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Internet of Things Based Vehicle Monitoring System

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Abstract - *In the present day world, vehicle security becomes one of the top most concerns for an individual. Now a days, the existing alarm systems of vehicles could be easily overridden since required tools are equally easily available.*

The proposed system which can be an android/iOS based "app" or application, offers a continuous monitoring of the vehicle for any suspicious movement where the vehicle will be fitted with a smart device having inbuilt G.P.S., a SIM card with internet facility, SMS/Notification sending interface and support for the Accelerometer application programming interface (A.P.I) along with an application that can capture the vibrations of an external surface. This system, using the concepts of "machine to machine communication" and "Internet of Things" will intimate the owner of the vehicle location in case of the movement whenever detected. One of the major advantages of the proposed system is that it can differentiate between the "theft" and the "tow" allowing users to take appropriate action.

Key Words: **Vehicle monitoring system, Internet of Things, Machine to machine communication, Accelerometer, IOT, Vehicle theft**

1. INTRODUCTION

Today we live in the time where the security of one's assets are of the top priority concerns for one, their vehicles being one of these. Every individual feels the need of monitoring their vehicle parked in unknown vicinity. The vehicle may or may not be fitted with an alarm system and the alarm system may or may not trigger. The proposed system will monitor the vehicle continuously whenever it is in motion. The vehicle will be fit with a smart device with a Global Positioning System (G.P.S.), internetwork and Global System for Mobiles (G.S.M.) based notification sending facilities along with an Accelerometer (A.M.).

1.1 Problem Definition:

According to Wikipedia, "The removal of a parked vehicle is done either by breaking and entry, followed by hotwiring or other tampering methods to start the vehicle, or else towing [1]." As the technology has evolved and is getting more and more sophisticated as the days pass, so have the techniques of the criminals. Even though we may think we have the best possible security for our vehicles, there always will be criminal minds that will be one step ahead to work around it.

In present time, the criminals have more enhanced tools to either disable the vehicle security or override it. Hence we should upgrade the existing security by adding some features that can detect, if not prevent, any kind of suspicious movement of the vehicle.

Also, whenever a vehicle is towed to the traffic police station due to incorrect parking, we always get to know about it after getting back to the parking location. It then becomes cumbersome to find the location and then going there.

It will be very useful to the vehicle owners if there is way to know about the vehicle being picked up while it is in progress. This way the owners can directly approach the police station and pick up the vehicle which saves both time and other resources.

For this we need a way for the vehicle to be able to "communicate" with the smart device that the owner of the vehicle carries. Here, comes into picture the concept of "machine to machine (M2M) communication" and the Internet of Things.

Internet of Things a.k.a. IoT:

According to Gartner, "The Internet of Things is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."

The key components of IoT are the "things", smart connected products and other physical things, the "communication infrastructure", wired or wireless networks using which things communicate with each other and the "computing infrastructure", which does the data capture and analysis.

1.2 Overview of Proposed System:

We are using an Android or iOS based smart device which will have inbuilt G.P.S., a SIM card with internet facility, SMS/Notification sending interface and which will support the A.M. application programming interface (A.P.I) along

with an application which can capture the vibrations of an external surface.

We are using the A.M. A.P.I. because it can be used to capture any kind of motion if it is sensitive enough, motion such as, motion in straight line parallel to the ground, vertical motion etc.

The vehicle will be fit with the said smart device in such a way that it remains tamper proof and safe from any kind of external damaging force such as water.

There are two possible scenarios in which the vehicle will be moved by someone other than the owner.

Theft
Tow

We need a way to differentiate between the theft and tow, former being the criminal activity and latter a disciplinary action by the law enforcement. We are categorizing the scenarios with the help of the state of the engine of the vehicle.

-If the vehicle is moving with the engine ON: Definite theft.

If there is a vibration in the engine while it is being moved, it will be classified as THEFT.

-If the vehicle is moving with the engine OFF: High probability tow/ Low probability theft.

If there is no vibration in the engine, we can check the angle of the vehicle, if the vehicle is moving with an angle more than 0 degrees in case of a four wheeler which indicates the vehicle being hooked to the towing vehicle or with Y-axis displacement more than 0 in case of a two wheeler which indicates the vehicle being lifted from the ground and put onto the towing vehicle, it will be classified as HIGH PROBABILITY TOW. There is no way to classify the scenario as DEFINITE TOW because there is still a chance, however slim, that a thief is trying to steal the vehicle by towing it.

Once the scenario is decided, the system will notify the owner that the vehicle is being moved stating the possible scenario.

Simultaneously, the system will start capturing the location of the vehicle and the updates will be sent to the Maps of the owner's device using which the owner will be able to track the vehicle. If there is a case where either the device in the vehicle or the owner's device loses the internetwork connectivity, the last known location of the vehicle will be sent using SMS.

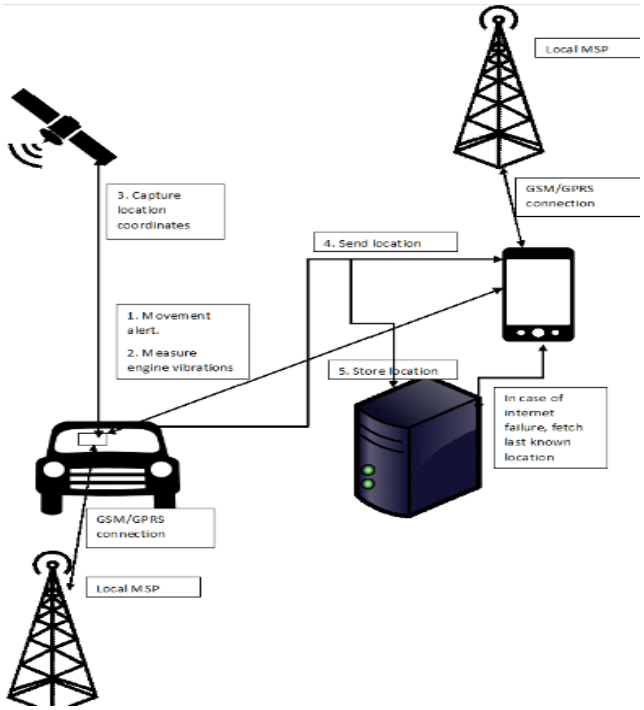

Fig -1: Block diagram of the system

2. PRACTICAL IMPLEMENTATION:

The system (Fig.- 1.) will be activated whenever the vehicle comes into motion, i.e. the system will be activated at the change in the accelerometer reading. The system will then check for the vibrations in engine using an external application specifically installed on the device to read these vibrations.

Using the reading from this application, the scenario for the movement will decided based on the *"state of the engine"* mentioned above.

Theft: If reading from both vibrator and accelerometer are above certain threshold.

Tow: Only reading from accelerometer is above threshold along with angular displacement being > 0.

Once the scenario is decided, a notification in the form of SMS will be sent to the mobile device(s) which will already be linked to the system application with the help of their contact numbers. There can be 'n' number of contacts that can be linked and that will get the notification, depending on the owner's requirement.

Along with the notification, the owner will be able to track the vehicle movement real time using the G.P.S. and the Maps application which are the most widely used technologies for vehicle tracking as well as capturing current position of the vehicle and the maps allowing owner to alert the authorities

in time with substantial information about location in hand in case of theft.

If it is a case of tow, using the same information, the owner will get to know where exactly they need to go to pick up their vehicle.

There are various application development software programs available today that allow us to create an android/iOS based "app" (application) to achieve the required functionality. One such software is the "Android Studio". We have various classes and interfaces readily available to create the required system application.

Following are a few code snippets which depict how we can develop the system app using Android Studio.

Class Intent: We can use an object of class "Intent" to read the data from the vibrator app which reads the vibrations in engine.

An intent is an abstract description of an operation to be performed. It can be used with startActivity to launch an Activity, broadcastIntent to send it to any interested BroadcastReceiver components, and startService(Intent) or bindService(Intent, ServiceConnection, int) to communicate with a background Service [2].

Following code snippet shows how we can read a text data from an external app.

```
Intent sendIntent = newIntent();
sendIntent.setAction(Intent.ACTION_SEND);
sendIntent.putExtra(Intent.EXTRA_TEXT,"This is my text to send.");
sendIntent.setType("text/plain");
startActivity(sendIntent);
```

Motion Sensors: The Android platform provides several sensors that let you monitor the motion of a device.

We can measure acceleration of the vehicle using the motion sensor of the type "accelerometer" provided by the Android platform [3].

We can use the "values" constant float array to capture the x,y,z axis displacement.

```
float[] values
```

The length and contents of the values array depends on which sensor type is being monitored.

```
Sensor.TYPE_ACCELEROMETER:
All values are in SI units (m/s^2)
values[0]: Acceleration minus Gx on the x-axis
values[1]: Acceleration minus Gy on the y-axis
values[2]: Acceleration minus Gz on the z-axis
```

Sending an SMS through the app to the owner: SmsManager
Manages SMS operations such as sending data, text, and pdu SMS messages. Get this object by calling the static method getDefault() [4].

We can make use of the object of SmsManager class and its methods such as,

```
sendTextMessage: Send a text based SMS.
void sendTextMessage (String destinationAddress,
        String scAddress,
        String text,
        PendingIntent sentIntent,
        PendingIntent deliveryIntent)
```

Location Services: Android gives your applications access to the location services supported by the device through classes in the android.location package [5]. The central component of the location framework is the LocationManager [6] system service, which provides APIs to determine location and bearing of the underlying device (if available).

Location updates:

```
startLocationUpdates(){

LocationServices.FusedLocationApi.requestLocationUpdates
(
      mGoogleApiClient,mLocationRequest,this);
```

Last known location:

```
mLastLocation=LocationServices.FusedLocationApi.getLastLocation(
                                        mGoogleApiClient);
                                    if(mLastLocation!=null){
mLatitudeText.setText(String.valueOf(mLastLocation.getLatitude()));
mLongitudeText.setText(String.valueOf(mLastLocation.getLongitude()));
```

3. PHYSICAL LIMITATIONS AND DRAWBACKS OF THE SYSTEM AND THEIR POSSIBLE SOLUTIONS

1. Device safety/Removal of the monitoring device: The smart device will be fit in such a way that some intermediate level of expertise and sophisticated tools

will be required to physically remove it. For instance, near or inside the vehicle engine.

2. Device battery life:
The inbuilt battery of the device may have lesser life in the proposed system as G.P.S. and internet connectivity consume a lot of battery and will be required continuously. Hence we can remove the inbuilt battery and the device will run on the vehicle battery itself. Voltage can be regulated using plug pins.

3. Network connectivity issue:
There may be a case where the device loses the network connectivity. In such a case the user will have the last known position of the vehicle. Furthermore, if the device recaptures the network, the system can start working again by picking up the current location.

4. The Ultimate failure: Device hardware failure
This is the "worst case" scenario from which the recovery will be next to impossible. The best solution for this is to prevent this scenario by regularly doing the maintenance of the device.

3.1. Some of the drawbacks of the system:

1. App crashes:
Sometimes the system application may crash and the system then can no longer be in use.

2. System installment in two-wheeler:
As bike engine is outside the device will be viewable or easily visible so we need to find a perfect place to install the system.

3. Portable mobile Jammer:
If the thief uses a portable jammer that will lock the service provider connectivity. In this scenario the system will no longer be functioning. This is a one of the biggest drawbacks of the system.

3.2 Future Enhancements:

The current proposed system may contribute in "theft detection", but we can enhance the system by upgrading it in such a way that in case of the theft, the vehicle engine will be locked by a signal sent by the smart device to the microcontroller in the system.

3. CONCLUSIONS

Vehicles are one of the most valuable assets of a person, hence their security becomes one of the top priorities.
Using the proposed system, we will be able to monitor the suspicious movement of vehicles which may result in the detection of the vehicle theft.
We will also be able to know if the vehicle has been towed and where to go to pick it up in case it has been towed.
The system is likely to falter in case of the app crash, hardware failure or network connectivity issue etc. Majority of these can be avoided by regularly maintaining the device.

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