Mobile Security Vehicle’s based on Internet of Things

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Abstract—The purpose of this research is to design and build a mobile security vehicle’s based on Internet of Things (IoT) that combines to Arduino-based microcontroller, internet networks and the needed hardware. The design is intended to monitor and control the vehicle condition and monitor the vehicle location based on IoT. This research uses the hardware and software component. The hardware uses the Arduino-based microcontroller that connects to some modules. This research uses Relay Module 2 Channel HL-525 to control the vehicle machine, GSM Module Neo-7M to get the vehicle location, SIM800L Module to connect to the internet network and ACS-712 Voltage sensor to detect the voltage in the vehicle electricity. This research uses multi-platform (web application) as the component software to monitor and control the vehicle condition and its location. The result of this research is Mobile Security Vehicle’s System Based on Arduino where the system can satisfy some functional needs such as can monitoring motorcycle location, controlling alarm, and motorcycle electricity to avoid theft through web application that can be used in multi-platform.

Keywords—Arduino UNO, Vehicle Security, Alarm, Internet of Things, Multi-platform, Web

I. INTRODUCTION

Nowadays, the human mobility is increasing to bolster their activity. The human mobility is bolstered by their vehicle. The vehicle is increasing rapidly nowadays [1]. But, there is a problem when having a vehicle. Because of its high value, the vehicle can be the target of the thieves. Based on the data from Indonesia Statistic Data Center, vehicle theft cases had been increased from 2011 until 2013. There were as many as 39.217 cases in 2011, 41.816 cases in 2012 and 42.508 cases in 2013 [13]. From the amount of the cases, not all cases were closed. There were some cases that cannot be closed because of the lost tracking of the stolen vehicles. This is the reason for the author to design and build a mobile security vehicle system that can monitor and control the vehicle using remote control.

Some researches has given for the vehicle security system with the vehicle tracking system. Some of them are vehicle security system using GPS module and IoT Platform [2][3][4]. The Internet of Things platform needs internet connection using GSM modules [5][6][7][8][9]. Some researchers have developed vehicle security system using biometrics [10][11][12]. Biometrics data could be an image form and it needs more memory to save the data rather than in a text form. The researches mentioned has not used the control system to the vehicle yet. The control system is used to taking control the vehicle (by the system) when the vehicle is stolen by the thieves. So, we proposed the security vehicle system that combined the vehicle position tracking and vehicle controlling.

A mobile security vehicle system is based on IoT that embedding the hardware (Arduino-based) in the vehicle and control it using the mobile application. The term of “control” consist of controlling the on/off vehicle engine when the system detects the thieves, tracking the vehicle location and ringing the alarms when the vehicle is exposed to a vibration or moving around. One of the existing service in this system is “force shut down” service. When the “force shut down” service is activated by the user, the vehicle engine will be off automatically. this remote system using IoT concept, so that wherever the user is, they can control and monitor their vehicle remotely.

II. METHOD

A. Anti-theft mechanism

Vehicles have several core parts that are crucial. One of them is the electricity. Usually, vehicle electricity is divided into two parts, engine electricity and electrical auxiliary devices such as lights, starters and others. In designing the system, the vehicle electricity will be manipulated by the device.

The device can put the vehicle in several modes, namely normal mode and anti-theft mode. In normal mode, the vehicle's electrical activities will be used normally. However, when the vehicle is in anti-theft mode, the vehicle's electricity will be completely cut off so that the vehicle cannot be operated, and also if the vehicle is touched, the alarm will be active. In making this design, several modules will be used, namely the relay module, GPS and alarm as well as a voltage sensor to detect vehicle electrical conditions and vibrations. In addition, a Web-based application is used to monitor and control the equipment installed on the vehicle in real time.

The system has two modes namely normal mode and anti-theft mode. The normal model is the normal activation engine electricity. The anti-theft mode is the turning off the vehicle's electricity so that the vehicle cannot be used. The system also has a buzzer control mode for sounding the vehicle when there is a vibration on it or the vehicle is moving around.

The system has two conditions, namely when it is stopped/parked or running. Because sometimes people/user forget to activate anti-theft mode. Turning off the vehicle's electricity directly during running will endanger the driver. For this reason, the upper limit speed of the vehicle to turn off the electricity is 20 Km/h. The system is drawn as Fig. 1.
As the flowchart description, there are four functional requirements in the system. They are, vehicle status monitoring, stopped vehicle controlling, moving vehicle controlling, and alarm activation of the certain cases of the vehicle. Here the functional requirement description as shown as TABLE 1.

From the TABLE 1 above, it will be build up the use case code as shown TABLE II.

| Use case code | Use case                        | Actor       |
|---------------|---------------------------------|-------------|
| UC-001        | Stopped vehicle controlling     | User        |
| UC-002        | Running vehicle controlling     | User        |
| UC-003        | Vehicle status and condition monitoring | User |

The system use cloud service for monitoring and controlling the system. The system saves the data and command execution center in the cloud services. The used network architecture is as shown as Fig. 2.

![Fig. 2. The system network architecture](image)

**TABLE II. USE CASE CODE EXPLANATION**

The system design consists of two parts, they are hardware design and web design.

- **Hardware design**
  Hardware design is the arrangement of modules into a system that work together to produce a needed function. The used modules are the Arduino microcontroller as the control center, the SIM800L module as a connection to the internet network, the GPS module as a location detector, the Buzzer module as an alarm sound, the Relay module as a vehicle electrical system manipulation and the vibration sensor as a vehicle vibration detector when the vehicle is exposed to a vibration and the module an electric current detector to detect whether electricity is active or not. Hardware design is as shown as Fig. 3.

- **Web design**
  The web application is designed as a hardware device monitoring and controlling. The application uses the Laravel framework that will be deployed on a cPanel-based cloud. The design will consist of two pages, namely the dashboard page and the device status log page. The dashboard page contains the vehicle control center and the latest status sent by embedded device in the vehicle. Dashboard page is as shown as Fig. 4.

![Fig. 1. The whole system flowchart](image)

**TABLE I. SYSTEM FUNCTIONAL REQUIREMENT**

| code  | Functional requirement       | description                                                                 |
|-------|------------------------------|-----------------------------------------------------------------------------|
| F-001 | Vehicle status monitoring    | Controlling the vehicle status : vehicle mode, alarm and vehicle position.  |
| F-002 | Stopped vehicle controlling  | Engine mode control and alarm status in stopped-mode vehicle.               |
| F-003 | Running vehicle controlling  | Engine mode control and alarm status in running-mode vehicle.               |
| F-004 | Activated alarm in anti-theft mode | Vehicle in the anti-theft mode. It means that the alarm will be activated when the vehicle is exposed to the vibration |
The device log page serves as a display of the vehicle status log data sent by the embedded device while it is active for a certain time which contains the date of delivery, vehicle mode status, alarm status, vehicle coordinates (vehicle position), vehicle speed and a button that has functions to view the position of the vehicle based on the coordinates on Google Maps. The device log page is as shown as Fig 5.

In addition, users can also view trip logs on the map according to the selected date range. The vehicle travel history will show a red line that is connected to the coordinates of the vehicle data stored in the system. The two flag images represent the start point and end point of the vehicle position based on the selected coordinate data range. The trip history of the vehicle is as shown as Fig 6.

**B. Arduino Uno**

Arduino Uno is a microcontroller based on Atmega328 (datasheet). Arduino Uno has 14 input pins 6 input pins are used as PWM output and 6 analog input pins [15][16][17]. Arduino Uno has 16 MHz crystal oscillator, USB connection, jack power, ICSP header and reset button. To power on the microcontroller, it can be connected to the computer via USB or AC to Adaptor-DC/battery.

**C. Relay Module 2 Channel HL-525**

Relay Module 2 Channel HL-525 has two relays with two kinds of level. They are level 10A @250, 125 V AC and 10A
ACS712 is a module that is used to detect the voltage in the electricity. This module can filter from the lowest voltage till the highest voltage using the analog data [28].

Fig 11. ACS-712 Voltage sensor [27]

G. Software

For designing the system, the authors use Star UML and for implementation, the authors use Arduino IDE to program the microcontroller [29] and Sublime Text 3 for the web application [30].

III. RESULTS AND DISCUSSION

The device is installed in a 150cc capacity motor vehicle with an injection combustion system. The electrical cable connected to the engine starter that is connected to channel 1 relay and the electrical cable connected to the power supply to the Engine Control Unit / ECU that is connected to channel 2 relay with the status of Normally Open / NO. Then on channel 2 the relay is given a jumper cable that is attached to the voltage sensor. The evaluation is exposed to the device environment explained in Table III that consists of hardware device and the software evaluation.

| Device | Device name | Specifications |
|---------|-------------|----------------|
| Hardware | Processor | AMD Ryzen 5 3.7Ghz |
| | RAM | 4 GB |
| | System Type | 64-bit Operating System |
| Software | Operating system | CentOS with cPanel |
| | IDE | Arduino Software IDE |

- Hardware Evaluation

Hardware evaluation is to evaluate Hardware device (Fig. 12) response to the command execution in stopped-mode and running-mode vehicle as shown in TABLE III and Table IV.

Fig 12. Hardware device
### TABLE IV. HARDWARE DEVICE RESPONSE TO THE COMMAND EXECUTION IN STOPPED-MODE VEHICLE

| No. | UC-001 |
|-----|--------|
| **Evaluation Name** | Hardware device response to the command execution in stopped-mode vehicle |
| **Evaluation aim** | To evaluate hardware device response to the command execution in stopped-mode vehicle |
| **Scenario 1** | The user activates the Anti-theft mode in the application |
| **Initial condition** | Vehicle status in the normal mode |
| **Evaluation steps** | The user activates Anti-theft mode |
| **Expected results** | The vehicle status is Anti-theft mode (disconnected relay) |
| **Obtained results** | The vehicle status changes to the anti-theft mode |
| **Obtained result status** | succeed |
| **Final condition** | The vehicle status is Anti-theft mode |

### Scenario 2
- **The user deactivates the Anti-theft mode in the application**

| **Initial condition** | Vehicle status in the Anti-theft mode |
| **Evaluation steps** | The user deactivates Anti-theft mode |
| **Expected results** | The vehicle status is normal mode (connected relay) |
| **Obtained results** | The vehicle status changes to the normal mode |
| **Final condition** | The vehicle status is normal mode |

#### Software Evaluation

Software evaluation is to evaluate the success of the device in monitoring vehicle status as shown in TABLE IV.

### TABLE VI. EVALUATION THE SUCCESS OF APPLICATIONS IN MONITORING VEHICLE STATUS

| No. | UC-003 |
|-----|--------|
| **Evaluation Name** | Evaluation the Success of Applications in Monitoring Vehicle Status |
| **Evaluation aim** | To evaluate the success of the device in monitoring vehicle status |
| **Scenario 1** | The user view the vehicle status on the dashboard page |
| **Initial condition** | Vehicle status data has not appeared |
| **Evaluation steps** | The user sees the dashboard page |
| **Expected results** | The application page can display the status of the vehicle condition |
| **Obtained results** | The application page can display the status of the vehicle condition |
| **Final condition** | The application page displays the status of the vehicle condition |

### Scenario 2
- **The user sees the log / history of the vehicle status on the Device Log page**

| **Initial condition** | The device log page is not open yet |
| **Evaluation steps** | The user opens the device log page |
| **Expected results** | The application page can display a log of vehicle condition status |
| **Obtained results** | The application page can display a log of vehicle condition status |
| **Final condition** | The application page displays the vehicle condition log |

Based on the data in Table IV, V, VI, all test scenarios were successful and the program ran well. So that it can be concluded that the functionality of the application can work as expected. A summary of the evaluation results can be seen at TABLE VII.

### TABLE VII. THE EVALUATION RESULT OF THE WHOLE SYSTEM FUNCTIONALITY

| code | Use case | Scenario | The Results |
|------|----------|----------|-------------|
| UC-001 | Stopped vehicle controlling | Scenario 1 | Succeeded |
| | | Scenario 2 | Succeeded |
| | | Scenario 3 | Succeeded |
| UC-002 | Running vehicle controlling | Scenario 1 | Succeeded |
| | | Scenario 2 | Succeeded |
| | | Scenario 3 | Succeeded |
| UC-003 | Vehicle status and condition monitoring | Scenario 1 | Succeeded |
| | | Scenario 2 | Succeeded |
IV. CONCLUSION

From the results of the observations made during the design, implementation and evaluation process, it can be concluded that the functionality evaluation is succeed in all given scenario. This is indicated by the success of evaluation the system response to a given control and the web application is succeeding in monitoring and controlling the hardware device in a distance based on IoT.

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