Abnormal Driving Detection Based on Accelerometer and Gyroscope Sensor on Smartphone using Artificial Neural Network (ANN) Algorithm

Fajar Manghayu Nuswantoro
Dept. of Electrical Engineering
Politeknik Elektronika Negeri Surabaya (PENS)
Surabaya, Indonesia
shellingford@te.student.pens.ac.id

Amang Sudarsono
Dept. of Electrical Engineering
Politeknik Elektronika Negeri Surabaya (PENS)
Surabaya, Indonesia
amang@pens.ac.id

Tri Budi Santoso
Dept. of Electrical Engineering
Politeknik Elektronika Negeri Surabaya (PENS)
Surabaya, Indonesia
tribudi@pens.ac.id

***Abstract*— *Transportation has become one of the needs of human life. One of the most used transportation in Indonesia is a motorcycle. This transportation is reliable, has a wide variety of uses, is capable of handling traffic jams, and is very economical. But motorbikes have a relatively high risk for the safety of the rider compared to cars. With driver behavior and road congestion conditions, accidents often occur. In this research, we observed the movement of the driver through a smartphone and built an application that was able to provide a warning to motorists. In this system we use 2 types of sensors, Accelerometer and Gyroscope sensors which are generally the basic features of a smartphone. We adopt a Machine Learning-based movement identification process with an Artificial Neural Network (ANN) algorithm. ANN will do what movements it does based on the data obtained from the Accelerometer and Gyroscope sensor values. The application is installed on a smartphone and put it on a vehicle with a fixed position. The device will calculate the activity based on several predetermined categories of the driver status. The status categories are normal, zig-zag, sleepy, turn right, turn left, U-turn, sudden braking, sudden acceleration, and speed bumps. The level of accuracy generated by Machine Learning using the Artificial Neural Network Algorithm in this research was 96,2%.*

***Keywords*— *Motorcycle, Accelerometer, Gyroscope, Machine Learning, Artificial Neural Network*

I. INTRODUCTION

The use of motorized vehicles is now very common. According to data from BPS, in 2017 there were 138,556,669 motorized vehicles in Indonesia. Motorcycles are the largest contributor with 113,030,793 units or almost 81.5% of the total motorized vehicles in Indonesia [1]. In the same year, the population of Indonesia was 261,891 million. This means that around 43.1% of Indonesia's population, use motorbikes in their activities. But in the same year, there were 98,419 accidents. The main causes of motor vehicle accidents are human factors such as drowsiness while driving, or the driver's incompetence by 35%. While from vehicle quality factors such as brake failure, it reaches 31%.[2]

Seeing the problem of a very large number of accidents as mentioned above, the need for a warning system to motorists when the motorist's movements endanger himself or others. For this reason, real-time monitoring of driver behavior is needed. Smartphone which are commonly used equipment are expected to be used as a solution to address these problems. In Indonesia, there is no system that can detect the movements of the drivers. Even if there is a system that can detect driver movements and give warnings, accidents due to driver fatigue can be avoided. At the moment there are studies that detect the abnormal movement of car drivers using the accelerometer sensor and gyroscope using the SVM algorithm [3]. However, this research is still limited to cars, whereas in Indonesia itself, motorcycles are vehicles that are used more in Indonesia than cars. Also, the research is not specific to motorists in Indonesia, so that the patterns of Indonesian society cannot be represented, plus there are some typical movements in Indonesia.

In this research, we propose detecting abnormal movements of motorcyclists using accelerometer sensors and gyroscopes using the Artificial Neural Network (ANN) algorithm. In this study, we specialize in motorcyclists, because motorcycles are vehicles that are widely used in Indonesia. Also, we add motion to be detected, namely "Speed Bump" or in the Indonesian Language "Polisi Tidur". we also use a different algorithm, namely Artificial Neural Network (ANN). ANN and SVM algorithms have good accuracy so we chose the ANN algorithm. ANN algorithm is based on neurons in the human brain. The incoming data will be processed as in the human brain processing until a decision is found. The smartphone will be placed in the fixed position on the motor, then the accelerometer sensor and the gyroscope on Smartphone will record the output value of the sensor every 100ms for 5 seconds. The data generated will be processed by machine learning until a decision is made.

The research conducted will detect 9 movements, namely: Normal, Turn right, turn left, zig-zag, sudden acceleration, sudden braking, U-turn, Speed bump, and sleepy. This 9 movement is a movement that is often found in Indonesia. It is hoped that later the results of this study can be used to detect any motions performed by motor drivers. It also can be used as a warning system for the driver who makes dangerous movements for themselves and others. So that the accident rate due to driver negligence can be reduced.

II. RELATED WORKS

There are researchers who discuss Machine Learning using Accelerometer and Gyroscope sensors.

Research [3] proposes the detection of movement of car drivers using the accelerometer sensor and gyroscope that is on a smartphone. In this research, we try to detect the abnormal movement of car drivers using the SVM algorithm. Obtained decision making accuracy of larger than 90%.

Research [4] proposes human recognition using accelerometer and gyroscope sensors in smartphone. In this study, we try to detect general movements performed by humans using several algorithms such as KNN, Naïve Bayes, SVM, C-Tree, J48, and Random Forest. The result is that each algorithm has a different level of accuracy.

Research [5] proposes measuring kinematic changes in the ankle using an accelerometer sensor and a gyroscope. In this research, we try to detect a person's movement based on ankle kinematic changes. The result is the accelerometer sensor and the gyroscope successfully determine the movements made by the person.

III. Driving Behavior Characterization

This session will be explained about data retrieval as well as the definition of the movement to be detected.

A. Collecting Data

The data taken is data from the Accelerometer and Gyroscope sensors that are on the Smartphone. The smartphone used is Xiaomi Redmi 4A which has an Accelerometer sensor and Gyroscope. Data will be retrieved every 100ms for 5 seconds. Data taken using the same motorcycle, namely Yamaha Force and are on the same road. Figure 1 is a map of the road used in data collection. The road was chosen because it has conditions similar to those of main roads in general and is still relatively quiet, so it is safe to collect data.

Fig. 1 Data Collection Location

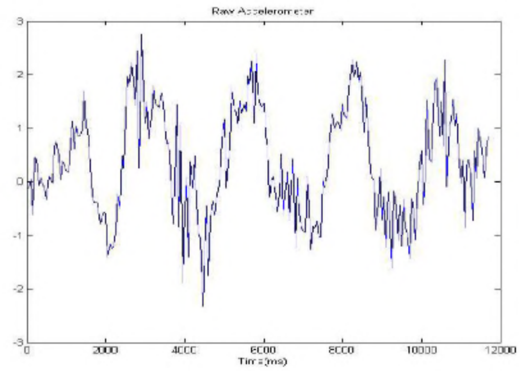


Fig. 2. Raw Accelerometer x-axis

The data taken is raw (not filtered), so it needs to be filtered so that the pattern of the data is more visible. Figure 2. shows x-axis accelerometer data that is still raw. In the data, there is still a lot of high-frequency noise so it needs to be filtered using a lowpass filter. Lowpass filter is a digital filter that passes low frequency signals and blocks high frequencies. Low pass filters are a good way to remove noise (both mechanical and electrical) from the Accelerometer sensor [6]. The LPF used is IIR Filter. IIR Filter is used so that the computation process can be done as fast as possible. IIR filters do not have a phase delay, so there is not a time delay. Since we do not want a time delay, an IIR filter may be more appropriate [7].

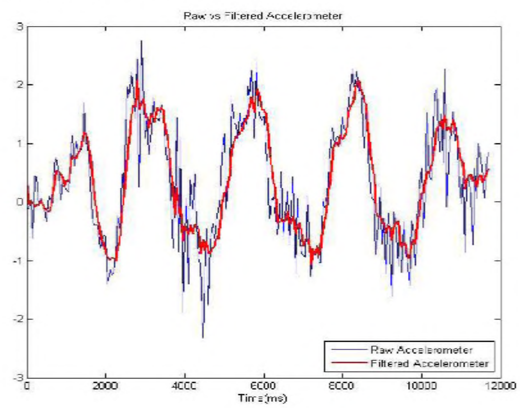
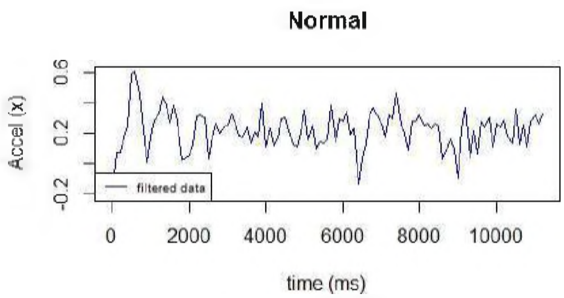


Fig. 3. Raw vs Filtered Data

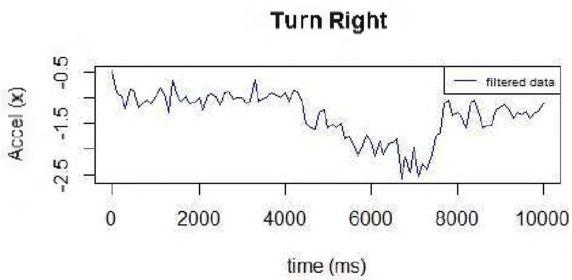
Figure 3. shows the comparison between raw and filtered data. We can see, the pattern of data after filtering is more visible than the raw data. After collecting data the data will be entered into Machine Learning.

B. Driving Behaviour

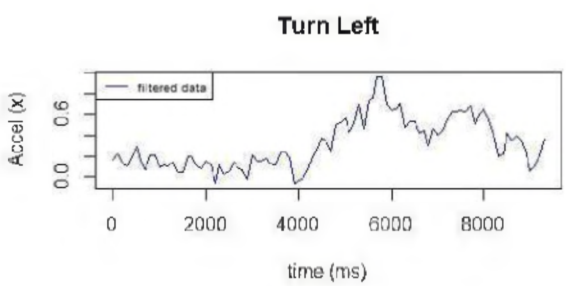
In this research, we detect abnormal driving which can endanger the driver or other people. We detect 9 movements that are often found in Indonesia. 9 movements to be detected are: Normal, Turn Right, Turn Left, U-Turn, Zig-zag, Sudden Braking, Sudden Acceleration, Sleepy, Speed Bump.



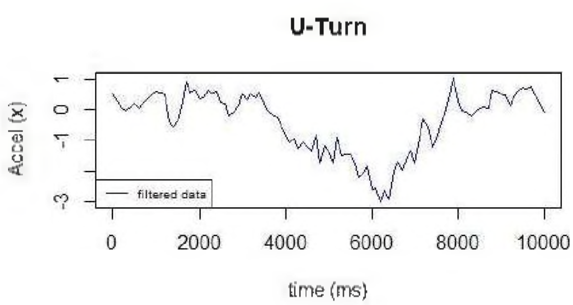
(a) Normal



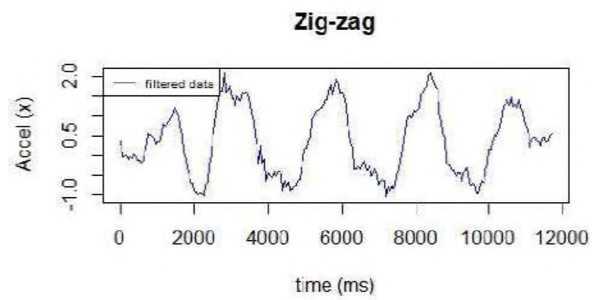
(b) Turn Right



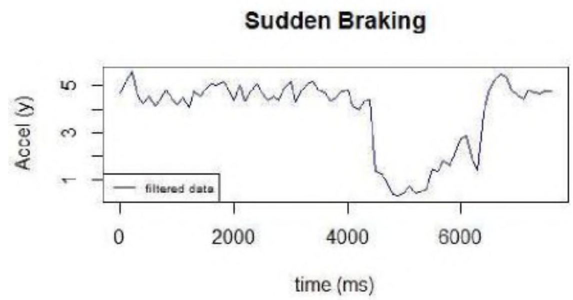
(c) Turn Left



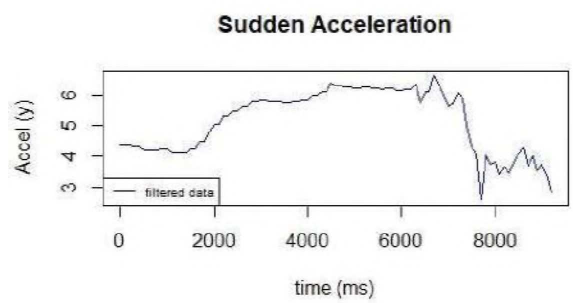
(d) U-turn



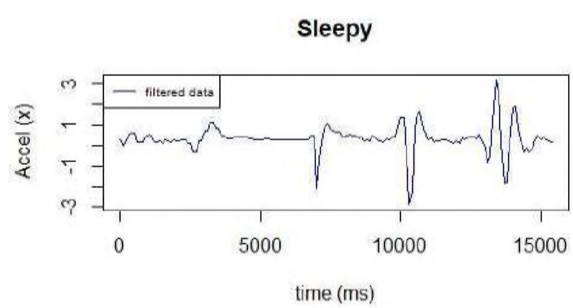
(e) Zig-zag



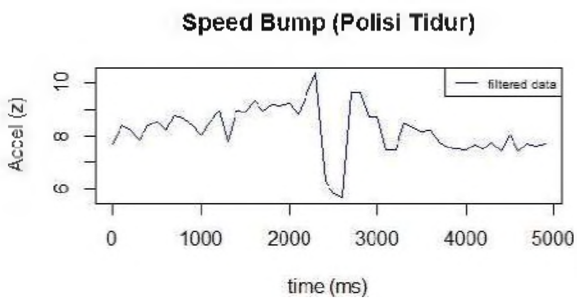
(f) Sudden Braking



(g) Sudden Acceleration



(h) Sleepy



(i) Speed Bump

Fig. 4. Pattern each movement

The definition of each movement is:

- *Normal*. The driver is categorized as doing normal movements when the driver is driving on a straight road and not doing much movement. Figure 4. (a) and the speed tends to be constant (there is no sudden change in speed).
- *Turn Right*. The driver is categorized as doing turn right when the driver turns right. In Figure 4. (b) the value of the accelerometer sensor on the x-axis will decrease in value.
- *Turn Left*. The driver is categorized as doing turn left when the driver turns left. In Figure 4. (c) the value of the accelerometer sensor on the x-axis will increase in value.
- *U-turn*. The driver is categorized as doing U-turn movements when the driver makes U-turn movements with fairly fast and sharp movements. In Figure 4. (d) the accelerometer sensor value on the x-axis will decrease and increase quite sharply.
- *Zig-zag*. The driver is categorized as doing Zig-zag movements when the driver makes changes to the left and right constantly and continuously. In Figure 4. (e) the value of the accelerometer sensor on the x-axis will decrease and increase which is not too sharp and continuous.
- *Sudden Braking*. The driver is categorized as doing Sudden Braking movements when the driver suddenly reduces speed. In Figure 4. (f) the accelerometer sensor value on the y-axis will experience a significant decrease.
- *Sudden Acceleration*. The driver is categorized as doing Sudden Acceleration when the driver suddenly speeds up. In Figure 4. (g) the accelerometer sensor value on the y-axis will increase.
- *Sleepy*. The driver is categorized as doing Sleepy when the driver makes sudden changes in movement and speed. In contrast to the Zigzag movement that results from this Sleepy state is not continuous. In Figure 4. (h) the value of the accelerometer sensor on the x-axis will decrease and increase quite sharply in a relatively short time.
- *Speed Bump*. The driver is categorized as doing Speed bump when the rider passes the speed bump. In Figure 4. (i) the accelerometer sensor value on the z-axis will increase and decrease relatively quickly.

Abnormal driving behavior is a movement that is not commonly done by drivers and if done for a long time can endanger safety. Some of the movements that are categorized as abnormal driving are Zig-zag, U-turn, Sleepy, Sudden Acceleration, Sudden braking. Why is this movement considered abnormal? Because this movement can endanger the driver and others. Continuous zig-zag movements, drowsy driver conditions, sudden changes in speed can endanger driver safety. So that targeted in this study can detect abnormal movements made by the driver quickly and precisely so that if the driver makes an abnormal movement the driver will get a warning so that the driver returns to focus on driving.

IV. System Design

To be able to detect movements made by drivers with accuracy several steps need to be done. The first stage is the training process. In this training process, we collect data from each movement that will be detected. The data taken is 3-axis accelerometer and 3-axis gyroscope data every 100ms within 5 seconds. The data that has been collected is then filtered to get the actual pattern of the data. Then the data will be entered into Machine Learning for the Training process, but before that the data will pass precomputation where the data will be normalized so that the data computing process can be done faster. After the precomputation process, the data is trained into Machine Learning. After the training process, we will get a model of Machine Learning which consists of weight values for each neuron. This weight value is what we will use in the process of detecting driver movements.

Then after we pass the training stage, we will do the driver movement detection stage. This process is often called monitoring driving behavior. In this process, the smartphone will capture the value of the accelerometer and gyroscope sensor every 100ms within 5 seconds, the same as the previous process. Then the data from the accelerometer and gyroscope sensors will be filtered and passed precomputation. Then the data will be entered into Machine Learning to get a decision in the form of a movement. The value of the weight that has been obtained will be used in computing this Learning Machine. After getting a decision, then we will counter each movement. If there are too many abnormal movements, there will be a warning to the driver to refocus while driving. That way the accident rate due to driver negligence can be reduced.

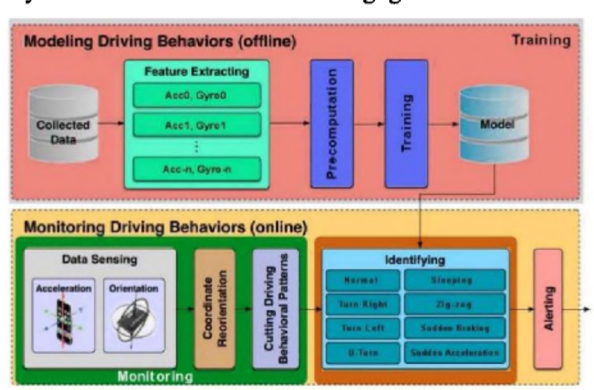


Fig. 5. System Design

The design of this system can be seen in Figure 5. To get the right decision, Machine Learning needs to be trained. The algorithm used in Machine Learning is Artificial Neural Network (ANN). This algorithm is based on neurons in the human brain. This session will explain algorithms, machine learning training processes, and decision making from machine learning.

A. Artificial Neural Network

Why use Artificial Neural Networks (ANN)? ANN is one of the most popular Machine Learning algorithms. This algorithm is based on the workings of neurons in the human brain. Artificial Neural Network has a fairly high degree of accuracy. Therefore in this research, we decided to use this algorithm. Beside, this algorithm has several advantages compared to other algorithms, namely:

- Neural networks can learn and can produce unlimited output.
- Inputs are stored in the network itself and not in the database, so the loss does not affect the work of the neural network.
- This network can learn from examples and apply them when similar events occur, making neural networks work in real-time.
- Even though neurons do not respond or information is lost, the neural network can still detect errors and produce output.
- Neural Networks can perform many tasks simultaneously without affecting system performance.

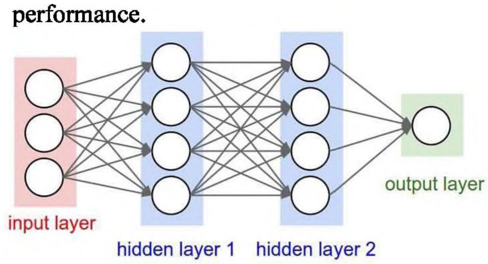


Fig. 6. Overview of Artificial Neural Networks

Figure 6. shows a general description of the Artificial Neural Network algorithm. There are 3 types of layers in ANN, namely the input layer, hidden layer, and output layer.

1) Input Layer. The input layer consists of neurons that receive input data. All neurons in this layer can be connected to neurons in the hidden layer or directly to the outer layer of the tissue and do not use a hidden layer.

2) Hidden Layer. The hidden layer consists of neurons that receive and process data from the input layer so that it can be used by the output layer.

3) Output Layer. The output layer consists of neurons that receive data from the hidden layer or directly from the input layer.

ANN which only has 1 hidden layer is called perceptron. If you have more than 1 hidden layer, it is usually called multi layer perceptron (MLP). The more hidden layers, the better the accuracy of the machine learning, but the longer the calculation process is done.

B. Training Machine Learning

In the training process, we will train Machine Learning. Machine Learning will be trained with data that has been taken previously. The data taken is data from the Accelerometer and Gyroscope sensor values that are on the Smartphone. The frequency of data collection is every 100ms for 5 seconds. The pattern of each movement is visible when taking data for 5 seconds. The data taken is still raw and has quite a lot of high-frequency noise. Therefore it is necessary to do the filtering process. To reduce high-frequency noise, we use Low Pass Filter. After filtered data has a variety of ranges, a range that is too wide is feared to prolong the computing process, even though we want Machine Learning to make quick and precise decision making. For that, we do the data normalization process or we call the precomputation process. This normalization process uses min-max normalization. Min-max normalization will change the data into a range of 0 to 1. The equation of min-max normalization is:

$$xscaled = \frac{x - xmin}{xmax - xmin} \tag{1}$$

By using (1), the calculated data will be faster. After the precomputation process, the data is ready to be inputted to Machine Learning for the training process. There are 718 data that will be used. 628 data will be used in the training process and 90 data will be used in the testing process. This 90 test data is in the form of 10 times the data for each movement. So it is hoped that it can represent each movement being tested. These data represent 9 movements to be detected. The data we will use is data that is taken every 5 seconds.

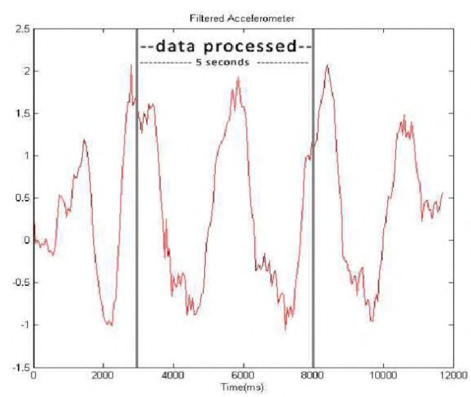


Fig. 7. Collecting data for 5 seconds

We can see in Figure 7. the data taken is data from 3000ms to 7900ms. After that, the training process will be carried out using ANN. The equation of the ANN algorithm is:

$$y = \sum_{i=1}^{m} w_i x_i + b \tag{2}$$

where:
y is output,
w is weight every neuron
x is input
b is bias

By using (2), the training process will be carried out. The machine learning training process uses its functions in R Language programming. In this training process, the output we get is the weight and bias of each neuron. In general, the training process to get weight and bias values for each neuron consists of 2 stages. Forward Pass and Backward Pass. Forward pass or commonly called forward propagation is a process where we carry data on the input through each neuron in the hidden layer to the output layer where the error will be calculated. While the process of the Backward Pass, the error we get on the forward pass will be used to update each weight and bias with a certain learning rate. The two processes above will be repeated until the weight and bias values are obtained which can give the smallest possible error value on the output layer. We will use the weight and bias we will use in the process of monitoring driving behavior. The data used in the training process were 628. With the amount of data trained as many as 628 pieces, it is sufficient to represent 9 movements to be detected.

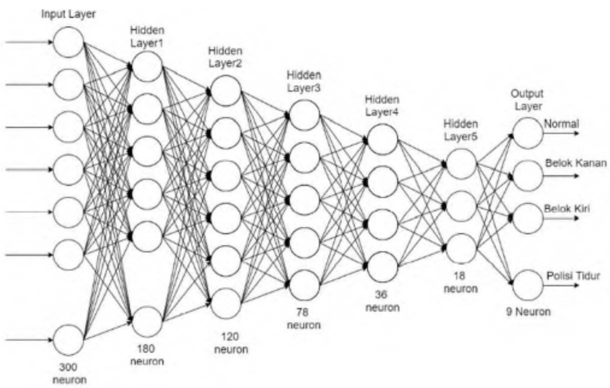


Fig. 8 Machine Learning Model

After the training process, we will get a machine learning model that we designed. Figure 8. shows the Machine Learning model obtained after the training process. In this Machine Learning model, we design Machine Learning with an Input Layer, 5 Hidden Layers and an Output Layer. On the input layer there are 300 inputs. Then at Hidden Layer 1 there are 180 neurons, Hidden Layer 2 there are 120 neurons, Hidden Layer 3 there are 78 neurons, Hidden Layer 4 there are 36 neurons and on Hidden Layer 5 there are 18 neurons. Whereas in the output layer there are 9 outputs that represent each movement. So that from the 300 input from the Accelerometer and Gyroscope data entered, 9 outputs will be obtained in the form of the value of each movement.

TABLE I. COMPARISON OF DECISION RESULTS BASED ON NUMBER OF DATASETS FOR TRAINING

Movements	Movement decision based on number of dataset for training Machine Learning		
	100 datasets	**300 datasets**	**628 datasets**
Normal	0.0001809	0.019802	0.0196082
Turn Right	7.35E-05	1.31E-05	3.37E-12
Turn Left	0.0107333	0.04337	1.32E-05
U-turn	3.85E-27	1.03E-39	6.98E-12
Zigzag	0.0697171	0.887004	0.9256486
Sudden Braking	0.0002427	2.29E-06	5.85E-05
Sudden Acceleration	0.0017957	0.000934	0.0016829
Sleepy	0.0079657	0.001092	3.40E-07
Speed Bump	0.0648937	0.089587	2.11E-05

To see whether the number of datasets for training has an effect on the decision result, we can see in the Table I. The movement used for testing is a Zigzag. We can see that the Zigzag value on 100 datasets is 0.069. The 300 dataset is 0.887, and the 628 dataset is 0.92. From Table I, we can see that the more datasets used in the training process, the higher the decision results produced by Machine Learning. So that the more datasets used in training, the better machine learning will be in making decisions. After this training process, we will go to the driving behavior monitoring process. On the Smartphone side, the process of taking sensor data, making Machine Learning decisions is done. The machine learning calculation process still uses equation (2). Machine learning testing is done through 5 different drivers. The driver will drive a motorcycle and perform 9 movements that are researched.

C. *Monitoring Driver Behavior*

In the process of monitoring driver behavior, we will detect driver movements using Machine Learning that has been previously trained. The smartphone will retrieve the Accelerometer and Gyroscope sensor value data every 100ms within 5 seconds. Then the data that has been taken will be filtered and passed precomputation before being entered into Machine Learning. Then the data will be entered into Machine Learning for the computational process using the Artificial Neural Network (ANN) algorithm. The output of Machine Learning itself is the value of 9 movements. The scale used in the output is 0 to 1. The highest movement output value, according to Machine Learning, the movement is carried out by the driver. If there are 2 or more similar movement values, then the greatest value will be determined by Machine Learning.

V. IMPLEMENTATION AND MEASUREMENT

In the first, we want to know at what speed Machine Learning can work optimally. For this reason, testing is performed on normal movements with different speeds ranging from 20 km/h to 50 km/h in 100 seconds. We get 20 movements of each speed. The results of the experiment can be seen in Figure 9.

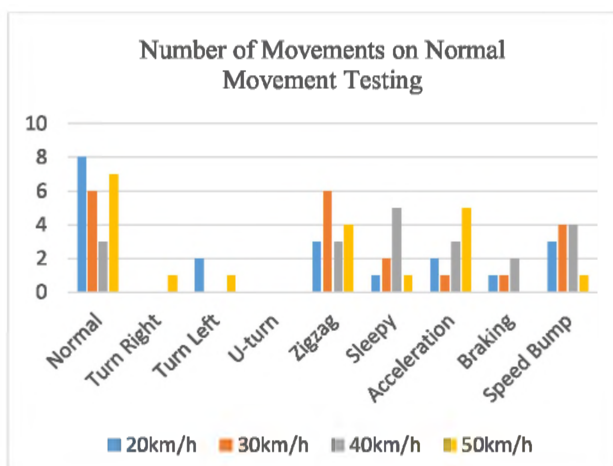


Fig. 9. Normal Movement Testing

In Figure 9. we can see that speeds of 20 km/h, 30 km/h, and 50 km/h produce normal motion which is much higher than other movements, on the other hand, a speed of 40 km/h produces the least normal movement. At a speed of 20 km/h the number of normal movements obtained is 8, then followed by zig-zag and speed bump that is 3. While at a speed of 30 km/h, Normal movement has the same amount as Zig-zag that is 6 and followed by Speedbump is 4. At a speed of 50 km/h, the normal number of movements is 7 and is followed by Sudden Acceleration which is 5.

Unfortunately, at speeds of 20 km/h and 50 km/h, although it produces a lot of normal movement, it also produces Turn Right and Turn Left movements, which of course is very different from normal Movement. While for speeds of 30 km/h do not produce Turn Right or Turn Left movements. It's just that the number of Normal movements and the resulting Zig-zag movements are equal to 6. The resulting Zig-zag movements can occur due to the sensitivity of the Accelerometer sensor which is high, so that slight changes in movement occur and are not realized, causing the value of the sensor to change. But for speeds of 20 km/h and 50 km/h which results in Turn Right and Turn Left movements, of course, requires large changes in movement. So it can be concluded that the speed of 30 km/h is the ideal speed so that Machine Learning can work optimally.

The next experiment aims to determine the output value of each movement in the Turn Right Movement. The experiment will be carried out by 5 different drivers. These drivers will make a right turn, and the output produced by Machine Learning is displayed in Table II.

TABLE II. OUTPUT RIGHT TURN MOVEMENT

Movements	Value of Movements				
	Driver1	*Driver2*	*Driver3*	*Driver4*	*Driver5*
Normal	5.20E-05	1.27E-06	0.0001	0.0007	0.0017
Turn Right	0.9996	0.98579	0.9993	0.9984	0.9973
Turn Left	2.72E-10	1.61E-10	1.63E-09	3.96E-09	1.02E-07
U-turn	3.84E-11	4.54E-11	2.44E-10	3.41E-09	6.60E-08
Zigzag	3.08E-15	6.75E-13	7.11E-15	2.06E-12	6.77E-15
Sudden Braking	2.81E-13	6.16E-12	1.38E-13	2.54E-12	6.92E-13
Sudden Acceleration	1.05E-09	7.36E-08	6.00E-11	6.61E-10	8.32E-13
Sleepy	0.0001	0.00289	8.99E-05	7.63E-05	1.80E-06
Speed Bump	0.0004	0.00917	0.00025	4.78E-05	0.00013

From Table II, we can see that each movement has a different value. In Driver1 the most striking value is the turn right movement with a value of 0.9996. While the value for other movements is far from value 1. The value that approaches the turn right is a speed bump with a value of 0.0004. While other values are very far from the value of turn right. So it can be concluded for Driver1 to make a turn right movement. In Driver2 the result is the same as Driver1, the highest movement value is obtained by turn right with 0.98579. A fairly close value is the speed bump with a value of 0.00917, while the value is quite far from the turn right value. The same results were obtained by Driver3, Driver4, and Driver5. The values of successive turn right movements from Driver3 to Driver5 are 0.9993, 0.9984, and 0.9973. While for other movements, the value is quite far from the turn right movement.

TABLE III. ACCURACY OF EACH MOVEMENTS

Movements	Accuracy				
	Driver1	*Driver2*	*Driver3*	*Driver4*	*Driver5*
Normal	0.85993	0.90737	0.92779	0.95532	0.96167
Turn Right	0.99937	0.97051	0.99429	0.99744	0.99887
Turn Left	0.99807	0.98637	0.99871	0.99709	0.99306
U-turn	0.9996	0.99311	0.93925	0.99982	0.99982
Zigzag	0.98730	0.99536	0.99399	0.95486	0.92564
Sudden Braking	0.99883	0.90383	0.99894	0.99761	0.99897
Sudden Acceleration	0.99864	0.98002	0.93182	0.98719	0.96109
Sleepy	0.99563	0.83184	0.99488	0.84788	0.99645
Speed Bump	0.98738	0.85124	0.89807	0.97655	0.85758

From Table III it can be seen the accuracy value of each movement made by 5 drivers. The value generated by machine learning in each movement is mostly close to 1. Some values are not close to 1, like Normal movements performed by Driver1. The resulting normal value is 0.85, this value occurs because the normal movement made by Driver1 has moved a little to avoid obstacles on the road. This causes the normal value to be not good. The same thing happened to Driver2 when doing the Sleepy move. The resulting value is 0.83. Like Driver1, Driver3 has passed the hurdle before doing Sleepy so the resulting score is not good. But overall, the value Machine Learning generates for the rest of the moves is excellent.

TABLE IV. AVERAGE ACCURACY FOR EACH MOVEMENTS

No	Movements	ANN
1	Normal	0.9224
2	Turn Right	0.9921
3	Turn Left	0.9946
4	*U-turn*	0.9863
5	Zig-zag	0.9714
6	Sleepy	0.9333
7	Sudden Braking	0.9796
8	Sudden Acceleration	0.9717
9	Speed Bump	0.9141

From Table IV, we can see the average accuracy of Machine Learning for each movement. The lowest average accuracy is the Speed Bump movement with an accuracy of 0.914 and the highest is the left turning movement with an accuracy of 0.994. So that the average accuracy of Machine Learning is 0.962 or 96.2%. It can be concluded that the accuracy of Machine Learning with the ANN algorithm has high accuracy. With a high accuracy value is expected to identify the movements made by the Driver so when abnormal movements are carried out by the Driver too much, the system will give a warning to the Driver so that the driver is more focused and careful in driving.

TABLE V. COMPARISON OF ACCURACY BETWEEN ANN AND SVM ALGORITHMS

No	Movements	ANN	SVM
1	Normal	0.9224	0.9429
2	Turn Right	0.9921	0.9118
3	Turn Left	0.9946	0.9375
4	*U-turn*	0.9863	0.8750
5	Zig-zag	0.9714	0.8824
6	Sleepy	0.9333	0.9091
7	Sudden Braking	0.9796	0.8824
8	Sudden Acceleration	0.9717	0.8235
9	Speed Bump	0.9141	0.70

Table V is a comparison of the accuracy of the ANN and SVM algorithms. The data used by these two algorithms are the same. From table V, we can see that overall, the ANN algorithm has better accuracy than the SVM algorithm. Seen in every movement only in normal movements, the accuracy of SVM is better than ANN. The average accuracy of the ANN is 96.2% while the SVM is 87.3%. So, it can be concluded that in this study the ANN algorithm has better accuracy than SVM.

VI. CONCLUSION

Based on the data and explanations that have been submitted, the Accelerometer sensor has a high sensitivity, in addition to the presence of high-frequency noise, the data taken from the sensor cannot be directly processed because the pattern of the sensor value has not been seen. Therefore it is necessary to do the filtering process using a Low Pass Filter. The selection of LPF is based on the presence of high-frequency noise that we don't want. LPF Filter used is IIR Filter.

The amount of data trained in Machine Learning during the training process is 628. The more data that is trained, the better decisions will be made by Machine Learning. To speed up the computational process when making decisions by Machine Learning, the data to be entered is normalized before using min-max normalization. With this normalization, the data that previously had a large enough range will be normalized so that the range of data will range from 0 to 1. The algorithm used in Machine Learning is Artificial Neural Network (ANN). The concept of ANN is based on neurons that exist in the human brain. There are 3 layers in ANN, namely the input layer, hidden layer, and output layer.

From the tests that have been carried out by 5 different drivers, the average accuracy of Machine Learning is 96.2%. This means that Machine Learning is made to have high accuracy to detect abnormal movements made by drivers. So that the driver's abnormal motion detection system can be used to alert drivers to refocus on driving.

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