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Design of automatic turn signal of motorcycle based on Arduino Uno

Ryan Febridion Putra[1], Oriza Candra[1]
[1]Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang, Padang, Indonesia

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ABSTRACT

The purpose of this research is to design a series of automatic turn signal lights on and off using GPS and maps to help motorcyclists be comfortable in driving traffic within and between cities, and help motorcyclists use turn signal lights correctly and precisely when turning them on and off. With this tool, riders can turn on and off the turn signal automatically by simply connecting the tool and application to the internet or bluetooth, making it easier for riders to ride motorbikes. This research uses engineering research methods which include system design, hardware design, software design, hardware and software testing, and test analysis. The programming used is Arduino IDE software. The working principle of this system is that the turn signal lights will automatically be driven by a relay, before the device will be connected to maps through a web-based application as a bridge. This web application connects to Maps to get route data and uses a Bluetooth connection via the HC-05 module to send signals to the Arduino Uno R3. After turning, Maps sends a signal back to turn off the turn signal. The test results show the relationship between speed and active time on the automatic turn signal device, that the higher the speed of the vehicle being traveled, the shorter the active time of the turn signal lights to the turn to be passed, and vice versa. So this research is useful for motorists to turn on and off the turn signal automatically.

Corresponding Author:

Ryan Febridion Putra
Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang
Kampus UNP Pusat, Jl. Prof. Hamka, Air Tawar, Padang 25131, Indonesia
Email: ryanfebridionputra@gmail.com

1. INTRODUCTION

In Indonesia, motorcycles are a very common mode of transportation, both for intra-city and inter-city travel. However, there are still many riders who do not fully comply with traffic rules, so traffic accidents often occur. The accidents are caused by human negligence in riding the motorcycle. One such negligence is caused by forgetting to turn on and off the motorcycle's turn signals while driving. Vehicle turn signals are an important safety feature. Together with the horn, vehicle turn signals are a means of communication [1]. Car turn signals are much more advanced than motorcycle turn signals. After the vehicle turns, there is a system that allows the turn signal lights to automatically turn off. However, if you don't put the switch back in place, your motorcycle's turn signal light will remain on. Take the example of a motorcycle; the rider apparently forgot to turn off the turn signal after each use, so it constantly shows the left turn signal. Seeing this, other cars will inevitably move to the right side of the motorcycle. Unfortunately, an unavoidable collision occurs when the motorcycle suddenly turns right. This example is quite common in the real world and is a major cause of car accidents. Given these facts, there is a need for a mechanism to activate and deactivate a motorcycle's turn signal when turning the motorcycle. The idea behind this is to make motorcyclists safer and more comfortable in situations where drivers are careless, such as when they do not turn on their turn signal when they want to turn or when they turn it off too soon, which disrupts communication with other drivers and other road users and can lead to accidents [2].

The number of motorcycle accidents in Indonesia in 2023, especially those caused by human negligence, continues to increase, according to a survey from databoks.katadata.co.id, so an automated tool is needed. In 2023, there were 146,854 traffic accidents in Indonesia, according to statistics from the National Police's Criminal Information Center (Pusiknas). [3]. Another common cause of accidents is drivers not paying enough attention to the road in front of them when turning or changing lanes. This is especially true in the areas to the right and left of the driver, which are not visible to either the rearview mirror or the driver's eyes; these areas are also known as blind spot zones [2]. The use of technology continues to increase along with the development of more advanced technology, reflecting the trend of modern times. We have developed an automatic turn signal prototype [4]. Automatic machine is one of the technologies that is deliberately created to change an activity that is manual to automatic with the aim of simplifying the activity process. Automatic machines use technology and control systems to perform certain functions independently. In an industrial context, these machines are often used to replace manual tasks previously performed by humans. Thus, automated machines not only reduce human workload but also minimize errors that may occur due to human factors [5].

This automatic turn signal system is designed using an app that connects with Google Maps to determine the travel route. When the driver approaches a turning point, the app will activate the turn signal a few meters before the turn, and turn it off after the turn is complete. This turn signal is accessed through two interfaces, namely internet and bluetooth. Internet is used as an interface between maps and Android devices, while bluetooth is used to connect Android devices with turn signals [2]. The device used is the Arduino Uno which is a microcontroller board based on the ATmega328P microcontroller, designed to facilitate the development of electronic projects. With 14 digital input/output pins and 6 analog input pins, the Arduino Uno allows users to control various devices and sensors. The board also comes with USB connectivity for programming and power, and has the ability to generate PWM (Pulse Width Modulation) signals on its six digital pins. The Arduino IDE (Integrated Development Environment) is the software used to program the Arduino board. This IDE provides a simple interface for writing code, compiling, and uploading programs to the Arduino board. Users can write programs in the simplified C/C++ programming language with libraries that support various functions [6]. Arduino Uno, as a popular microcontroller, offers a flexible and affordable platform for designing automation systems in vehicles. Several studies have been conducted to develop an Arduino Uno-based automatic turn signal extinguishing system. For example, Kusnaidy (2022) designed an automatic turn signal extinguishing system with a counter technique, which uses switches as inputs and relays as outputs [7]. In addition, an Arduino Uno R3-based implementation for automatic turn signals on motorcycles has also been developed, with an Arduino Uno microcontroller as the control center [1].

Based on the background of these problems, the purpose of writing this article is that a system can help turn on and off the turn signal lights if the motorcyclist is negligent and a system can help turn off the turn signal lights that are on but not turning. Thus this article is entitled “Designing Automatic Turn Signal Lights on Arduino Uno Based Motorbikes”. With this design, it is hoped that it can make automatic turn signal lights that reduce accident cases due to human negligence in turning on and off turn signal lights on motorbikes while driving. Designing a series of automatic turn signal lights on and off using GPS and maps to help motorcyclists be comfortable in driving traffic within and between cities, as well as helping motorcyclists use turn signals correctly and precisely when turning them on and off. With this tool, motorists can turn on and off the turn signal automatically only by connecting the tool and application to the internet or bluetooth, making it easier for motorists to ride motorbike.

2. METHOD

This system design block diagram is a concise description of the combined cause and effect between the input and output of the system [8]. The parts in this block diagram are hardware consisting of Arduino Uno as a data processing center and reading sensors from maps via bluetooth HC-05, relays as on/off turn signal lights, and motor batteries as a 12 VDC voltage source. Based on the block diagram, it can be described that the working principle of this system is that the automatic turn signal will be driven by a relay, before the device will be connected to maps through a web-based application as a bridge. The Android web application is connected to Google Maps via an internet connection to obtain travel route data. This application is connected to Maps to get route data and uses a Bluetooth connection via the HC-05 module to send signals to the Arduino Uno R3. After receiving the signal from the application, HC-05 sends the data to Arduino Uno R3 for further processing. Arduino Uno acts as the brain of this system. After receiving data from the Bluetooth module, the Arduino will determine whether to activate the right relay or left relay based on the desired turning direction. The Arduino is also responsible for setting the duration of the turn signal activation to suit the needs. The Arduino then activates the relay to turn on the turn signal according to the turning direction. After turning, Maps sends a signal back to turn off the turn signal [7]. The power source for

this system comes from a 12V motor battery, which provides electrical energy for all components in the system, including the Arduino, relays, and turn signals to ensure that the hardware can operate properly and efficiently. With this design, the automatic turn signal system is expected to improve driving safety by reducing the risk of accidents due to driver negligence in using turn signals.

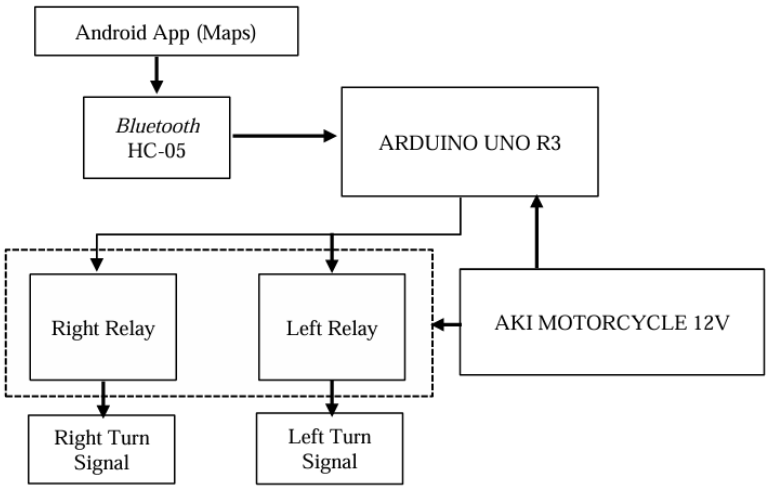

Figure 1. Block diagram of the proposed automatic turn signal system

Hardware design consists of mechanical design and electronic design. Mechanical design, namely making designs for door mechanics and electronic design, namely making electronic circuits that will be realized into PCB (Printed Circuit Board) form. When making hardware devices, mechanical design is an important step. The goal of mechanical design is to make hardware production easier and error-free so you can get the best results [8]. The mechanical design in this project focuses on creating a system that can integrate electronic components into the physical structure of a motorcycle. The results of the mechanical design of this final project can be seen in Figure 2.

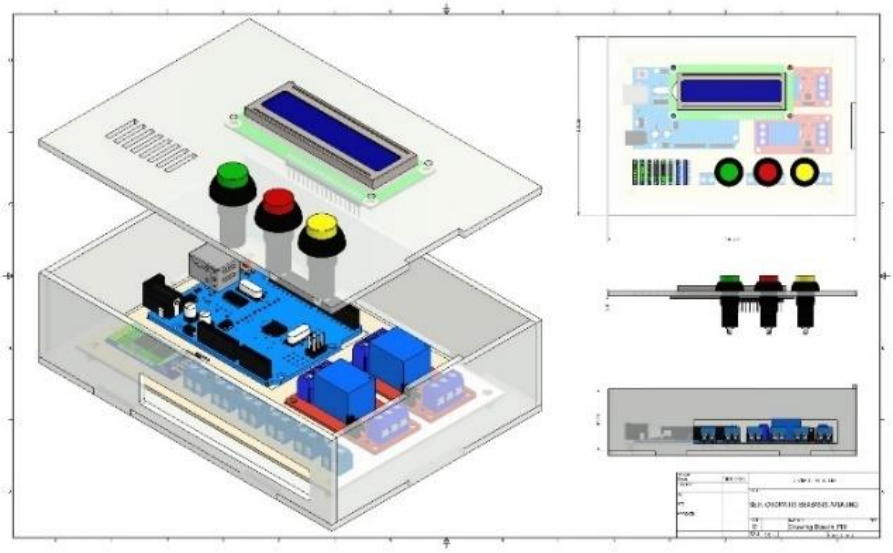

Figure 2. Mechanical components of the proposed turn signal

In the electronic design, Arduino uno functions as the overall system controller mounted on the main control PCB mainboard [9]. Electronic design includes making a circuit that will be realized into PCB (Printed Circuit Board) form. In Arduino, input data processing occurs and the processed data is then displayed on the output component. In the circuit there are also terminals that connect to bluetooth, relays, and motor batteries. Schematic results of the main electronic design circuit can be seen in Figure 3.

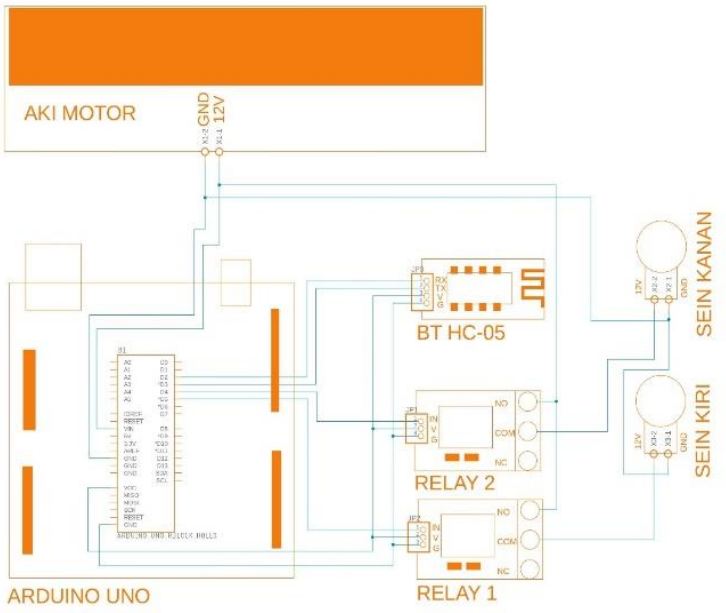

Figure 3. Main circuit schematic

Software design can be divided into 2 parts which include Arduino programming and android application design. The programming tool used is the Arduino IDE software. This software uses the C programming language. This arduino program listign is known as a sketch, “void setup” and “void loop” are two functions of each sketch. Void setup is executed when the sketch or Arduino program starts. The function is used to initiate variables, declare pins to be used, use libraries and others. While the Void loop is run after the setup function has finished running, the void loop aims to execute and run the program that has been created**.** [10]. Unlike void setup, which is only run once by Arduino, void loop is run regularly and actively controls the Arduino board by accepting inputs and changing outputs. So, it is called a loop because it repeats [9].

This code serves to integrate turn signal control with GPS navigation data and communication via Bluetooth, allowing automation based on geographic location and instructions received wirelessly. This program is designed to control automatic turn signal lights on a motorcycle using Bluetooth and GPS modules with the help of an Arduino microcontroller. The code starts by importing the SoftwareSerial library to support additional serial communication and TinyGPS++ to process GPS data. The Bluetooth module is connected through digital pins 2 and 3, while the GPS is used to get the location coordinates. Digital pins 9 and 10 are set as outputs to control the left and right turn signals. The variables currentLat, currentLng, targetLat, and targetLng store the coordinates of the current and destination locations, while instruction is used to store the instruction data received via Bluetooth. The setup() function initializes the output pins, enables serial communication with the Bluetooth module, and turns on the turn signal. The loop() function continuously checks the availability of data from Bluetooth, reads the received data, and processes it to determine when the turn signal should turn on based on the instruction and location. This system enables more advanced turn signal automation and responsiveness to the surrounding environment through GPS navigation and wireless commands.

The program excerpt above describes the algorithm for the actual automatic turn signal process. In the program, there is an input in the form of a signal from the RX bluetooth and is executed by sending an output signal to the relay according to the detected direction with an output delay of 1 second and will reset the instructions after executing the signal. The author uses a distance sensor in the application as far as 100 meters from the turn so that it is more efficient and not too short when activating the automatic turn signal because the GPS maps delay used in the application ranges from 2-3 seconds.

The application was created using the MIT Inventor App online. MIT App Inventor is a web-based visual programming platform developed by the Massachusetts Institute of Technology (MIT). The platform is designed to make it easy for users, including those with no programming background, to create mobile applications for Android and iOS devices. With an intuitive drag-and-drop interface, users can design the app's interface and define its functionality logic using visual code blocks. The benefit of using MIT App Inventor is its accessibility which is suitable for beginners, including students and educators, in learning

programming and app development concepts and enables rapid prototyping of apps without the need for in-depth programming skills [11]. In the application designed there is 1 screen, namely the monitoring screen itself which contains a connection to bluetooth, an exit feature from the application and a display of maps with a position according to the GPS cellphone used. For destinations, you can click directly on the maps that appear and wait a few seconds to bring up the route to be taken as well as a description of the distance and travel time during the trip. Figure 4 shows the display of application design.

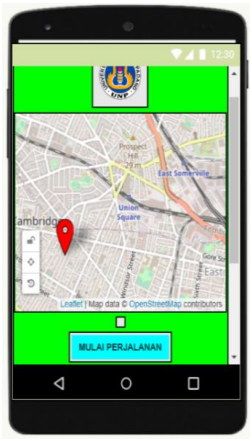

Figure 4. Initial View of the Application

Flowchart is a sequence of instructions in the creation of a program. flowchart is used as a tool to describe the logical sequence of a problem-solving procedure, breaking the problem into smaller parts to facilitate analysis and implementation [12]. Making a flowchart is needed to make it easier to make the program can be seen in Figure 5.

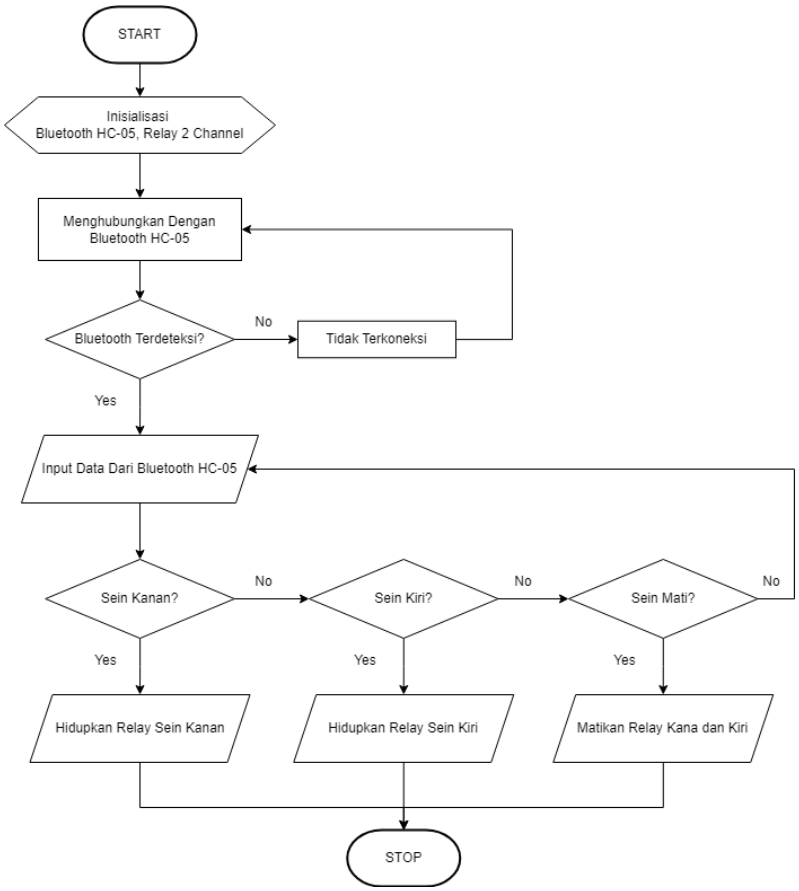

Figure 5. Tool work flowchart

Based on Figure 5, the flowchart explains the workflow of the turn signal automation system on a motorcycle using a Bluetooth HC-05 module and a 2-channel relay. The process begins with system initialization, which includes the Bluetooth HC-05 module and relays. After initialization, the system attempts to connect the device with Bluetooth HC-05. If the connection is successful, the system will proceed with receiving input data from the Bluetooth module. The received data is then processed to determine whether the right or left turn signal is active. If the signal indicates a right turn, the relay for the right turn signal will be activated. Conversely, if the signal indicates a left turn, the relay for the left turn signal will be activated. If there is no turn signal (turn signal off), the system will turn off both relays for the right and left turn signals. After performing the task according to the received signal, the system will return to the initial state to wait for the next signal. This process ensures that the turn signals function automatically, reducing the risk of driver negligence in activating or deactivating the turn signals during driving.

3. RESULTS AND DISCUSSION

The first tests are run to turn on the LED using the Arduino Uno output to ensure the tool can operate correctly and in accordance with the desired capabilities. The LED used is a device that is already present on pin 13 on the Arduino Uno board. This testing process is important because the internal LED on pin 13 is a simple visual indicator that can provide immediate feedback on the operational status of the microcontroller. By turning the LED on and off via code uploaded to the board, developers can ensure that communication between the hardware and software is working properly. If the LED is blinking, this indicates that the Arduino Uno has been successfully installed with a program via the Arduino IDE and is capable of executing basic instructions [13]. This testing step is usually done before moving on to more complex stages of project development to ensure the basic stability of the device. If these initial tests are successful, developers can proceed to integrate additional components such as sensors, communication modules, or other actuators. On the other hand, if the LED does not blink, then this indicates an issue that needs to be addressed, such as errors in software installation, connectivity issues, or even damage to the board itself. Therefore, this test serves as a crucial first step in the development cycle of an Arduino-based device.

The auto turn signal application must first be installed on the cellphone, then in the application there is a close, connect, and maps display with the position where the cellphone is located. Connect the application with the tool using bluetooth by pressing the “connect” option and connect with the available turn signal bluetooth. To connect the application with the tool, the user must select the connect option and connect the application with the Bluetooth module on the turn signal that is available. That way, the application can automatically activate the turn signal according to the direction of the vehicle [14]-[16]. The implementation of this system aims to improve the comfort and safety of motorcyclists by reducing the risk of forgetting to turn on or off the turn signal when turning. Arduino Uno serves as the system's control center, while the smartphone application is used to provide instructions via Bluetooth connection.

After the application is connected to bluetooth, the driver can select the destination location and the route that will be passed will appear as well as a description of the distance, time, and name of the road to be traveled. If the driver goes off the route or the selected route cannot be passed, the application will automatically replace the closest new route to reach the destination. The destination location can be selected directly through the maps available in the application, and the user has the flexibility to change the destination location as long as the application is still open. This system utilizes Arduino Uno as the main control center, which works together with the application on the smartphone to automatically adjust the turn signal according to the direction of the turn. With this system, it is expected that drivers no longer need to manually turn on or turn off the turn signal, so as to minimize the risk of accidents due to forgetting or using the wrong turn signal.

Next, the test is carried out by measuring the distance of the turn signal trigger and the active time interval when used with different constant vehicle speeds. The vehicle speeds used are 25km/hour and 30km/hour. In this test, the author used 6 routes where 1 route was carried out 3 times. In this test, the data taken is the active distance of the turn signal (m) and the time interval (t). The following are some of the experimental routes chosen as shown in Figure 6. The results of the automatic turn signal research are displayed in the form of Table 1 and 2.

Figure 6. Automatic Turn Signal Testing Route

Table 1. Testing the automatic turn signal device at a speed of 25 km/hour

Testing Route	Experiment	Tool on-time interval (s)				
		Turn 1	Turn 2	Turn 3	Turn 4	Turn 5
Route 1	1	12,3	12,1	11,8	-	-
	2	12,5	12,3	12,2	-	-
	3	12,1	12,1	12,2	-	-
Route 2	1	12	12,2	12,1	-	-
	2	12,2	12,5	11,9	-	-
	3	12,3	11,9	12,1	-	-
Route 3	1	11,9	12,2	12,5	12	-
	2	12,3	12,3	12,1	12,4	-
	3	12,1	12,2	12,2	12,3	-
Route 4	1	12,1	12,3	12,4	12,1	-
	2	12,4	12,1	12,5	12	-
	3	12,1	12,2	12,2	11,9	-
Route 5	1	12,3	12,2	11,8	12,3	12
	2	12,1	12,3	12,2	12,1	12,2
	3	12,1	11,9	12,3	12,4	12
Route 6	1	12,1	12,2	12,2	12,4	12
	2	12,3	12,1	12,3	12,1	12,2
	3	12,3	12,1	12,4	12,2	12

Table 2. Testing the automatic turn signal device at a speed of 30 km/hour

Testing Route	Experiment	Tool on-time interval (s)				
		Turn 1	Turn 2	Turn 3	Turn 4	Belok 5
Route 1	1	10,3	10,1	9,6	-	-
	2	9,7	9,8	9,9	-	-
	3	9,8	10,3	10,1	-	-
Route 2	1	10,4	9,9	10,2	-	-
	2	10,3	10,1	10,4	-	-
	3	10,2	9,7	10,1	-	-
Route 3	1	10,3	10	10,3	10,1	-
	2	10,4	10,1	10,1	10,3	-
	3	10,3	9,8	9,7	9,9	-
Route 4	1	10,4	10,4	10	10,1	-
	2	10,2	10,2	10,1	9,8	-
	3	9,9	10	10,4	10	-
Route 5	1	10,3	10,2	10,1	10,3	10
	2	10,4	10,3	10,2	9,6	10,3
	3	10,2	10,1	10	9,8	10,2
Route 6	1	10,3	10	10,1	10	10,3
	2	10,2	10,3	10,1	10,1	9,8
	3	10,1	9,9	10	10,2	10,4

4. CONCLUSION

Based on the results of testing the application, it is concluded that the test results show the relationship between speed and active time on the automatic turn signal device, that the higher the speed of the vehicle being traveled, the shorter the active time of the turn signal to the turn to be passed, and vice versa. The application can only be used in an open room and has sufficient internet signal and turns on the GPS on the user's cellphone. So that this research is useful for motorists to turn on and off the turn signal automatically only by connecting the tool and application to the internet or bluetooth so that it makes it easier for motorists to ride motorbikes.

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