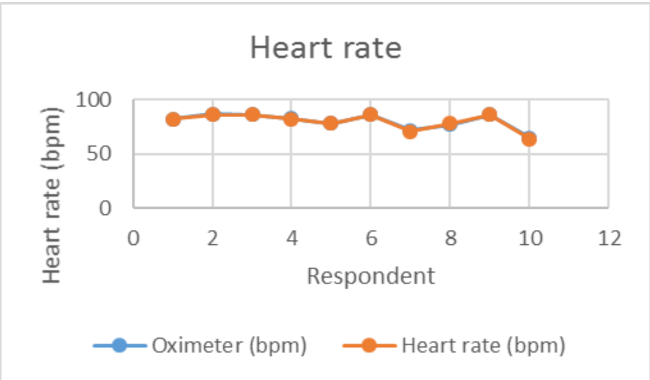

Fig. 5. Graph of heart rate measurement result

The results of the measurement of the oxygen saturation parameter in the blood and heart rate are represented in units of measurement values displayed on the monitor display. The measurement value is fluctuating, because the measurement uses a non-invasive method (without surgery).

IV. CONCLUSION

The system made in this study is able to work according to the plan, which can measure oxygen saturation in the blood (SpO_2) and provide a warning if the measured results are < 95%. The measurement results are compared with a pulse oximeter and show that the percentage of errors that occur is relatively small. The average error that occurs is 0.52% for oxygen saturation measurement and 0.65% for heart rate measurement.

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DECLARATION

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Ethics Approval	We are a research team.
Consent to Participate	We are a research team.
Consent for Publication	We are a research team.
Availability of Data and Material	Not applicable.
Authors Contributions	The first author is responsible for the course of the research and coordinates with the team in designing and realizing the research. The second author is responsible for testing the data on the system. The third author is responsible for analyzing the parameters of the measurement data.
Code Availability	Not applicable.

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AUTHORS PROFILE

M. Taufiq Tamam, S.T., M.T. was born at Cilacap on 1970. Lecturer at Electrical Engineering Departement Universitas Muhammadiyah Purwokerto. Under graduate program has finished at Electrical Engineering Departement Institut Teknologi Sepuluh Nopember Surabaya (1998). Post graduate program has finished at Electrical Engineering Departement Universitas Gadjah Mada Yogyakarta (2005). Research interest on electronics signal system. Publication article: Design a System of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2017), Visualization of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2018). Member of IAENG. Email: tamam@ump.ac.id.

Arif Johar Taufiq, S.T., M.T. was born at Demak on 1971. Lecturer at Electrical Engineering Departement Universitas Muhammadiyah Purwokerto. Under graduate program has finished at Electrical Engineering Departement Universitas Muhammadiyah Yogyakarta (1998). Post graduate program has finished at Electrical Engineering Departement Universitas Gadjah Mada Yogyakarta (2007). Research interest on electronics signal system. Publication article: Design a System of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2017), Visualization of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2018). Member of IAENG. Email: arifjt@gmail.com.

Dr. Anis Kusumawati, M.Sc., M.Med.Ed.. was born at Kebumen on 1970. Lecturer at Medical Faculty Universitas Muhammadiyah Purwokerto. Under graduate program has finished at Medical Fakulty Universitas Diponegoro Semarang (1996). Post graduate program has finished at Medical Faculty Universitas Gadjah Mada Yogyakarta (2014). Research interest on medical science. Publication article: Design a System of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2017), Visualization of Measurement of Heart Rate, Oxygen Saturation in Blood and Body Temperature with Non-invasive Method (2018). Member of IAENG. Email: dokteranis@yahoo.co.id.

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