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MiDA (Microsleep Detection Base on Arduino)

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Abstract:- One of the human factors that cause traffic accidents is sleepiness. This is caused by the circadian rhythm or our body's biological clock which is influenced by body temperature, alertness level, and body energy level. The sleep detection system known as "Microsleep Detection Base On Arduino" is designed to detect heart rate and eye blinking data via Arduino. This tool uses an impulse sensor placed on the tip of the index finger and a proximity sensor placed on assistive devices such as glasses. The proximity sensor is an electronic sensor that can detect the presence of objects in the vicinity without any physical touch that is used to determine whether a person's eyes are open or closed. The method used in this study is the behavioral measure method, namely by paying attention to the movement of the blinking of the eye because if a person is sleeping, the distance between the two eyelids narrows, and the frequency of blinking decreases until he falls asleep. So if this happens the glasses will give a warning as soon as possible. Based on this background, the author's goal is to utilize or develop glasses as a tool that can provide a warning as quickly as possible to sleepy drivers to prevent traffic accidents. The results of this experiment can be helpful for the development of real-time sleep detection and help manage sleepiness to avoid accidents.

Keywords:- *Microsleep, Impulse, Proximity, Traffic Accidents, Sleepiness.*

I. PREFACE

The operator is the person who drives the vehicle, both motorized vehicles and other vehicles such as planes, ships, etc. The ideal time for a person to drive is about 4 hours and then take a 30-minute break, the rules are contained in pasal 90 UU No. 22 Tahun 2009 about LLAJ. The maximum driving duration is 8 hours a day for drivers or workers driving public transport and goods. Each driver is allowed to drive for 4 consecutive hours. This is conveyed or agreed upon so that the driver can safely arrive at his destination and not endanger other people.

Traffic accidents are the 8th leading cause of death in the world (WHO, 2018). Still, according to WHO data (2018), there were 50,416 accidents. The main factor causing traffic accidents is human error, one of which is sleepiness. A study conducted by the American Automobile Association (AAA) (2018) showed that about 10% of traffic accidents that occur are caused by sleepy drivers. Drowsiness is a condition in which the driver loses the power of reaction and concentration due to lack of rest (sleep) and or has driven the vehicle for more than 5 hours without rest (Warpani, 2002). A sleepy rider will have less stamina if he rides a motorbike at 80 km/h for 2 hours without stopping. The number of accidents caused by drowsy riders is because motorcycle riders generally do not feel that they are sleepy, they often force themselves to keep riding a motorcycle (Kartika, 2009). Sleepy drivers are generally caused by a lack of rest, for example, working overtime and not having time to sleep but insisting on driving their motorbike home. The drowsiness factor can also be caused by motorcycle riders constantly inhaling carbon gas from the combustion of other vehicles. The results of burning motor vehicles contain carbon, which can affect the working power of the brain, causing a drowsy effect (Raymond, 2008). From table 5.5, data show that the number of deaths caused by drowsy drivers is 13 accidents (48.1%). When compared to the cause of the accident, the driver is careless, sleepiness is less likely to cause death than the careless driver. However, if you look at the percentage, sleepiness has a greater proportion in causing death tolls than careless drivers. This can be caused by a sleepy driver who completely loses control of driving his vehicle. The Asian Development Bank states that the highest accident risk occurs in drowsy drivers (ADB, 1998).

Several methods can be used to detect sleepiness in motorists. The first is vehicle-based measures, namely by monitoring the vehicle, for example by measuring speed, steering wheel movement, or pressure on the gas pedal (Liu, Hosking, and Lenné, 2009). The next method is behavioral measures, namely by monitoring the movement of the driver, such as yawning, eye blinking, or head position (Fan, Yin, and Sun, 2007). The last is physiological measures, namely monitoring the driver's psychology, for example, heart rate, muscle movement, or retinal movement (Sahayadhas, Sundaraj, and Murugappan, 2012). One of the methods above will be implemented into a pair of glasses.

The method used in this study is the behavioral measure method, namely by paying attention to the movement of the blinking of the eye because if a person is sleeping, the distance between the two eyelids narrows, and the frequency of blinking decreases until he falls asleep. So if this happens the glasses will give a warning as soon as possible. Based on this background, the author's goal is to utilize or develop glasses as a tool that can provide a warning as quickly as possible to sleepy drivers to prevent traffic accidents.

II. BASIC THEORY

The method used in this study is the behavioral measure method, namely by paying attention to the movement of the blinking of the eye because if a person is sleeping, the distance between the two eyelids narrows, and the frequency of blinking decreases until he falls asleep. So if this happens,

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the proximity sensor on the glasses will give a warning as soon as possible.

Based on this background, the aim is to utilize or develop glasses as a tool that can provide a warning as quickly as possible to sleepy drivers to prevent traffic accidents. Observations are applied to recorded EOG and ECG of 8 volunteers of different ages while monitoring simulated drowsiness.

Microsleep is an involuntary sleep lasting for a fraction of a second or not more than a minute in which a person fails to respond to his surroundings and becomes unconscious. Due to the elapsed time, microsleep can create dangerous situations, for example, when a user is driving, that can result in an accident situation or even death.

A system is designed that detects and predicts a microscope using data collected from pulse monitoring ECG capable heart. The results showed that microsleep detection has a 96% accuracy rate and can predict the period in which the next microscope will be at this level of accuracy 83%. Once microsleep is detected or predicted, the system will warn the subject.

A. Microsleep

Drowsiness is a condition in which a person tends to feel like sleeping (Hall, 2016). Sleep can be classified into 3 stages, namely awake, Non-Rapid Eye Movement Sleep (NREM), and Rapid Eye Movement Sleep (REM) (Sahayadhas, Sundaraj, and Murugappan, 2012). The NREM phase is further divided into 3 phases likely drowsiness, light sleep, and heavy sleep (Brodbeck et al., 2012). Drowsiness that occurs at night after finishing activities is normal, but if drowsiness comes during the day when we are active, this is a problem because it will greatly interfere with daily activities. According to the American Sleep Association (ASA), 9 factors can cause daytime sleepiness, including 1. An uncomfortable bed environment. 2. Sleep duration is not enough. 3. Uncertain sleep schedule. 4. There is no routine before bed.5. Drink caffeine or have a heavy meal right before bed. 6. Exercise right before bed. 7. Sleeping because of alcoholic drinks. 8. Effects of drugs or chronic disease. 9. Sleep disorders.

B. Sleepy eyes

Drowsiness and tiredness have the same effect, namely eyelids that feel heavy so that the blinking of the eyes will start to slow so it doesn't feel like the eyes will be closed 100%, vision starts to blur and it doesn't feel like the eyes will be completely closed 100% so that the eyes can't be able to work together anymore. With this happening, it will be able to trigger things that are not desirable as accidents. It is a sign that someone is sleepy. Therefore, this study will detect the blink of an eye and a person's heart rate.

C. Heart rate

Heart rate is the number of times the heart beats at one time (MedicineNet, 2019). The beating heart aims to pump clean blood from the left ventricle to all the body's blood vessels through the aorta. In general, the heart rate is mensurable in one minute, so the heart rate has units of beats per minute (BPM). The heart rate can change depending on human activities. Several factors can affect heart rate, like air temperature, body position, emotions, body size, and drug use. The heart rate also varies in each age range. Table 1 shows the heart rate during ordinary activity by age range according to the National Institute of Health (NIH) (MacGill, 2017).

Denyut Jantung Normal			
Usia	Minimal (bpm)	Maksimal (bpm)	Rata-rata (bpm)
Baru Lahir	100	180	140
1 bulan - 1 tahun	80	160	120
1 tahun - 3 tahun	80	130	105
3 tahun - 6 tahun	80	120	100
6 tahun - 12 tahun	65	100	83
12 tahun - 18 tahun	60	90	85
19 tahun - 69 tahun	60	100	80
> 70 tahun	60	100	80

Table 1. Heart rate during ordinary activity by age range

Body parts that might be used to measure heart rate include the wrist, below the eyebrows, the side of the neck, and above the soles of the feet, but overall the wrist shows more accurate results (Harvard Health Publishing, 2019). A sufficient duration to obtain accurate heart rate measurements according to the Consensus Panel of the European Society of Hypertension (in Palatini, 2010) is 30 seconds. The heart rate can be dedicated as a signal of a person's sleepiness. When in a sleepy state, there is an accumulation of the hormone triphosphate in the brain (Peters, 2019). This accumulation of the hormone adenosine triggers the parasympathetic nerves to lower the heart rate (Holst and Landolt, 2015). A person's heart rate in a sleepy state will decrease by about 8 BPM compared to usual daily conditions (Waldeck and Lambert, 2003).

D. Reflective sensor QRD1114

The QRD1113 and QRD1114 reflective sensors consist of an infrared emitting diode, and an NPN silicon phototransistor mounted side to side in a black plastic housing. The on−axis radiators of the emitter and the on−axis response of a detector are both perpendicular to the face of the QRD1113 and QRD1114. The phototransistor responds to the radiation from the diode only when a reflector or surface is in the detector's field of view.

➢ *Features*

- Phototransistor Output
- No−Contact Surface Sensing
- Unfocused on Sensing Diffused Surfaces
- Compact Package
- Daylight Filter on Sensor
- This Device is Pb−Free and RoHS Compliant

E. BPM Max30102 sensor

The MAX30102 is an integrated pulse oximetry and a heart rate sensor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on a single 1.8V power supply and a separate 3.3V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. The module can be shut down through software with zero standby current, allowing the power rails to remain powered at all times.

➢ *Benefits and Features*
- Heart-Rate Monitor and Pulse Oximeter Sensor in
- LED Reflective Solution
- Tiny 5.6mm x 3.3mm x 1.55mm 14-Pin Optical Module
- Integrated Cover Glass for Optimal, Robust Performance
- Ultra-Low Power Operation for Mobile Devices
- Programmable Sample Rate and LED Current for Power Savings
- Low-Power Heart-Rate Monitor (< 1mW)
- Ultra-Low Shutdown Current (0.7µA, type)
- Fast Data Output Capability
- High Sample Rates
- Robust Motion Artifact Resilience
- High SNR
- -40°C to +85°C Operating Temperature Range

F. Wemos D1 Mini

Fig.1.Wemos Module

Wemos D1 is a module development board based on wifi from the ESP8266 family which can be programmed using Arduino IDE software. Although the shape of this board is designed to resemble the Arduino Uno, in terms of specifications it's far superior to Wemos D1. One of them is because the core of the Wemos D1 is the ESP8266EX which has a 32-bit processor. While Arduino Uno only core 8 bit.

G. Arduino IDE

IDE is an acronym for Integrated Development Environment, or simply an integrated environment used for development. It is referred to as an environment because it is through this software that Arduino is programmed to execute the onboard functions embedded through programming syntax. Arduino uses its programming language that resembles the C language. The Arduino programming language (Sketch) has been changed to make it easier for beginners to programming from the original language. Before being commercialized, the Arduino microcontroller IC was implemented with a program called Bootloader that works as an intermediate between the Arduino compiler and the microcontroller. Arduino IDE is made from the JAVA programming language. Arduino IDE is also equipped with a C/C++ library commonly called Wiring which makes input and output operations easier.see fig2. Ardunio Programing Laguage.

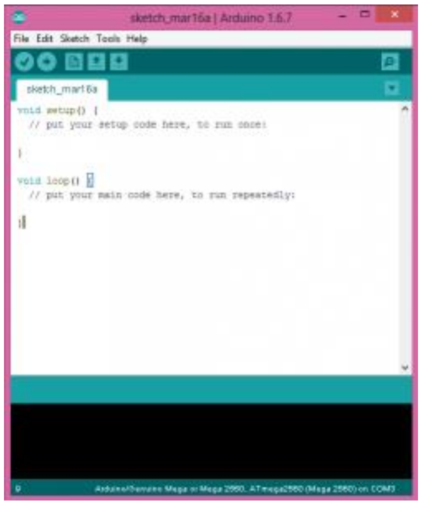

Fig 2.Ardunio Programing Laguage.

H. SUS

SUS is one of the most popular usability testing tools. SUS was developed by John Brooke in 1986. SUS is a usability scale that is reliable, popular, effective, and inexpensive. SUS has 10 questions and 5 answer options. The answer choices ranged from strongly disagree to agree. SUS has a minimum score of 0 and a maximum score of 100. SUS in its original language uses English. However, there has been researched or a paper that has made it into Indonesian in the research of Z. Sharfina and H. B. Santoso (2016). After collecting data from respondents, then the data is calculated. In using the System Usability Scale (SUS) there are several rules for calculating the SUS score.

These are the following rules when calculating the score on the questionnaire :

1. For every odd-numbered question, the score of each question obtained from the user's score will be deducted by 1.
2. For each question with an even number, the final score is obtained from a score of 5 minus the question score obtained from the user.
3. The SUS score is obtained from the sum of the scores for each question which is then multiplied by 2.5.

The rules for calculating scores apply to 1 respondent for further calculations, the SUS score of each respondent is sought-after for the average score by adding up all scores and dividing by the number of respondents. This is the formula for calculating the SUS score :

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$$\bar{x} = \frac{\sum x}{n}$$

$\bar{x}$ = skor rata-rata
$\sum x$ = jumlah skor SUS
n = jumlah responden

III. METHOD

A. Time and Place
Time : Desember 2021 – Januari 2022
Place: Physics Laboratory SMA N 1 Semarang

B. Timeline Diagram

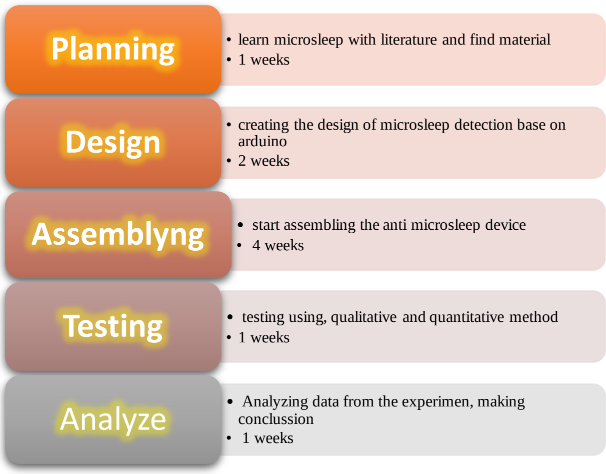

Fig. 3.Research time line.

The schedule of this research we can see on Fig. 3. Research time line.

C. Research Design

➢ *Block Diagram*

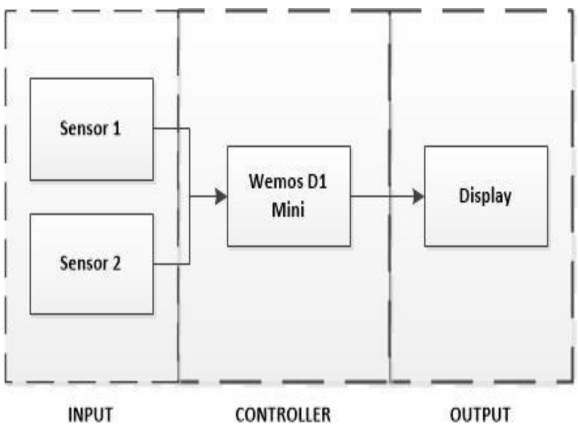

Fig. 4. Research Block Diagram

This research contains 3 blocks see fig 4. . Research Block Diagram :

1. *Input*
The input contains 2 parts: Sensor Heartbeat Max3100 and Sensor Proximity QRD1114, this input condition will be sent to Controller.

2. *Controller*
The controller is Wemos D1 Mini which collects data from input and processes it then sends it to Output.

3. *Output*
The output will receive data from Controller and show the data from the Input. The display is used for showing the data on a smartphone.

D. Circuit Diagram

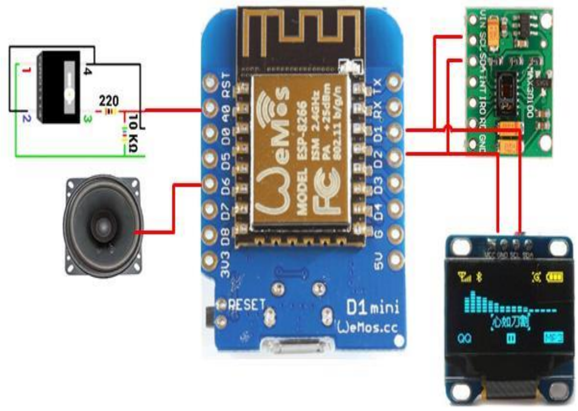

Fig. 5. Research circuit module

E. Flowchart

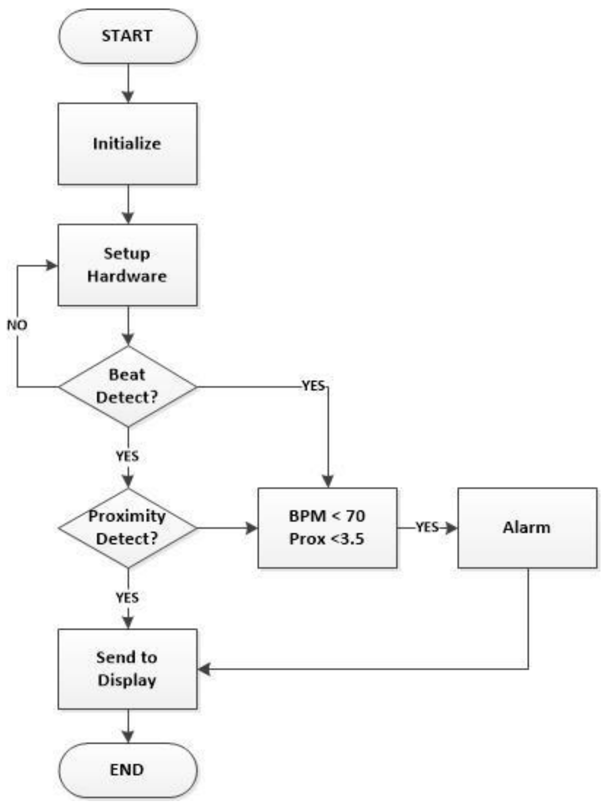

Fig. 5. Research flow chart

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START
Program begin to start
Initialize
Program will initialization all that need to run it

Setup Hardware
Program will prepare all the hardware that use in this application.

Beat detect?
If beat detect, then sensor will read heartbeat
Proximity Detect?
If proximity detect, then sensor will read eyes condition.
If BPM < 70 and Proximity 0-3.5 then Alarm will sound

Send to Display
The display will receive the information about heartbeat
END
Program terminate

IV. DISCUSSION

A. Tools and Materials

- *Tools :*

1. Laptop
2. Arduino IDE
3. Blynk
4. Electric soldering gun
5. Nose plier tool

- *Materials* :

1. Wemos mini D1
2. Heart rate sensor MLX90164
3. Proximity sensor QRD114
4. Solder
5. Finger splint
6. Glasses

B. How to Use?

1. Connect the device to the Arduino IDE on the laptop.
2. Insert your index finger into the finger plinth and glue it. Make sure the index finger fits on the ArduinoIDE so that the heart rate can be read.
3. Put the glasses at a maximum distance of 0.5 cm to detect the presence of a blink sensor.
4. Heartbeats and blinks will be recorded with Arduino IDE.
5. Record observations with three phases, normal, sleepy, and asleep.

C. Result

The system design starts from the number of heartbeats detected by the pulse sensor which will then be processed by the Wemos D1 Mini for decision-making, if the number of detected heartbeats is less than 60 bpm, the buzzer will be turned on. Wemos D1 Mini will send pulse sensor measurement data to ArduinoIDE as monitoring media.

After the program has been created, the next step is program testing, testing with what is expected. The testing carried out is like checking the pulse sensor, whether it detects a heartbeat or not, and checking the heart rate display on the LCD so that the driver's condition can be known in real-time. At the time of testing whether there were errors or not, and during testing, each step needed to be recorded so that it could make it easier to repair the system and make solutions to The following is heart rate data and the results of testing the drowsiness detector for motorized vehicle drivers that have been carried out :

1. Heart rate data according to the American Heart Association

- *Average resting heart rate :*

Children 10 years, older adults, and seniors: 60-100 beats per minute (BPM), and Pro-trained athletes are 40-60 beats per minute (BPM) these errors.

No.	Respondent	Age	Normal	Sleepy
1.	1	15	79	59
2.	2	15	88	68
3.	3	19	91	70
4.	4	29	87	63
5.	5	36	88	66
6.	6	53	83	66
7.	7	56	82	62
8.	8	58	85	55

Table.2. Heart Vs Age

2. And the data of Proximity detect the eyes of human when they are sleepy (closed eyes) or not.

No.	Respondent	Age	Open	Close	Blink
1.	1	15	5,0	0,7	4,1
2.	2	15	5,0	0,5	4,3
3.	3	19	5,0	3,05	4,7
4.	4	29	4,8	1,05	4,0
5.	5	36	5,0	3,0	4,5
6.	6	53	5,0	2,45	4,4
7.	7	56	4,8	1,5	4,1
8.	8	58	5,0	0,8	4,5

Table 3. Response of Proximity detect the eyes of human when they are sleepy (closed eyes) or not.

3. SUS Analyze

No	Respondent	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Answer	Score
1.	Respondent 1	3	1	5	1	5	2	5	1	5	2	36	90
2.	Respondent 2	4	1	5	1	5	1	5	1	5	1	39	97,5
3.	Respondent 3	4	1	5	1	4	1	5	1	5	2	37	92,5
4.	Respondent 4	3	1	5	2	5	1	5	1	4	1	36	90
5.	Respondent 5	4	1	5	1	5	2	5	1	5	1	38	95
6.	Respondent 6	3	1	5	1	4	2	5	1	5	1	36	90
7.	Respondent 7	3	1	5	1	4	1	5	1	4	1	36	90
8.	Respondent 8	3	1	4	1	3	2	4	1	5	3	31	77,5

Table 4. Sus Analysys

D. Data Analyze

From the data result of the trial with 8 respondents, it can be seenon figure 6 BPM Scores and figure 7 Proximity Scores. that :

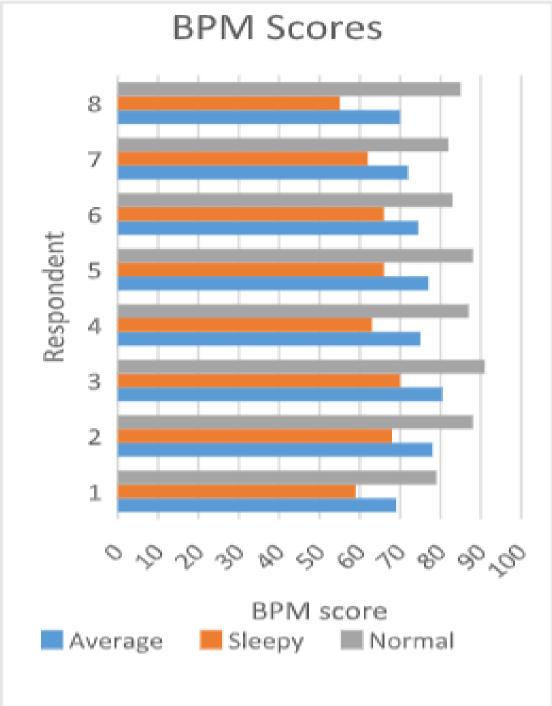

Fig 6. BPM Scores

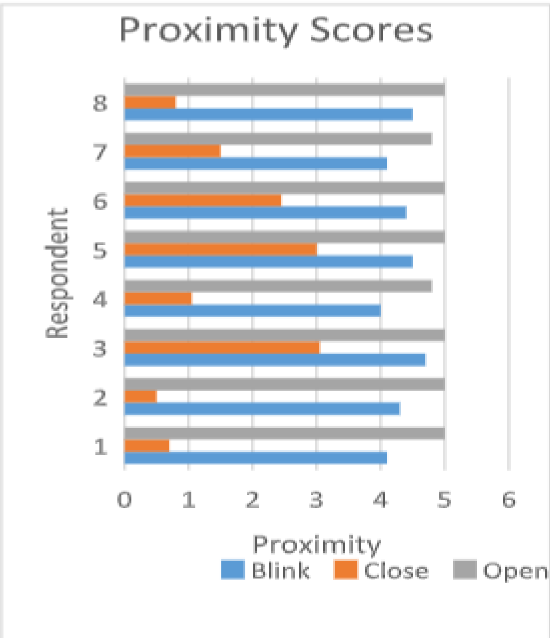

Fig 7. Proximity Scores

V. CONCLUSION

- This microsleep detection can help drivers to know when they are sleepy so they can pull over.
- Heart rate data according to the American Heart Association Average resting heart rate: Children 10 years, older adults, and seniors: is 60-100 beats per minute (BPM) and for Pro-trained athletes 40-60 beats per minute (BPM).
- The data of Proximity detect the eyes of humans when they are sleepy (closed eyes) or not.
- Heart rate and the number of blinks of the eye are important indications in detecting drowsiness.

RECOMMENDATION

The device should be developed in a more ergonomic form and without the use of many complicated cables.

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[4]. Sugiharto, Wibowo Harry. 2019. Pemodelan Alat Pencegah Micro-Sleep Sebagai Upaya Mitigasi Kecelakaan Transportasi (LED) blinks simultaneously for every heartbeat Proximity