International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Control System Turn Signal Indicator and Motorcycle Accident Detection Using GPS Based on Arduino

Suluh Argo Pambudi, R Gaguk Pratama Yudha, Aulia El Hakim
Madiun State Polytechnic, Madiun, Indonesia
Email address: suluh(at)pnm.ac.id, gaguk(at)pnm.ac.id, aim(at)pnm.ac.id

***Abstract*—** *Currently, there are many motorcycle eligibility systems, but it is still undeniable that there are still many accidents, for example, when the driver forgets to turn off the turn signal after using it, it can result in being hit from behind because of this. Currently, there are few information systems to speed up driver assistance when an accident occurs. Therefore, in this final project the author makes a system entitled "Automatic Turn Signal Control System And Accident Detection On Arduino-Based Motorcycles". In this title there are 2 systems, namely an automatic turn signal control system that uses a Photodiode sensor and an accident detection system that uses an MPU6050 sensor and a GPS sensor Ublox Neo 6m. The results of testing the automatic control system when the driver turns on the turn signal turn right with a handlebar tilt of > 10°, the Photodiode sensor detects the driver turning right as well as when the driver turns on the left turn signal. As for testing the accident detection system, when the value of the MPU6050 sensor is <-40° or >40°, it will send a notification to the driver's closest family smartphone in the form of the accident location from the GPS sensor reading to speed up help. The success rate of this system in the tests that have been carried out has reached 95% where the system runs according to predetermined parameters*.

***Keywords*—** *Motorcycle; Accident; Notification*.

I. Introduction

Motorcycles are the most widely used means of transportation by the community. Based on data from BPS (Badan Pusat Statistik) in 2018, in Indonesia, the number of motorcycles reaches 106.657.952 units [1]. With so many vehicles, the risk of accidents is also high. It was recorded that in 2018 the number of road traffic accidents was 196,457 incidents and 73.49% involved motorcycles [2]. Traffic accidents themselves, occur due to several factors, one of which is human error [3]. Among other things, when the driver neglects to turn off the motorcycle's turn signal while driving which can result in confusion for other drivers and it could be because the negligence can cause a collision with other riders. And one of the factors that is confused when an accident occurs is contacting the victim's closest family [4]. And one of the factors that is confused when an accident occurs is contacting the victim's closest family.

In previous research on automatic turn signals, Bondan and Bayu (2016) [5], they made a tool to turn off the turn signal automatically using an arduino mini and programmed in C language where the turn signal light was calculated from a predetermined timer. However, when testing at the traffic light intersection, you must turn on the turn signal 2 times because the time set is 30 seconds while the traffic light is more than 30 seconds. And in the research of Via et al. (2019) they made a prototype turn signal lights turn off automatically by using the Gyro MPU5060 sensor as a seeker and determining the degree of slope used for setpoint input [6]. As well as for research on Accident Detection conducted by Suprayogi et al. (2019) uses the MPU6050 Gyroscope sensor to read the slope value of the motorcycle, then sends a notification in the form of an SMS to the victim's family cellphone via the SIM900A GSM Module [7]. In this study, it only sends notifications that the driver has an accident and there is no GPS notification to provide information where the driver has an accident.

Based on this background, in this final project the author makes the title "Automatic Turn Signal System and Accident Detection on Arduino-Based Motorcycles", a tool to turn off the turn signal automatically and detect accidents based on the slope of the motorcycle and send the accident location to the closest family if the driver have an accident to speed up first aid. When the turn signal lights up and the Photodiode sensor detects the predetermined set point value, the turn signal will turn off automatically. And the MPU6050 sensor functions to detect the slope of the motorcycle to indicate that the driver has an accident or not and the system will send location coordinates based on the GPS NEO UNBLOX 6M which has been installed on the motorbike and the NodeMCU ESP8266 module for data communication to the smartphone of the driver's closest family. It is hoped that this tool will be useful for the community in reducing the risk of accidents due to lack of sensitivity to turning off the turn signal and speeding up first aid when an accident occurs.

II. Methods

This chapter describes the system diagram and tool design.

2.1 System Diagram

The following is Figure 2.1 which is a system design that will be applied in the manufacture of tools.

For "Automatic Control System and Accident Detection on Arduino-Based Motorcycles" is described in the yellow dotted line. Here's an explanation of the system:

1. Tegangan The voltage from the battery goes to the regulator to manage the voltage so that the voltage that enters the Arduino Mega, Photodiode sensor, right and left Relay, MPU6050, GPS sensor, and Esp8266 is not more than 5V. And for the turn signal, the voltage source comes from a 12V battery.
2. Sensor Photodiode sensors will be used to detect the occurrence of turns. Figure 2.2 shows the process of turning off the turn signal.

Suluh Argo Pambudi, R Gaguk Pratama Yudha, and Aulia El Hakim, "Control System Turn Signal Indicator and Motorcycle Accident Detection Using GPS Based on Arduino," *International Research Journal of Advanced Engineering and Science*, Volume 7, Issue 1, pp. 142-148, 2022.

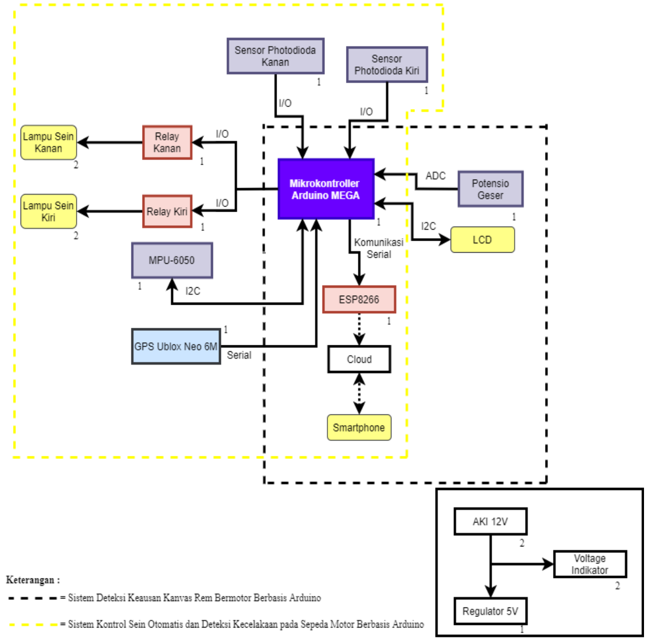

Figure 2.1 System Work Diagram

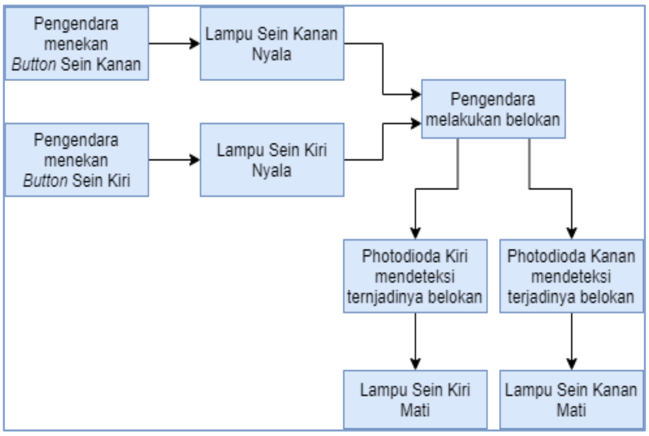

Figure 2.2 Process Diagram of Turning Off Turn Signal

At this stage, when the driver presses the turn signal button, the button is "HIGH" and the turn signal lights up. Then when making a turn, the barrier mounted on the handlebar of the motor will block one of the photodiodes. So the Arduino Mega microcontroller will read whether the driver is turning right or left. In this way, when the right Photodiode is "LOW" and the left Photodiode is "HIGH" it will detect that the driver is turning "right", and when the right Photodiode is "HIGH" and the left Photodiode is "LOW" it will detect that the driver is turning to "left". After it is detected to make a turn, the turn signal will turn off after the state of the right photodiode and the left photodiode have returned to "HIGH" all for 5 seconds The turn signal lights that turn off correspond to the turn signal lights detected on the microcontroller.

3. MPU-6050 and GPS will be used to detect the accident and the location of the accident. Figure 2.3 shows the process of detecting accidents.

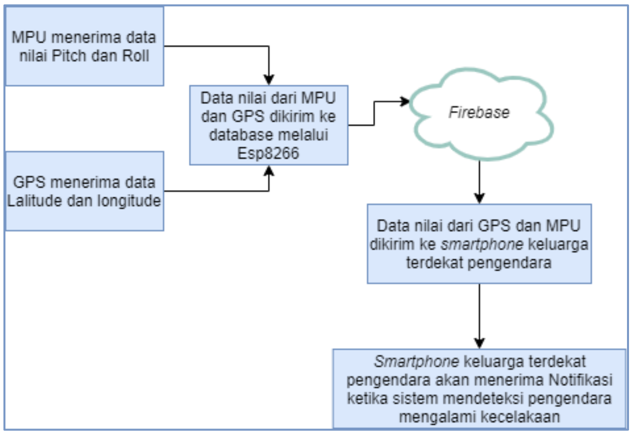

Figure 2.3 Accident Detection Process Diagram

At this stage the MPU value in the form of Pitch and Roll values and GPS values in the form of Latitude and Longitude received by the Arduino Mega microcontroller will be sent using serial communication to the NodeMCU ESP8266.

After the MPU and GPS data are received by the NodeMCU, the data will be sent to Firebase which will then be sent to the smartphone of the closest family. If the Roll value received by the system is not between -40 to 40, the system detects an accident and the system will send a notification to the smartphone of the closest family containing notification of the driver having an accident and the location of the accident. The location of the accident is obtained based on the GPS latitude and longitude values received by the system, then it will be connected directly to Google Maps.

4. Arduino Mega and NodeMCU8266 microcontrollers are used as communication between devices and send MPU sensor data and GPS sensors to Firebase.
5. The relay is used to disconnect the turn signal when it is detected that it has made a turn.
6. Cloud firebase is a place used to store data from MPU and GPS sensors that are always connected to the driver's closest family device and smartphone. So that it can be accessed in real-time to send notifications.
7. The smartphone used is an android smartphone from the driver's closest family, where there is an interface created using the MIT APP Inventor in the form of an application that displays information in the form of notifications automatically when the system detects an accident on the driver containing the location of the driver's accident.

2.2 Tool Design

Figure 2.4 is a tool placement plan. Where the tool will be installed on the handlebar and in the motorcycle seat.


Figure 2.4 Tool Placement Design

Suluh Argo Pambudi, R Gaguk Pratama Yudha, and Aulia El Hakim, "Control System Turn Signal Indicator and Motorcycle Accident Detection Using GPS Based on Arduino," *International Research Journal of Advanced Engineering and Science*, Volume 7, Issue 1, pp. 142-148, 2022.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Figure 2.5 is a plan for laying components in the toolbox.

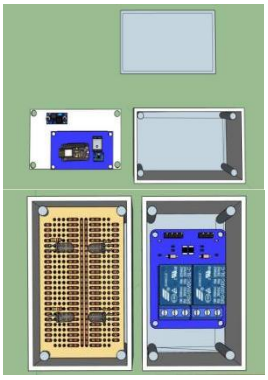
Figure 2.5 Component Layout Design

The following Figure 2.6 is an image of the circuit design that will be used in the manufacture of the tool

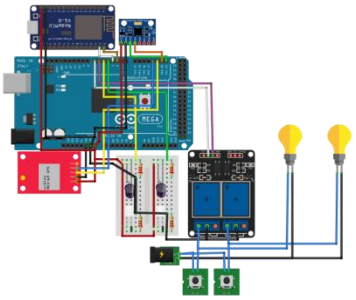
Figure 2.6 Component Circuit Design

III. Results and Discussion

At this stage, several tests were carried out as follows:

3.1 Angle Test MPU6050

This test aims to compare the accuracy of the slope angle of the MPU6050 Roll, so that it can provide good angle values. Where a good angle value is the angle obtained by the MPU6050 is the same as manual calculations using an angle arc / geniometer

Figure 3.1 shows the results of calculating the MPU6050 Roll angle value manually.

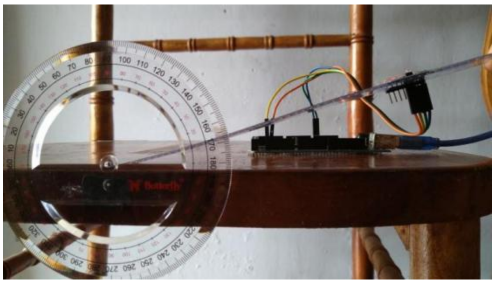
Figure 3.1 Testing Using Angle

Figure 3.2 shows the results of calculating the MPU 6050 value on a serial monitor.

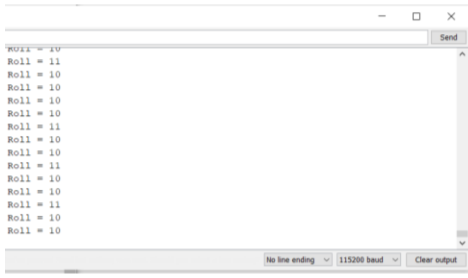

Figure 3.2 MPU6050 Value Display on Serial Monitor

In the following Table 3.1 contains the results of the MPU6050 test by comparing the accuracy of the manual calculation value with the value read by the MPU6050 sensor.

TABLE 3.1 Test Results MPU6050

No	Arc Angel	Data Testing	Angel MPU6050	*Error*
1	10˚ (Right Tilt)	1	11˚	0,1%
		2	10˚	0%
		3	10˚	0%
		4	10˚	0%
		5	11˚	0,1%
		6	10˚	0%
2	20˚ (Right Tilt)	1	19˚	0,05%
		2	19˚	0,05%
		3	20˚	0%
		4	19˚	0.05%
		5	19˚	0,05%
		6	18˚	0,1%
3	-10˚ (Left Tilt)	1	-7˚	1,7%
		2	-8˚	0,2%
		3	-9˚	0,1%
		4	-10˚	0%
		5	-10˚	0%
		6	-10˚	0%
4	-20˚ (Left Tilt)	1	-21˚	0,05%
		2	-20˚	0%
		3	-21˚	0.05%
		4	-21˚	0.05%
		5	-20˚	0%
		6	-21˚	0,05%
5	-30˚ (Left Tilt)	1	-30˚	0%
		2	-33˚	0,1%
		3	-30˚	0%
		4	-30˚	0%
		5	-34˚	0,13%
		6	-35˚	0,16%
Average *error*				0,103%

From Table 3.1 the test results show that the average error obtained is 0.103**%** which is still a tolerable value So it can be concluded that the MPU6050 sensor readings get a good value and can be implemented in this system for accident detection.

3.2 Testing GPS Ublox Neo6m

This test aims to determine the time needed by the GPS to receive the latitude and longitude value data signals and determine the accuracy of the coordinates of the latitude and longitude values generated by the Ublox Neo 6m GPS reading,

Suluh Argo Pambudi, R Gaguk Pratama Yudha, and Aulia El Hakim, “Control System Turn Signal Indicator and Motorcycle Accident Detection Using GPS Based on Arduino,” *International Research Journal of Advanced Engineering and Science*, Volume 7, Issue 1, pp. 142-148, 2022.

so that it can provide good value results. Where a good value is the resulting coordinate value is the same as the coordinates of Google Maps and the time it takes to receive the signal does not take a long time.

Figure 3.3 GPS Location Test

Figure 3.3 shows one of the locations for the Ublox Neo 6m GPS test conducted on Jl. Sawahan-West, Ngronggo, Rejosari Kec. Sawahan Kab. Madiun.

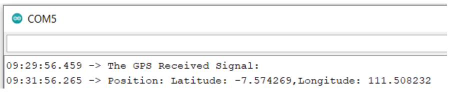

Figure 3.4 Display of GPS Signal Time Test on Serial Monitor

Figure 3.4 shows the test of the duration of time needed for GPS to receive lalitude and longitude data signals that are displayed on the serial monitor.

The following is Table 3.2 which is the result of testing the time needed for GPS to get a data signal.

TABLE 3.2 GPS Signal Time Duration Test Results

No	Time Tool On	GPS Time Receiving Signal	Duration
1	12:12:52	12:17:32	4 minutes 40 seconds
2	10:58:45	11:02:01	3 minutes 16 seconds
3	09:29:56	09:31:56	2 minutes
4	15:54:08	15:55:04	56 seconds
5	19:22:08	19:23:32	2 minutes 24 seconds
6	12:56:00	12:57:33	1 minutes 33 seconds
7	15:43:24	15:45:28	2 minutes 4 seconds
8	18:45:18	19:05:37	20 minutes 19 seconds
9	22:27:15	22:30:47	3 minutes 32 seconds
10	01:10:37	01:19:39	9 minutes 2 seconds
Average duration			4minutes 58,6 seconds

From Table 3.2, the test results show that the average time required for GPS to receive a data signal is 4 minutes 58.6 seconds.

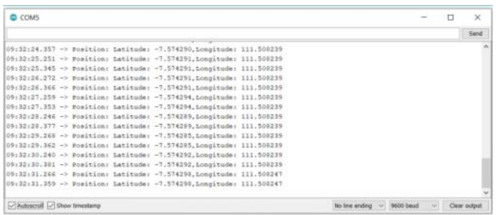

Figure 3.5 Display of GPS Coordinate Value on Serial Monitor

Meanwhile, Figure 3.5 shows the latitude and longitude coordinates of the GPS sensor which can be seen on the serial monitor and Figure 3.6 shows one of the coordinates of the test location from Google Maps.

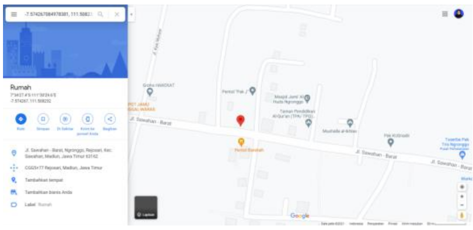

Figure 3.6 Test Locations on Google Maps

Meanwhile, Figure 3.7 shows the distance due to the comparison of the values of the two coordinates from GPS and Google Maps.

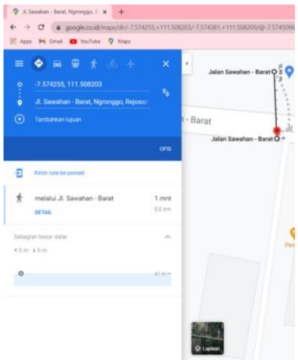

Figure 3.7 Distance Due to Comparison of Coordinate Values

The following is Table 3.3 which is the result of GPS testing in several places.

TABLE 3.3 Ublox Neo 6m . GPS Test Results

No	Location	*Google Maps*	*GPS Ublox Neo 6m*	*Error*
1	Jl. Sawahan-Barat, Rejosari, Kec. Sawahan, Kab. Madiun.	-7.574255, 111.508203	-7.574381, 111.508209	13,96 m
2	The Forest Cafe Jl. Rimbakaya, Kartoharjo, Kec. Kartoharjo, Kota Madiun, Jawa Timur 63117	-7.627396, 111.52788	-7.627390, 111.527790	9,92 m
3	Jl. Serayu Timur III No.20, Pandean, Kec. Taman, Kota Madiun, Jawa Timur 63133	-7.648478, 111.523363	-7.648568, 111.523384	10,27 m
4	Nglencong, Golan, Kec. Sawahan Kab. Madiun	-7.557435, 111.504928	-7.557479, 111.504928	4,88 m
Average *error*				9,75 m

From Table 3.3 the test results show that the average error obtained is 9.75 m, which is still a tolerable value. So it can be concluded that for testing the time required for GPS to receive latitude and longitude data signals, it is around 54 seconds to 20 minutes 19 seconds with an average duration of 4 minutes 58.6 seconds, the length of time this GPS signal reception is influenced by several factors, namely weather and climate change. pick-up location. Meanwhile, for testing the accuracy of the GPS reading coordinates, the average error is 9.75

meters. So that this GPS can be used in this system to find out the location of the driver when he has an accident.

3.3 Notification Test

This test aims to display notifications on smartphones. By the way, when the system detects an accident, this notification will appear on the smartphone of the driver's closest family.

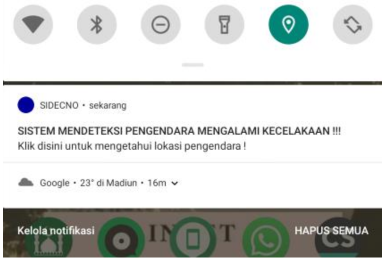

Figure 3.8 Display Login Notification on Smartphone

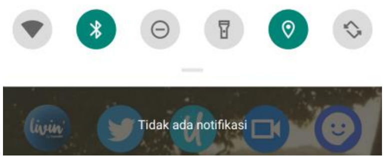

Figure 3.9 Display No Login Notification on *Smartphone*

Figure 3.8 shows the notification display displayed on the smartphone of the driver's closest family. This notification is in the form of a warning display that reads “DETECTION SYSTEM DETECTING DRIVERS HAD AN ACCIDENT!!!”. Then when clicked it will go to the crash menu on the SIDECNO application. And Figure 3.9 shows the display if there is no notification on the smartphone.

TABLE 3. 4 Notification Test Results

No	Score Roll MPU *Firebase*	Notification
1	40.00	Appear
2	-25.00	Not Appear
3	-40.01	Appear
4	37.50	Not Appear
5	67.92	Appear
6	-87.90	Appear
7	-39.99	Not Appear
8	56.67	Appear
9	-54.06	Appear
10	25.25	Not Appear

From the test data in Table 3.4, a notification will appear if the Roll MPU value of firebase is <-40 and >40. Meanwhile, the notification will not appear when the Roll MPU value from firebase is between -40 to 40. It can be concluded that the notification test is running well and accordingly.

3.4 Photodiode Test

This test aims to determine the function of the photodiode in receiving data, in this test there are 2 conditions, namely when the left photodiode is blocked it will detect that the driver is turning left and when the right photodiode is blocked it will detect that the driver is turning right.

Table 3.5 shows the results of the photodiode test as a turn detector.

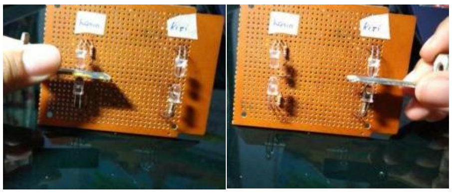

Figure 3.10 Photodiode Test

TABLE 3.5 Photodiode Test Results

No	Data Testing	P. Right	P. Left	*Serial Monitoing*	Ket.
1	1	*HIGH*	*HIGH*	“Straight”	Good
2	2	*HIGH*	*HIGH*	“Straight”	Good
3	3	*HIGH*	*HIGH*	“Straight”	Good
4	4	*HIGH*	*HIGH*	“Straight”	Good
5	5	*HIGH*	*HIGH*	“Straight”	Good
6	1	*LOW*	*HIGH*	“Turn Right”	Good
7	2	*LOW*	*HIGH*	“Turn Right”	Good
8	3	*LOW*	*HIGH*	“Turn Right”	Good
9	4	*LOW*	*HIGH*	“Turn Right”	Good
10	5	*LOW*	*HIGH*	“Turn Right”	Good
11	1	*HIGH*	*LOW*	“Turn Left”	Good
12	2	*HIGH*	*LOW*	“Turn left”	Good
13	3	*HIGH*	*LOW*	“Turn Left”	Good
14	4	*HIGH*	*LOW*	“Turn Left”	Good
15	5	*HIGH*	*LOW*	“Turn Left”	Good
16	1	*LOW*	*LOW*	“Not Detected”	Good
17	2	*LOW*	*LOW*	“Not Detected”	Good
18	3	*LOW*	*LOW*	“Not Detected”	Good
19	4	*LOW*	*LOW*	“Not Detected”	Good
20	5	*LOW*	*LOW*	“Not Detected”	Good

From Table 3.5 the test results, it is found that the photodiode is able to receive data properly and appropriately. The photodiode circuit itself consists of an IR sensor as a transmitter and a photodiode sensor as a receiver. So when the photodiode receives radiation from the IR, the photodiode has a HIGH value because the resistance read is low and if the beam is blocked by a barrier, the photodiode will be LOW because the resistance read is high. So in the test the results show that if P. Right is HIGH and P. Left is HIGH it will be detected "Straight", and if P. Right is LOW and P. Left is HIGH it will be detected "Turn Right", and P. Right is HIGH and P. Left is LOW it will be detected "Turn Left" , and P. Right is LOW and P. Left is LOW then “Not Detected”.

3.5 Final Test

The purpose of this overall test is to test whether the tools and applications can work properly after all components are combined and implemented directly on the motorcycle. Where for the automatic turn signal system can be said to work well when it can turn off the automatic turn signal after making a turn and for the accident detection system it can be said to work well when the system detects a driver has an accident then the system will send a notification to the smartphone of the driver's closest family who has the "SIDECNO application".

TABLE 3.6 Turn Parameters

Handle Angel	Photodiode		State
	Right	Left	
>10° to the right	*LOW*	*HIGH*	Turn Right
>10° to the left	*HIGH*	*LOW*	Turn Left
0°	*HIGH*	*HIGH*	Straight

Table 3.6 shows the turn identification parameters used in this tool and test. When the handlebar angle is >10° to the right, the right photodiode is "LOW" then it is categorized as "Turn Right". Likewise, when the handlebar angle is >10° to the left, the left photodiode is "LOW" then it is categorized as "Turn Left". Conversely, when the handlebar angle is 0° or the right photodiode or left photodiode is "HIGH" then it is categorized in a "Straight" state.

TABLE 3. 7 Automatic Turn Signal System Testing

 Figure 3. 11 Turn Right Signal	 Figure 3. 1 Turn Signal after Turning Right
 Figure 3. 2 Turn Left Signal	 Figure 3. 3 Turn Signal after Turning Left

Table 3.7 shows the process of testing the Automatic Turn Signal System, where in Figure 3.11 the driver turns on the right turn signal to make a right turn and in Figure 3.12 after the driver has made a turn and the handlebar is back in a straight state for 5 seconds, the turn signal will turn off automatically. Likewise when making a left turn, as in Figure 3.13 the driver turns on the left turn signal to make a left turn and in Figure 3.14 after the driver has made a turn and the handlebar is back in a straight state for 5 seconds it will turn off the left turn signal automatically.

TABLE 3.8 Automatic Turn Signal System Test Results

No	**State**	**Turn Signal**		**Turn Signal After 5 seconds**	
		Left	**Right**	**Left**	**Right**
1	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
2	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
3	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
4	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
5	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
6	Turn Right	*ON*	*OFF*	*OFF*	*OFF*
7	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
8	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
9	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
10	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
11	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
12	Turn Left	*OFF*	*ON*	*OFF*	*OFF*
13	Straight	*OFF*	*OFF*	*OFF*	*OFF*
14	Straight	*OFF*	*OFF*	*OFF*	*OFF*
15	Straight	*OFF*	*OFF*	*OFF*	*OFF*

In Table 3.8 are the results of the Automatic Turn Signal System testing that has been carried out. It can be seen that the results of the tests carried out produce good data where when the turn signal is turned on and after making a turn, the photodiode detects a straight state for 5 seconds the turn signal can turn off automatically.

TABLE 3.9 Accident State Parameters

Angel Roll MPU	State
(-40°) - 40°	Safe
< -40°	Accident
> 40°	Accident

Table 3.9 shows the accident state parameters used in this tool and test. Where when the MPU6050 Roll angle is between -40° to 40° it will be categorized in a "Safe" state, and if the MPU6050 Roll value is less than -40° it will be categorized in an "Accident" state as well as when the MPU6050 Roll value is more than 40° it will be categorized in a state of "Accident". "Accident" too.

TABLE 3.10 Accident Detection Test

 Figure 3. 4 Safe State	 Figure 3. 5 Accident State

Table 3.10 shows the process of testing the Accident Detection System, where in Figure 3.15 the driver is in a safe state while driving while in Figure 3.16 the driver is in a state of falling/accident while driving on the road.

Figure 3.17 Notification Display When Accident Keadaan

Figure 3.17 shows a notification that appears on the smartphone of the driver's closest family. Where there is a notification with the words "DETECTION SYSTEM DETECTING DRIVERS IN ACCIDENT!!!". And in the notification there is an order to click on the notification to find out the location of the driver who has an accident.

Figure 3.18 Application Display When Accident Keadaan

Figure 3.18 shows the display after the notification is clicked where it will enter the SIDECNO application on the crash menu.

Figure 3.19 Google Maps Display When Accident

Figure 3.19 shows the display of the location of the driver who had an accident on Google Maps

TABLE 3.11 Accident Detection Test Results

No	Field Condition	Corner *Roll* MPU *firebase*	State Reading	Notification
1	Motorcycle falls to the left	-48.94°	Accident	Notification appears
2	Motor tidak jatuh	-2.23°	Safe	Off Notification
3	Motorcycle falls to the left	-52.13°	Accident	Notification appears
4	Motorcycle not fall	-2.38°	Safe	Off Notification
5	Motorcycle falls to the left	-52.71°	Accident	Notification appears
6	Motorcycle not fall	-2.12°	Safe	Off Notification
7	Motorcycle falls to the right	41.97°	Accident	Notification appears
8	Motorcycle not fall	-2.46°	Safe	Off Notification
9	Motorcycle falls to the right	53.57°	Accident	Notification appears
10	Motorcycle not fall	-2.12°	Safe	Off Notification

Table 3.11 is the result of testing the Accident Detection System that has been implemented. Where when the driver falls or is in an accident the system will identify that the driver has an accident and send a notification to the smartphone of the driver's closest family, so that the driver immediately gets help. And when the system does not identify that the driver had an accident then no notification appears.

From the overall test results that have been carried out, it can be concluded that in this test the system has worked well in accordance with the purpose of this system where the system can turn off the turn signal automatically and the system can detect accidents and send notifications containing the location of the accident scene.

IV. CONCLUSIONS

In closing, there are several things that can be concluded from this final project. After testing the entire system, and based on the data that has been obtained, some conclusions can be drawn as follows:

1. The Photodiode circuit is used to detect the occurrence of turns in order to read straight conditions, turn right or turn left. Where is this circuit placed on the handlebar at the bottom of the motorcycle.
2. As well as to detect a straight state, when the handlebar is in a state of 0° and the right and left photodiodes will have a HIGH value.
3. The MPU6050 module is used to detect accidents and the Ublok Neo 6m GPS is used to find out where the accident happened to the driver.
4. To identify the occurrence of an accident based on the reading of the Roll MPU6050 value when the value is < -40° and >40°.
5. The average time required for GPS to receive coordinate data is 4 minutes 58.6 seconds and the average error for GPS coordinates is around 9.75 meters.
6. Notifications that are sent when an accident is detected contains the location of the driver's accident based on the coordinate value sent by the GPS in the device.

REFERENCES

[1] Perkembangan Jumlah Kendaraan Bermotor Menurut Jenis, 1949-2018. Badan Pusat Statistik. https://www.bps.go.id/. Diakses tanggal 1 Juli 2021.

[2] Pesepeda Motor Menyumbang Kecelakaan Terbesar di Jalan Raya. https://www.bisnisnews.id. Diakses tanggal 6 Januari 2021.

[3] Sugiyanto,G. dan Mina Y.S. Mei 2015. *Karakteristik Kecelakaan Lalu Lintas dan Pendidikan Keselamatan Berlalulintas Sejak Usia Dini: Studi Kasus di Kabupaten Purbalingga*. Jurnal Ilmiah Semesta Teknika. Vol. 18 No.1, 65-75.

[4] Afandi, M.T.A., Hurriyatul F., Gembong, E.S., 2019. *Sistem Deteksi Rem mendadak dan Tabrakan Menggunakan Sensor Akselerometer Dengan Metode K-Nearest Neighbour Berbasis Arduino*. Prodi Teknik Komputer, Fakultas Ilmu Komputer, Universitas Brawijaya.

[5] Y.Bondan P.S. dan Bayu Setiaji. 2016. *Pemanfaatan Mikrokontroller Untuk Lampu Sein Otomatis Pada Sepeda Motor*. Teknik Informatika STMIK AMIKOM Yogyakarta.

[6] Via, V.Y., Basuki R., Ronny G.S. 2019. *Implementasi Berbasis Arduino Uno R3 untuk Ptototipe Lampu Sein Otomatis Pada Kendaraan*. Prodi Teknik Informatika, Fakultas Ilmu Komputer, Universitas Pembangunan Nasional "Veteran" Jawa Timur.

[7] Suprayogi, A., Hurriyatul F., Tibyani. 2019. Sistem Pendeteksi Kecelakaan Pada Sepeda Motor Berdasarkan Kemiringan Menggunakan Sensor *Gyroscope* Berbasis Arduino. Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer. Vol.3, No.3.