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Development Eco Idle Kit System for Motorcycle

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Abstract: Eco idle system is a system to reduce exhaust emission, fuel consumption and number of engines spend during idling on the road by shutting off the engines automatically. The purpose of this project is to develop the simulation of an eco-idle system and install it on a motorcycle which is the system will turn off the motor after several seconds in idling mode. In this project, there are a few parts that have been used to develop this system kit for motorcycles. The circuit and coding of the system were created in Integrated Development Environment (IDE) software. Data acquisition System (DAQ) was developed, which will lead to the analysis of acceleration and deceleration of motorcycles. In this simulation, the main component is Arduino UNO. In this project, the coding has been added 4 seconds for engine to stop according to driver's behaviour in real road conditions. After simulating the eco idle kit system, this kit needs to install to motorcycle which is YAMAHA LC135 to analyse data acceleration and deceleration of motorcycles during development of eco-idle kit system. The test methodologies and results for development of eco idle kit system which were tested in different checkpoints. Five different checkpoints were selected to conduct tests of eco idle kit system. Parking lot student UTHM Campus Pagoh served as the site of each checkpoint, which was used to evaluate the eco idle kit system. In conclusion, the simulation of the eco idle system has been successfully run by the connection between required part and coding of the program.

Keywords: Eco idle, IDE software, DAQ

1. Introduction

Eco idle is a technical solution to the problem of fuel efficiency. Eco idle systems are designed to minimize gasoline. Depending on various factors, it can save three to ten percent on gas. More fuel savings come with longer stops. If a car gets 20 miles per gallon on average, eco-idle technology may boost that to around 22 miles per gallon. The car's starter, battery, computer system, and other components would need to be modified to enable start-stop technology [1-5]. At the end of this study, this research is focused on the objectives which are to develop low-cost data acquisition system (DAQ) that uses an Arduino for a motorcycle eco idle kit application. Then, to simulate the eco-idle kit system using Integrated Development Environment (IDE) software. After that, to analyze data acceleration and deceleration of motorcycles during development of eco-idle kit system. During this process of idling, it also produces exhaust emissions that particulate matter that cause global warming and health issues [3-4]. The increasing use of fuel, global warming and depletion of fossil fuel are gaining concerns and the situation has forced search for alternatives solutions as the emissions from internal combustion engine (ICE) vehicle which is the major contributors emits with various type of air pollutant emissions such as carbon monoxide (CO), nitrogen oxide (NO_X), hydrocarbon (HC) and other compounds [6-7].

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1.1 Arduino Integrated Development Environment (IDE) Software

IDE software allows developers to create programming new applications quickly because integrated as part of the setup process. IDE features are meant to help developers organize their workflow and solve the problem according to their parameter. IDE code as it is written, so bugs caused by human error are identified in real time. C and C++ language can be supported by IDE software and come up with many common input and output procedures. The Arduino programming language (Sketch) has been updated to make it easier for beginners to learn how to write code. The JAVA programming language was used to create the Arduino IDE. The Arduino IDE also includes the C/C++ library, which simplifies input and output tasks. Arduino IDE is a redesigned version of processing software that was created specifically for programming with Arduino. Programs written using Arduino software are called sketches. Sketch is written in a text editor and saved in a file with extension. The text editor in Arduino software has features such as cutting, copying, and searching/replacing making it easy for us to write programmed code [8-9]

1.2 Eco Idle System

The start-stop system, which shuts off the engine when it is idle, such as in traffic jams or at traffic signals, is one of the most effective technical solutions. The first attempts to create a system that would control the engine operation and shut off the engine when it idle was made in the 1970s by Toyota. Toyota Crown sedan fifth generation was equipped with a device that can turn off the powertrain unit after its idling in 1.5 seconds [10]. Toyota Crown also can monitor other parameters of the engine such as engine temperature, timing, and speed to adjust air-fuel ratios.

Toyota Crown was the first vehicle that had equipped an auto start-stop system. It allows to reduce the content of harmful substances in exhaust gases by 8% and fuel consumption by 15%. The result for efficiency engines was to gain 10% more power and reduced emission. The starting latency is another problem. Even though it is insignificant (0.8 s for systems with a reinforced starter, 0.4 s for systems with a reversible alternator, and 0.35 s for systems with fuel injection adjustment), it makes driving uncomfortable for many people [10].

2. Materials and Methods

Eco idle kit system was constructed as a development the programming on motorcycle system by using simulation software. The list of parts will be done during creation while designing of Arduino system that should be installed on the motorcycle and the system are completely functional.

2.1 Simulation Setup

IDE software is open-source software that is used to write, compile, and run the code program into Arduino. The software was designed to introduce programming with C and C++ programming that provided common input and output procedures. In this development, IDE simulation software was used as a platform to create the parameter of the eco idle kit. IDE programs read and write data to Arduino hardware and access connected devices. The data obtained can be analysed using IDE software and it can control the microcontroller based on the parameter that needs to be setup according to real conditions on the real road [11].

2.2 Develop The Eco Idle Kit System Part

Figure 1 shows an infrared sensor is a device that can measure the heat of an object and detect the motion of an object. There are two types of IR sensors which are passive and active Infrared Blaster (IR) sensors. In comparison to passive IR sensors, active IR sensors have greater benefits, such as good precision in both the lateral and longitudinal directions, as well as being less sensitive. It comes in two varieties: image active sensors that utilize laser diodes and non-imaging active sensors that use Light Emit Diode (LED). Commonly, the laser diode or LED will detect motion and rotation. From that, the sensor processes the information by using a variety of signal processing algorithms to the desired information. IR sensors emit infrared waves and detect infrared ways [12-13].

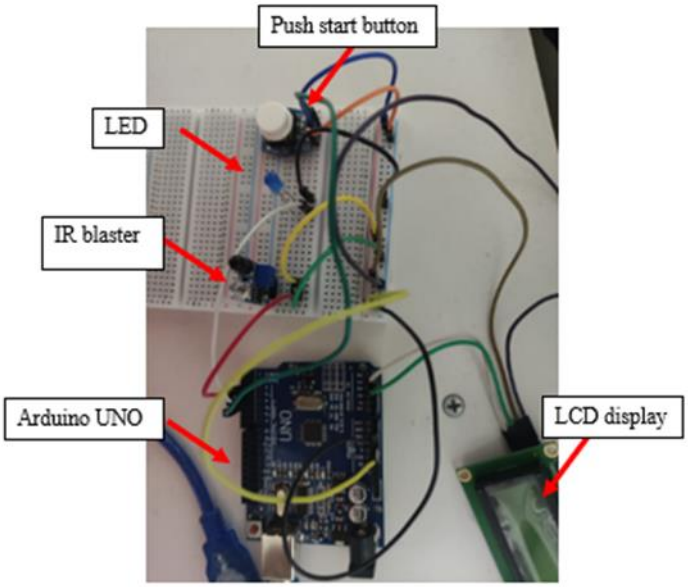

Fig. 1 - Eco idle kit system prototype for turning off the engine

Arduino is a free open-source microcontroller that can be readily programmed, erased, and reprogrammed. The Arduino Uno contains a set of analogue and digital pins that are input and output pins which are used to connect the board to other components. All the components are attached to the Arduino Uno board to make it function and can be used in this project. A variety of components are required to make the Arduino board complete and fully functional such as a microcontroller, external power supply, USB plug, internal programmer, analogue pins, and ground (GND) pins. The board can be easily connected to the computer via a USB port. It can be used to supply power to the board [12].

Figure 2 shows a limit switch sensor that are input and output devices components that change its working state in reaction to the crossing of the value its input. This limit switch is used to monitor and control values of temperature, voltage pressure and others. Limit switch are electromechanical devices consisting of an actuator mechanically linked to an electrical switch. When an object has contacted the actuator, the switch will operate causing a connection with an electric signal or break. Limit switches are available in several types of configurations, which are normally open, normally closed or one of each.

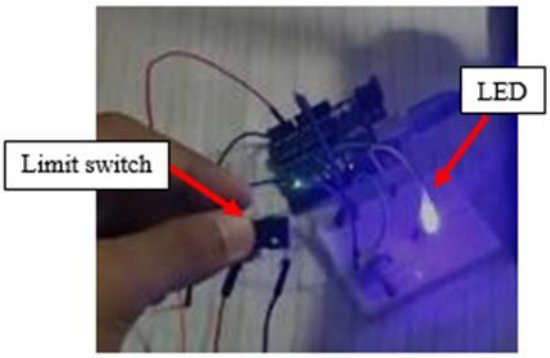

Fig. 2 - Eco idle kit system prototype for turning on the engine

2.3 Parameters Test for Each Checkpoint

Figure 3 shows an overview of whole experiment to collect data which is used to record engine to start and stop response time based on the parameters the motorcycle in real situation.

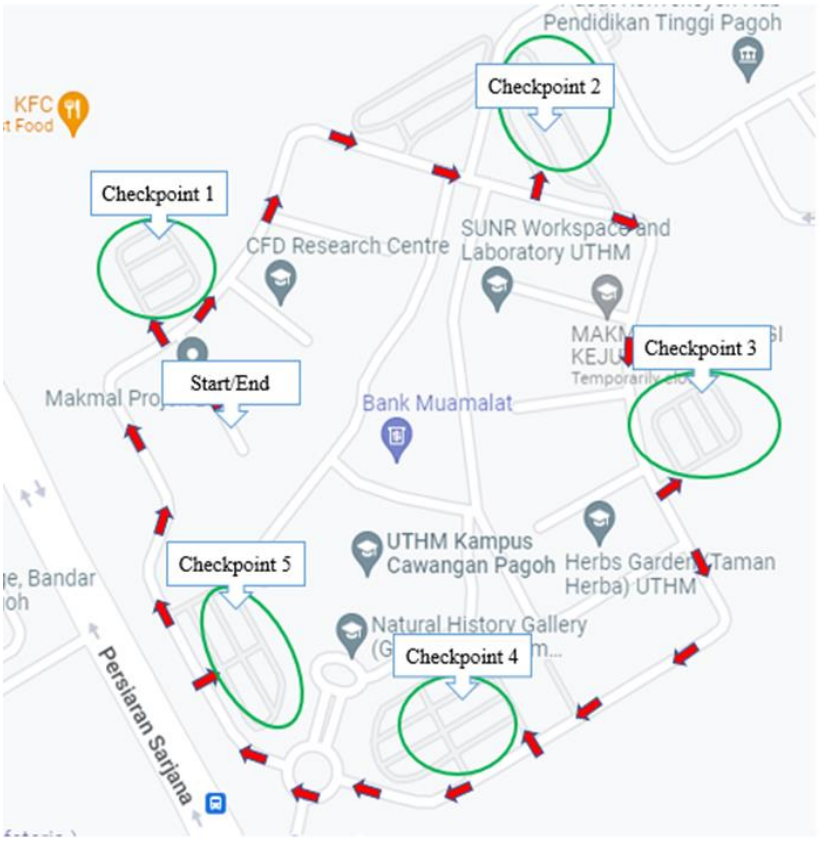

Fig. 3 - Test track for collecting data

The test procedure was driven in the test track with range speed 0-40 kilometer per hour (km/h) with the distance 2 kilometer (km). The project kit was conducted through a test to simulate traffic conditions, and the results of the test proved that it was functionally stable. Table 1 shows the parameters test for the motorcycle at the test track. In this test the parameters have been conducted to know the functionality of eco idle kit system.

Table 1 - Parameters test for each checkpoint

Parameter test	Checkpoint 1	Checkpoint 2	Checkpoint 3	Checkpoint 4	Checkpoint 5
Make a U-turn		■		■	
Make a sharp turn		■		■	
Deceleration	■	■	■	■	■
Acceleration	■	■	■	■	■
Pico Scope test			■		■

Table 1 shows the parameters that need to be analysed at each checkpoint. Before conducting the experiment, all the electrical accessories must be in ON mode using a power bank as the power source. The motorcycle is ridden at variable speeds. The eco idle kit system needs to be applied according to these parameters to ensure that the functionality of eco idle kit system was suitable to be applied at real road conditions. The test was conducted at each checkpoint to get the stable data in terms of real road conditions.

3. Results and Discussion

The result presented the development of eco-idle kit system for motorcycles will enhance the environment towards green vehicles. The eco-idle kit system will reduce the amount of idle engines when the engine is idling. The parameter

for engine to auto start and stop by using Arduino UNO. The input from the push button, limit switch and IR blaster sensor analyses as input for engine to start or stop.

3.1 Make a U-Turn

To make a U-turn, the motorcycle needs to stop for a while. In this experiment, the engine did not automatically stop because Arduino UNO set to stop the engine after the push button pressed more than 4s. In real road situations, to make a U-turn, the motorcycle just needs to stay for a moment and the brake releases to make a movement. From these results, eco idle kit system demonstrate that was appropriate on real road conditions and the functionality of eco idle kit system was reliable to use.

3.2 Make a Sharp Turn

To make a sharp turn, the motorcycle needs to hard brake to slow down the speed and make a turn. In this conducted test, the eco idle kit system did not have any problem making a sharp turn although the rider pressed the brake during acceleration, the engine was not automatically stopped. It shows that the Arduino UNO gets input from IR blaster sensor which is RPM exceed 0 and the engine will not automatically stop. At both checkpoints, eco idle kit system results indicate that is appropriate for usage on real road situations in congested traffic.

3.3 Deceleration

Table 2 shows the time response for the engine to start. The time response for the engine to start has been recorded at each checkpoint to ensure the engine is quickly started in congested traffic.

Table 2 - Time response for the engine to stop (s)

Checkpoint	Time response for engine stop (s)
1	5.07
2	6.22
3	4.92
4	6.12
5	5.42

Figure 4 shows the graph shown that data measurement obtained from deceleration for engine to stop. In this project test, the result may have a different result cause of the condition of the rider to decelerate the vehicle.

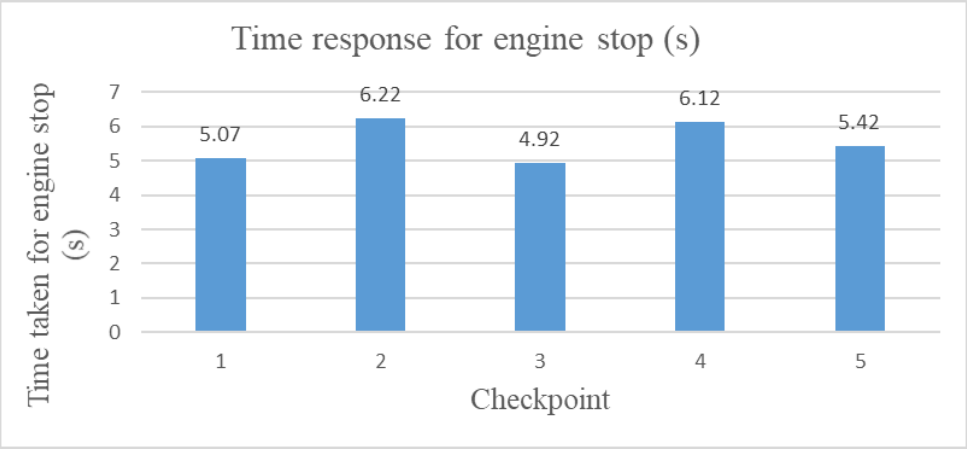

Fig. 4 - Bar graph time response for engine stop

As in normal brake, the result may get the higher time response for engine stop because of the reading from the IR blaster sensor to get the value equal to zero. Therefore, in checkpoint 3, the engine response time is 4.92 s which is when in hard brake, the engine response to stop is lower compared to normal brake because of the reading from the IR blaster sensor to get the value zero is quick.

3.4 Acceleration

Table 3 shows the time response for the engine to start. The time response for engine to start has been recorded at each checkpoint to ensure the engine is quickly started in congested traffic.

Table 3 - Time response for the engine to start (s)

Checkpoint	Time response for engine to start (s)
1	1.62
2	1.85
3	1.82
4	2.95
5	1.93

Figure 5 shows the data obtained for the time response for the engine to start. The maximum current flow is below 5V because the Arduino UNO only supports a 5 V power supply. In this project test, the throttle was rotated to get the time taken for engine to start.

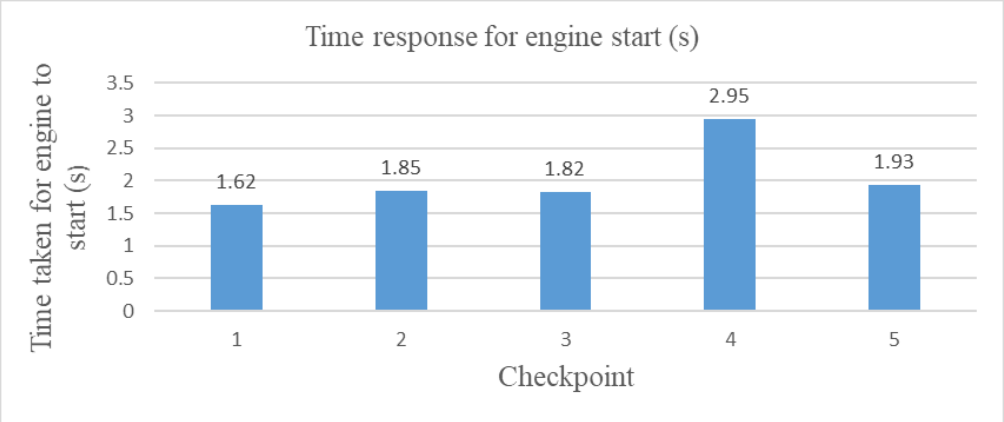

Fig. 5 - Bar graph for engine start

The result shows a stable time response for the engine to start. Therefore, checkpoint 4 shows the highest result which is 2.95 s because of the power battery from motorcycle becomes weak to start due to power loss from battery. When the battery voltage was below 12 V, the battery was weak to start the engine. Then, to get the proper start, the battery needs to power enough to start the engine. Thus, the connection between the limit switch to Arduino UNO and the relay needs a proper connection wire to avoid any miss signal from input.

3.5 Battery Voltage Drop

Battery voltage has been recorded using PicoScope6 during tests at checkpoints 3 and 5. Battery voltage has been recorded to measure the battery voltage drop during engine start and stop.

Checkpoint 3

Figure 6 shows the data obtained for battery voltage drop for engine to start and stop using eco idle kit system at checkpoint 3.

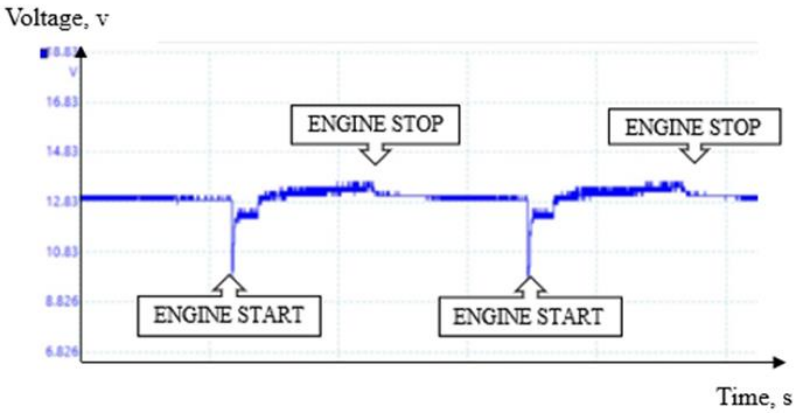

Fig. 6 - Battery voltage drop for engine start and stop at checkpoint 3

At checkpoint 3, the motorcycle was analysed for battery voltage drop using PicoScope6 software. According to this result, the battery voltage dropped by around 9 V because the battery voltage needs to power up the starter to start the engine. During engine running, the reading for battery voltage was above 13 V because the alternator charged the battery and the value during engine running was not consistent. From the result for engine to stop, a little reduction in battery voltage was needed to turn off the engine. After the engine stopped, the battery voltage was consistent above 12.5 V.

Checkpoint 5

Figure 7 shows the data obtained for battery voltage drop for engine to start and stop using eco idle kit system at checkpoint 5. At this checkpoint, the motorcycle was analyses for battery voltage drop

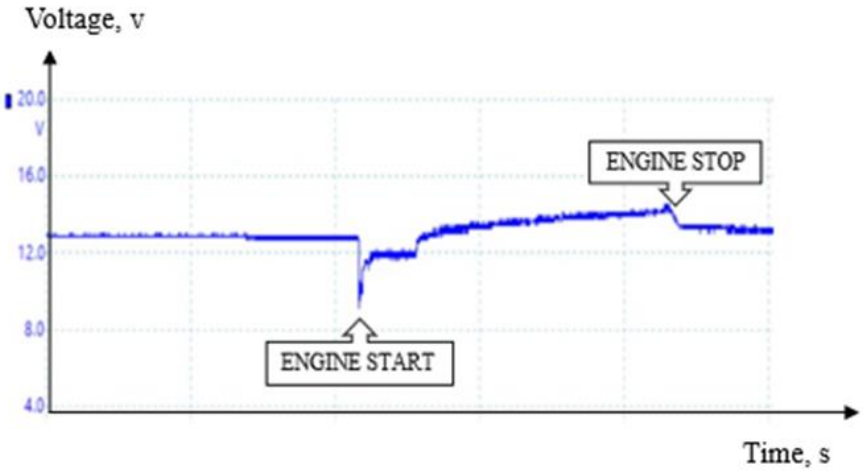

Fig. 7 - Battery voltage drop for engine start and stop at checkpoint 5

The result was taken by engine start and stop. From this result, the battery voltage shows the value of battery voltage before engine to starts that was about 12.5 V. When the throttle rotates, the engine is going to start, and the battery voltage drops about 8.0 V for engine to start. Battery voltage will drop for a short time before climbing back up for its engine running voltage. Once the engine is running, the measurement will be slightly higher because the alternator is actively charging the battery. With the engine running, battery voltage is between 13.5 and 14.7 V. From result engine stop, the reduction voltage occurs to turn off the engine. After the engine stopped, the voltage was consistently above 12.5 V.

4. Conclusion

The experiment tests were conducted to evaluate the usage of eco idle kit system on motorcycles with real road conditions. The tests were conducted on Yamaha LC135 based on parameters on a real road. The eco idle kit system has been successfully installed to motorcycle. Eco idle kit system was completely created and the coding to develop eco idle kit system has been constructed successfully on the IDE software. Besides eco idle kit system, there are a few other technologies that are capable to reduce emissions and fuel consumption The innovations include engine downsizing

with a turbocharger installed, fuel reduction during coasting, and a combination of these features with an eco-idle kit system.

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Appendix A (Optional)

Appendix 1: Attach sensors to motorcycle.

Appendix 2: Test conducted at checkpoint.

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