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Development of Engine Oil Maintenance and Battery Health Monitoring through Short Messaging Service (SMS)

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Abstract

With proper care and proper maintenance, vehicle can be maintained to work as it supposed to and has longer life cycle. Vehicle maintenance for new vehicle monitored using service booklet while for some of older vehicle, the maintenance totally depends on owner awareness and most cases, they are using service note provided by service centre which are sticked on the windshield. Prior to this situation, the owner may not be notified because sometimes the vehicle may exceed the recommended mileage and date for next service. The aim of the project is to develop the vehicle maintenance monitoring through short messaging system (SMS) using Arduino Uno and GSM SIM900A module. The proposed project helps the vehicle user to monitor on the engine oil mileage and battery voltage on mobile phone. The vehicle owner can check and notified their vehicle next service using phone message. The project is developed using simple programming software and hardware. Arduino Uno as microcontroller to receive data from voltage sensor and send battery voltage through SMS. The push buttons used to represent the input from vehicle owner about the type of oil used during vehicle service to check the vehicle condition. The GSM module act as a message transmitter and receiver for user communication. The task was programmed into Arduino Uno using Arduino Integrated Development Environment (IDE). The development of this project helps the user to monitor vehicle condition especially for their maintenance schedule. The maximum percentage error was 3.2725% and lowest percentage error of 1.9787% of vot meter reading is measured. This project can be concluded that the device was successfully being developed and the functionality was observed.

1. Introduction

The cars in general conditions need inspection and maintenance when they have been used after thousands of kilometers or months, such as changing the engine oil, checking the electronics, checking the brakes and so on [1]. Vehicle needs to be maintained regularly and repaired when needed in order to ensure vehicle condition, longevity and vehicle safety at top priority [3]. Vehicle maintenance consists of scheduled maintenance, component repairs and vehicle inspections to maintain vehicle condition to prevent unexpected breakdown. The common issue when vehicle breakdown happen are because of flat or faulty battery, damaged tyres and wheels, engine oil and overheating. Vehicle breakdown is one sort of event that often happens on highways, accounting for more than 80% of all occurrences [2].

The proper maintenance and checking are needed to check whether the engine oil and battery voltage is at proper condition. Usually, the engine oil and battery voltage were checked by the authorised mechanics. In vehicle information display provided by manufacturer, the mileage and the service date were fixed for certain kilometers and days. The system was not quite effective when considering the system treats all the oil change were same because there are different type of oil, viscosity and oil grade available with manufacturer recommendation. For older vehicle, there is no information display to alert the driver on the maintenance schedule and battery voltage. If the vehicle has any issues with the engine oil and weak battery, the vehicle breakdown can occur anytime if the issues is not fixed.

Engine lubricants are used to reduce the frictions of the components and keep the different elements clean, being able to work as detergents and dispersant agents [4]. There are different types of oil available which is mineral engine oil and the 100% synthetic engine oil, that derived from two different sources of 90% petroleum fractions and 10% additives. Synthetic oil is used because it is more efficient and expensive. It is more resistant to heat and more easily protected by antioxidant additives as oxidation is a natural process of oil degradation over time [5].

The technologies in engine oil monitoring is to determine the condition of the engine oil. Each of the technologies uses different types of sensor and method of determination engine oil condition. Absorbance spectra of different samples were measured using a halogen lamp delivering a power of 5W a voltage of 6V. The choice of sources depends on the size of the sample as well as on the acquisition mode of the absorbance spectra, according to the best signal-to-noise ratio and the quality of the spectra. NIR spectra were recorded with an optical spectrum analyzer (AVS-USB2000, Netherland) used for spectral acquisition in the spectral ranges from 500 to 1000nm and 1000 to 1700nmA multimode fiber (SMA905) with core diameter 400µm, a length of 2m and a numerical aperture 0.22 is used to guide the light to the detector spectrometer. All measurements were made in the dark and at ambient temperature with time integrating 100ms and average spectra equal to 1[3]. The sensor gives information on engine oil viscosity and temperature instantly using online data stream. It is because the sensor using wide operating range and plug and play connectivity. Vismart measures two different principles which is kinematic viscosity and intrinsic viscosity through its solid-state low shear bolt viscosity sensor. The vismart sensor monitor the variation of engine oil viscosity regularly and send the information to the data processing layer. The data processing layer analyse the comparison between previous and current the engine oil [6].

A measuring device which can only measure the state of charge (SOC) of the battery is suitable to test a conventional car battery. For testing the state of charge of a non-sealed battery type, a hydrometer can be used. If the voltage falls below 12.4 V, the battery should be recharged as soon as possible. A continuous low charge damages the battery due to sulfation because the sulphate on the plates can harden, making recharging difficult. The SOC of a battery is very important to monitor and it is not suitable to allow the state of charge to fall below 70% for long periods. If a battery is to be stored for a long period, then the battery must be recharged every so often to prevent from becoming sulphated. One of the measuring device such battery monitoring system (BMS). The BMS prevents a user from draining a car battery beyond the point of not being able to restart the engine. If the battery is discharged to approximately 11.8V +/- 0.15V, the BMS system will activate and it will disconnect the battery from discharging [7].

2. Materials and Methods

The proposed project was expected to send the information of the vehicle maintenance through SMS when user gives input to the system. The schematic diagram of the proposed project was designed in the Draw.io website. The material used in this project were based on the circuit design. The materials were selected following its function and suitability in the circuit. The electronic hardware used for designing the diagram were Arduino Uno, GSM Sim900a module, voltage sensor, SIM card and push button.

2.1 System Design

- The Arduino Uno
- GSM sim900a
- 12v battery
- Voltage sensor
- Push buttons
- USB connection
- Breadboard

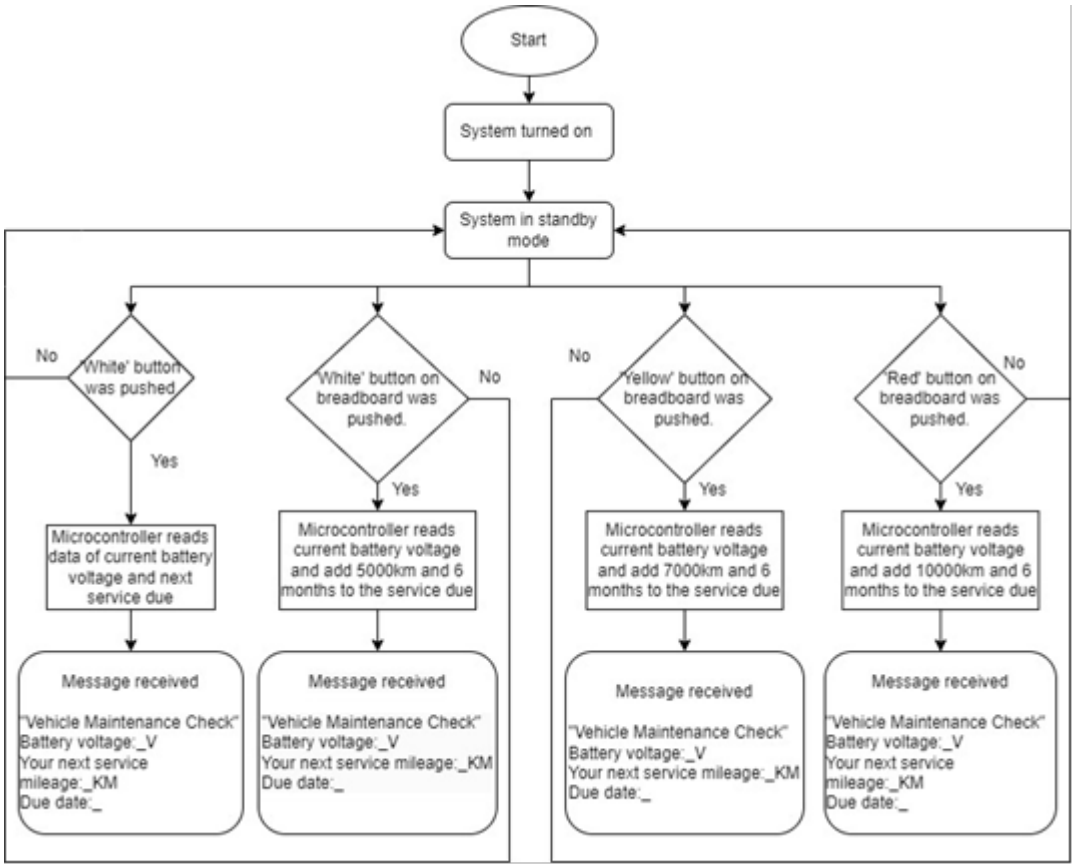

Fig. 2.1 *The proposed system functionality flowchart*

Based on the proposed system functionality flowchart, the start process of the system followed by system turned on. The power from USB connection will powering the system. After the GSM module established to network, the system will remain in standby mode. The SMS received by user from the system depends on the what type of button was pressed. When the white 'check' button was pressed, the microcontroller reads data of current battery voltage and next service due. The system should send the message containing information on battery voltage, mileage and due date for next service. After vehicle service, user pressed the 'selected' oil button based on the type of engine oil used. For mineral oil, user pressed 'white' button on the breadboard and the microcontroller will add 5000km and 6 months to the mileage and due date for next service. The system will send the message to user containing information on battery voltage, mileage and due date for next service. For semi synthetic oil, user pressed 'yellow' button on the breadboard and the microcontroller will add 7000km and 6 months to the mileage and due date for next service. The system will send the message to user containing information on battery voltage, mileage and due date for next service. For fully synthetic oil, user pressed 'red' button on the breadboard and the microcontroller will add 10000km and 6 months to the mileage and due date for next service. The system will send the message to user containing information on battery voltage, mileage and due date for next service. If there is no detection of button being pressed, the system will remain in the standby mode.

2.2 Circuit Design

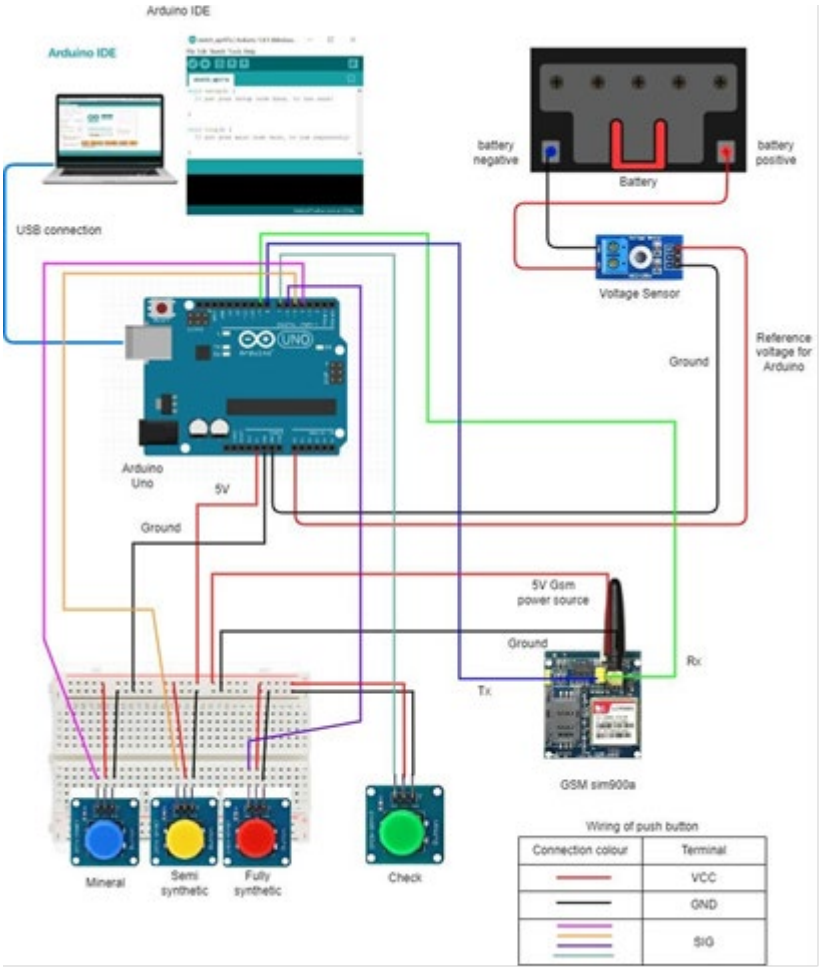

Fig. 2.2 *The proposed project circuit*

The development of the project starts with the proposing the circuit design. System hardware and software were chosen based on the proposed project circuit as above. Arduino Uno will be used as the microcontroller in this project. Along with Arduino Uno, Arduino IDE will be used as software programming to write coding for required task to microcontroller. In this project, Arduino Uno was powered by the USB connection. Also, the USB connection was used to upload the coding from Arduino IDE to Arduino Uno. The GSM module was powered by the 5v pin and 'GND' pin from Arduino Uno. Once the GSM were on, the indictor light will blink at a second. The Tx and Rx pin of the GSM module were used to transfer the command from Arduino Uno to the GSM module. In this project, there are 2 active SIM card needed, SIM card for the user mobile phone and SIM card for GSM module. The voltage sensor was connected to the battery terminal and sends the signal (reference voltage) to Arduino Uno. The battery positive terminal was connected to 'VCC' pin of voltage sensor and battery negative terminal was connected to 'GND' pin of voltage sensor. The voltage sensor will be reducing voltage from 12v battery to the amount compatible with Arduino Uno which is less than 5v. The 12v battery is used to indicate the actual battery in vehicle. The push buttons were used to provide different input to the system. There are 4 push buttons used which represent the type of oil based on different colour and check button. The 'blue' button represents mineral oil, the 'yellow' button represents semi synthetic oil and 'red' button represents fully synthetic oil. The 'green' button represents the check button. The 'VCC' pins and 'GND' pins of all push buttons connected to '5v' pin and 'GND' pin from Arduino Uno respectively. The 's' pins of push buttons connected to different digital pins of Arduino Uno.

The verification testing was conducted to determine the effectiveness of the system to send the message containing battery voltage reading, effectiveness of the system to calculate the due of engine oil mileage and date and ability of the system to send message on different SIM card number. The equation used in this experiment is to determine percentage error of the voltage reading. The measured value is the reading obtained in the message and actual value is the reading recorded using multimeter. The voltage reading in message and multimeter were calculated to get average reading for both and the result were compared. The percentage of errors were calculated using equation (1).

$$\text{Percentage error} = \frac{\text{Measured Value (average)- Actual Value (average)} \times 100}{\text{Actual Value (average)}}$$

(1)

3. Results and Discussion

The system was able to send message to user using SMS. The message containing information of battery voltage, mileage and date for next service. The testing process of the system to determine whether the system works effectively. From testing process, the result was analyzed to determine percentage of error of the system. The designed engine oil maintenance and battery health monitoring is shown in the Fig. 3.1 below. The circuit of the project was successfully developed following the hardware discussed in methodology. Arduino Uno was used as microcontroller of the circuit. The GSM module was connected to Arduino Uno for power source and transmitting and receiving message. The voltage sensor was connected between Arduino Uno and 12v battery. The input for voltage sensor is the 12v battery and the output is connecting to Arduino Uno analog pin. The push buttons placed on the breadboard will act as input to Arduino Uno for different type of engine oil used. The other button will be the input when user need to check for vehicle maintenance information.

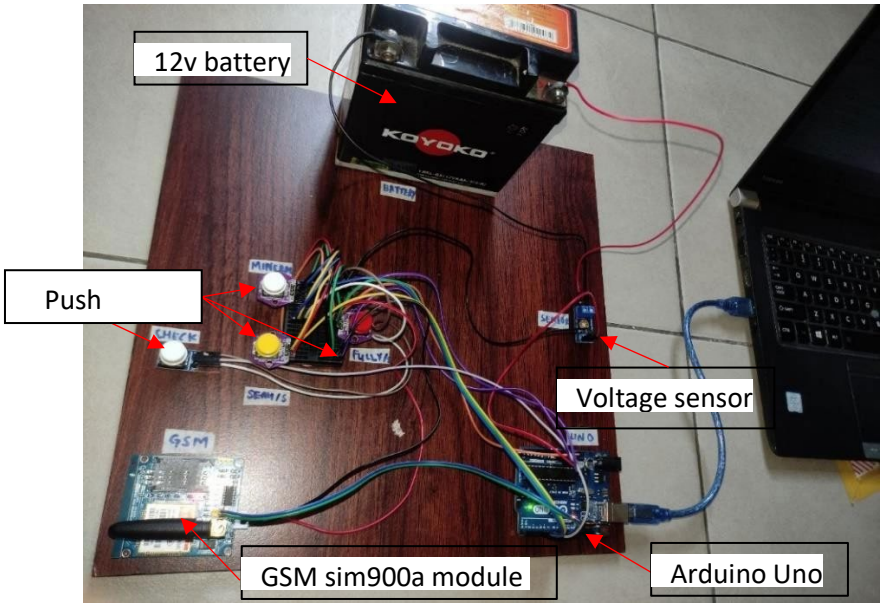

Fig. 3.1 *The actual project circuit*

In testing process, the message was successfully received by the user. The information in the message containing battery voltage reading and mileage and date for the next service. The battery voltage reading was successfully delivered in message with the reading in between optimum battery voltage value. All the reading in the message were in between 13v which acceptable because the rated voltage of the starting system for most passenger vehicle is almost 12v.

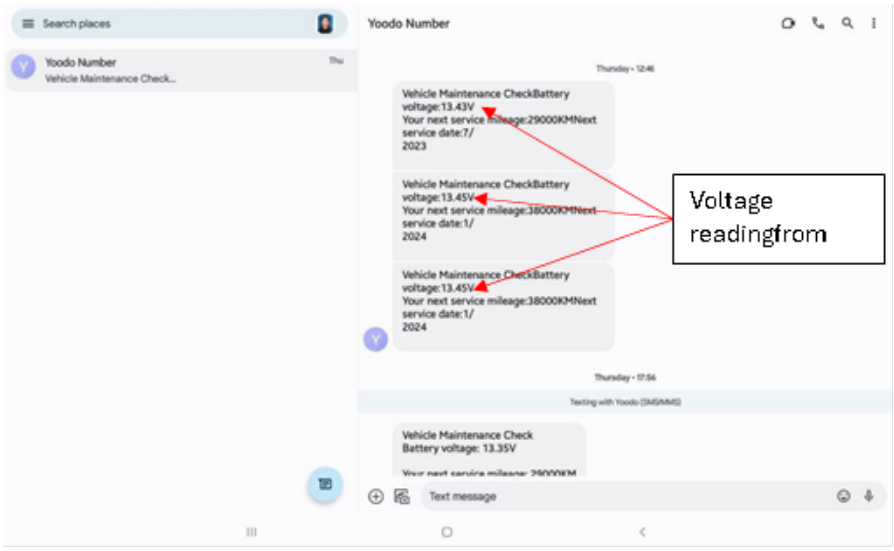

Fig. 3.2 *The voltage reading from messages*

Based on the messages received in Fig. 3.2, the messages containing the battery voltage reading as expected in proposal. All the reading was in optimum battery voltage value. In the message, the arrangement of the information was not proper. The adjustment in the coding needed to give proper message to the user.

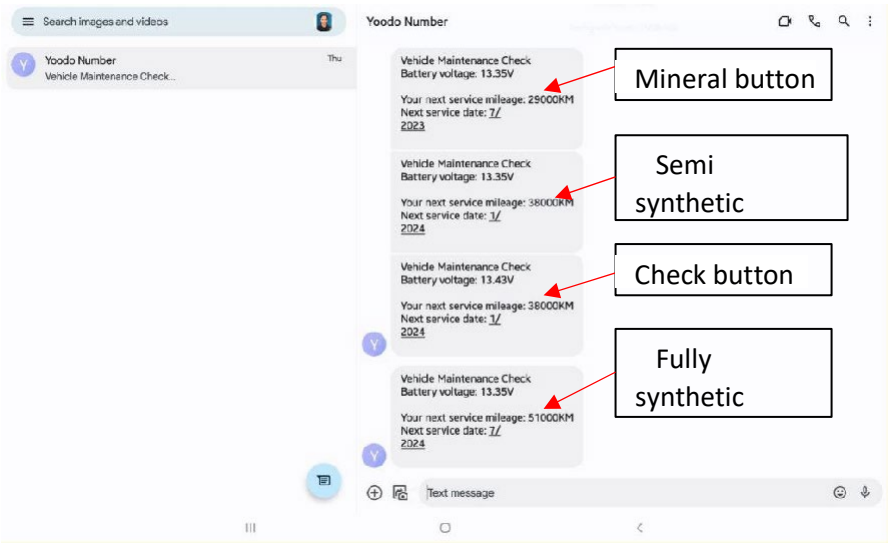

Fig. 3.3 *The message based on button selected*

The testing also covers the effectiveness of the system to calculate the due of mileage and date of vehicle service. The initial mileage for the vehicle was set to 1900km and the date for months and year were set to 01 and 2023 respectively. From the message in Fig. 3.3, the testing was started with pressing 'white' button represent mineral oil. The message received after first button pushed was successfully the project target. When the 'yellow' button represent semi synthetic oil was pressed, the system adds mileage and date into previous service due. The system adds 9000km to the semi synthetic oil which not as expected to be. Next, the white 'check' button was press and the button was successfully read the due for next vehicle service. Lastly, the 'red' button represents the fully synthetic oil was press and the system add 13000km into the next mileage. The mileage was not added according to the input given by push button. The system was not successfully added the mileage for vehicle service as its expected. For the due date for vehicle service, the date was successfully added to 6 months for all type of oil button.

The analysis was conducted to determine the percentage of error of the system. The measured values are the value of battery voltage contained in the message received. The measured values are the value recorded when the push button was press. The reading taken for actual value is conducted using the multimeter. For both measured and actual values, the reading was taken for 4 times and the average of both value and percentage error was calculated. By comparison of reading, the measured values show inconsistency of reading with maximum voltage of 13.57v and the lowest of 13.40v. By comparison with the actual value reading by multimeter shows consistent reading of 13.14v. In comparison of the percentage error, the maximum percentage error was 3.2725% and lowest percentage error of 1.9787%.

Table 1 *The measured and actual voltage reading value*

No	Voltage reading of the system, V	Voltage reading of the multimeter, V	Percentage Error, %
1	13.50	13.14	2.7397
2	13.40	13.14	1.9787
3	13.57	13.14	3.2725
4	13.40	13.14	1.9787
Average	13.4675	13.14	2.4923

4. Conclusion

The project was successfully being constructed which related to the research that had been made in the previous chapter. A system that is used to monitor vehicle information was developed using simple programming hardware and software. The hardware includes Arduino UNO, GSM Module, voltage sensor and many related components to complete the circuit. The measured values show inconsistency of reading with maximum voltage of 13.57v and the lowest of 13.40v. In comparison with the actual value, reading by multimeter shows consistent reading of 13.14v. The maximum percentage error was 3.2725% and lowest percentage error of 1.9787%. This project can be concluded that the device was successfully being developed and the functionality was observed.

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Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design****: Muhammad Muizzuddin Nawi;* ***data collection****: Muhammad Muizzuddin Nawi;* ***analysis and interpretation of results****: Muhammad Muizzuddin Nawi and Abd Fathul Hakim Zulkifli;* ***draft manuscript preparation****: Muhammad Muizzuddin Nawi. All authors reviewed the results and approved the final version of the manuscript.*

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