Abstract—This study presents an alternative solution to prevent motorcycle theft, which has been increasing recently, particularly in large cities in Indonesia. One problem, for the police and the owner is how to track a stolen motor vehicle. Consequently, a system was built to provide a solution by creating a web-based application and using Global System for Mobile (GSM)-based communication with a Global Positioning System (GPS) module and an accelerometer sensor as a vehicle tracker. The embedded system hidden in the motor vehicle also aims to detect any hard impact from a collision or fall; it then sends the GPS coordinates to individuals who need to be contacted in case of an emergency. The web-based system collects the GPS coordinates of the motor vehicle on a periodic basis to allow tracking to determine the location of the vehicle if stolen. Setup, activation, and tracking of a motor vehicle can be performed by vehicle owners using an Android-based mobile phone. This study reviews the literature and laboratory studies to determine the system settings that will be connected to the internet as an implementation of the Internet of Things. The results are expected to help owners locate their vehicles and provide assistance requests when accidents occur.

Index Terms—GPS, Embedded Systems, Internet of Things, Motor Vehicle Tracker.

I. INTRODUCTION

In 2005 reports of seizures or robberies of motor vehicles significantly increased. In Okezone on February 16, 2015, the police chief of Lubuklinggau South received a report concerning a theft involving violence that caused the death of the victim. Such an incident can be avoided if victims surrender the vehicle to the robber to ensure their safety. After such incidents, victims can then use a cell phone to report the theft and track the location of their motor vehicle. This information can be reported to the police, allowing the arrest of the robbers with the help of satellite navigation coordinate data, i.e., the Global Positioning System (GPS).

The embedded system created in this study is equipped with GPS, a 3-axis accelerometer, and the Global System for Mobile Communication (GSM), which is mounted on the motor vehicle (e.g., motorcycles and cars) [1]–[3]. The accelerometer detects when there are severe changes in the y-axis, indicating a collision or a motorcycle fall/car overturn event. The system will send a short message and/or email to a contact number in such an emergency containing the date, time, coordinates for satellite navigation, user name, vehicle number, and description of the incident.

A web server is built to allow users to track the location of a motor vehicle. The database includes the owner of the vehicle, vehicle fleet owners, financial institutions (leasing), car rental, and vehicle insurance. Users can use an Android-based program to enter detailed vehicle information and emergency contact information, send commands to activate or disable the system settings from afar, and track the whereabouts of a vehicle.

II. THE PROPOSED SYSTEM

The study uses the technology Internet of Things (IoT) with an implementation of an embedded system with GPS, GSM, 3-axis accelerometer, Android programming, and web server to build a System Motor Vehicle Tracker with GPS and accelerometer sensors in Jakarta [4]–[7].

The specific objectives of this study can be described as follows: first, to produce a system that can detect the occurrence of violent collisions (cars and motorcycles) or a fall (motorcycles) and transmits the scene location to an emergency contact via SMS; second, to produce a web-based system and a mobile phone Android app to allow users to access information to track a motor vehicle.

This study examines the system settings that incorporate the GPS, GSM, and 3-axis accelerometer installed in a motor vehicle to transmit data to a server [8]–[10].

This study is expected to be beneficial to all parties and provide additional security for motor vehicle ownership. Upon completion, this system is expected to provide an alternative solution to deal with crimes of appropriation or misappropriation of motor vehicles and will hopefully decrease such occurrences. Vehicle owners will be able to coordinate with the police to catch the robber of a vehicle based on the data traces of the stolen vehicle recorded on the server. The families or an emergency contact will be notified when any unfortunate accidents are caused by a collision or a falling motorcycle and can then immediately contact the relevant parties to send help to the accident scene.

As shown in Fig. 1, a company called Particle produced an Asset Tracker, which is a 3G mobile solution to track the location of any pinned object. The shielding has its own GPS
module and accelerometer, allowing users to create projects that use the location, orientation, and movement of a pinned object.

As shown in Fig. 2, Particle Electron is a small development kit made by http://Particle.io to create projects and products connected via GSM. Particle Electron is equipped with a SIM card and has an affordable data communication cost and low bandwidth usage. It is available in more than 100 countries worldwide and comes with Particle Cloud development tools and a cloud platform to manage and interact with additional connected hardware. The product reports vibration when the user is driving and saves power by keeping the cell modem and GPS in the off position if the device does not move or need to be tracked. The tracker has screw terminals for adding resources and a connector for adding an external GPS antenna.

The shield GPS module uses the Mediatek MT3339 GPS receiver. Note that the GPS module can take several minutes to obtain information from the GPS satellites. Therefore, there is a possibility that the module will not get much information if you do not have open access.

Particle Cloud (Fig. 3) helps users and the developers to create programs with http://Particle.io IoT products quickly. Particle Cloud is the center of the particle platform, containing many of the most complex parts needed to create IoT products.

After a successful login, there is an option to register the device on the Electron Particle Cloud to make a claim, as shown in Fig. 4.

As shown in Fig. 5, there are two WebHooks to access the accelerometer and the GPS. The Asset Tracker will periodically update the x, y, and z-axis value of the accelerometer and GPS location of the vehicle. The accelerometer value is used to detect whether a reading from the hardware will be interpreted as a motor vehicle collision or a fall. The GPS value is used to determine the final location of the tracker and can be displayed on Google Maps.

```cpp
void loop() {
  // Get some data
  String data = String(10);
  // Trigger the integration
}
The research was performed in one phase within one year. The stages include studying Particle Asset Tracker comprising a setting system placed on a motor vehicle is a car, which has a GPS, 3-axis accelerometer (triple axis accelerometer), and Global System for Mobile Communication (GSM). GPS location data are collected in the form of local databases and Google Map manually so that the location of the motor vehicle can be depicted on a map. We built a one-unit prototype that can be placed on a car, followed by an Application Tracker GPS and Accelerometer Sensor Vehicle in Jakarta. The coordinate points of a motor vehicle can be displayed with a simple program that uses Google Maps; this indicates the success of the first year of implementation.

III. METHODOLOGY

During phase one of this project, the Particle Asset Tracker (placed in a motor vehicle, e.g., a car) composed of a setting system that has a GPS, a 3-axis accelerometer, and a GSM was studied. GPS location data were manually collected using local databases and Google Map so that the location of the motor vehicle can be depicted on a map. Then, an Application Tracker GPS and Accelerometer Sensor Vehicle were built in Jakarta. The outcomes of the first year were published in journals and presented at international seminars, and a unit prototype imaging system that can be placed on a car was built. The indicators of success for the first year are that the coordinate points of a motor vehicle can be displayed with a simple program that uses Google Maps.

As shown in Fig. 6, when the Asset Tracker (particle device) is active, it contacts the Particle Cloud, and the periodic Asset Tracker reports its status to the cloud. Node.js is prepared to receive data from the Asset Tracker and save it onto the local database node. Periodically (every few minutes), the local database is synchronized with the TrackingDB database. Node.js waits for subscription request information from an Android-based mobile phone program. A Web Socket Server (WS Server) manages TrackingDB and receives user logins to the system, checking the passwords. The program on the Android-based mobile phone displays where users, after a successful login, can access features of the program. Users can choose to subscribe or track concerned assets and determine their location. Users can set the interval period for updating the Asset Tracker, the SMS contact number for when an accident occurs, and indicate the fashion

![Figure 6: System Flowchart (see Appendix for larger figure)]
in which a tracked vehicle was stolen or lost. The settings will be accepted by the web server and routed to the Cloud and Asset Tracker.

The Entity Relationship Diagram is shown in Fig. 7. There are four master files for users, their vehicle(s) information, SMS templates, and group of users. The trSMSRecipient, msSMStemplate, trSMSSending, trSMSStatus, and trLocation are used to send an alert message regarding the vehicle’s last location to the recipient when a vehicle meets with an accident or is stolen.

![Entity Relationship Diagram](image)

Figure 7: Entity Relationship Diagram (see appendix for larger
figure)

The technology used is as follows:
- Programming Language: Javascript, php;
- Framework: Socket.io;
- Database: SQL Server; and
- Other Technologies: Long polling.

The minimum requirements of the configuration are 1 GB RAM and dual core CPU, wherein the recommended configuration is 2 GB RAM and Quad Core CPU.

To access the application via a web browser, the redirect URL on http://202.58.181.203/vehicle Tracker is shown in Fig. 8.

- admin@admin.com with password = admin: he/she can add system users and access the addition of a group, type of vehicle, vehicle, and others.
- personal@user.com with password = personal: he/she can only access their vehicle.
- police@police.com with password = police: he/she only can access a vehicle that has been declared Lost or Crashed.

![Login Screen](image)

Figure 8: Login Screen

As shown in Fig. 9, there is an option for setting the time interval in minutes when a vehicle is declared missing.

![Period Setting](image)

Figure 9: Period Setting

At each time interval, it will report the GPS position of the vehicle to facilitate the pursuit or search for the missing vehicle.

![Member List](image)

Figure 10: Member List

In the backend screen, the user can access the following.
1. Upcoming Payment
   The display shows the user, the vehicle number, and the payment due the next month.
2. Payment Overdue
The screen displays the list of users, the number of vehicles, and the unpaid payment.

3. All Members
   The screen displays a list of users who can log into the system, as shown in Fig. 10.

4. Vehicle Types
   The screen displays the subscription fees for each type of vehicle. If you want to add a new type of vehicle, the user can click the “Add Type” button and the following screen will be displayed.

5. All Group
   The display shows all the groups along with the discount given. Discounts are determined based on the number of vehicles to be tracked.

6. Insert Payment
   The screen displays data for entering payment: Pay date, account holder name, account number and bank name, the number of months (1–12), total payment, group, and license plate number of the vehicle.

7. Pending Payment
   The screen displays pending payments, evidence of a payment, and payment confirmations.

IV. CONCLUSIONS

The system can detect collisions from the accelerometer readings and can use the GPS to determine the location of an accident. A web-based program has been created and Android is used to allow users to access information to track a motor vehicle. The system can provide a method to deal with and decrease crimes concerning the appropriation or misappropriation of motor vehicles. Vehicle owners can coordinate with the police to apprehend a vehicle robber based on the information of the motor vehicle recorded on the server.

REFERENCES


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Figure 6: System Flowchart
Figure 7: Entity Relationship Diagram