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Effective Car Monitoring And Tracking Model

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Abstract: Statistics shows that car production in the world is the increasing yearly as well as car theft attempts. Many international and local companies have good effort in term of producing car security systems, but the result is still less than expectations since the number of car theft cases are still increases. The thieves are developing their capabilities and inventing smarter and stronger stealing techniques which require more powerful security systems. On the other hand most of the cars use traditional alert systems (with no mobility or multimedia facilities) as well as the advanced car security system are still expensive and mainly used in expensive cars. To overcome such problems; this research project proposes a New Car Monitoring and Tracking Model. It introduces a powerful security model that can send SMS and MMS to the owner or security organizations to have fast response especially if the car is nearby. This paper focuses on using SMS, MMS and database technology, the picture of the intruder will be sent to user or police. The Database offers the required information about car and owner, which will help police or security authorities in tracking the car using GPS system that can be link to Google Earth and other mapping software. The implementation and testing results show the success of prototype in sending SMS and MMS to owner within seconds and receiving acknowledgment to the database (police or security unit) within 3-4 minutes. The timing and results are suitable to owner and police to take suitable action against intruder.

Key words: Car Monitoring; car alert; car tracking; SMS; MMS; database.

INTRODUCTION

Literature review and statistical studies shows an important fact, the number of cars is increasing rapidly and so is the number of car theft attempts. Although there are a lot of car security systems that had been produced lately with more advanced technology, but the result is still disappointing as the number of car theft attempt cases still increases. The thieves are inventing cleverer and stronger stealing techniques that need more powerful security systems. Statistics show that 96% of the public are not aware when they hear an car alert alarm. It also shows that the alarm itself does not contribute much in preventing a car theft and these car alarm systems cover limited areas; the area is just less than 100m (Brown, 1996). Vehicle crime is one of the essential issues for the Interpol. Interpol web on Vehicle crime (http://www.interpol.int/Public/Vehicle/Default.asp, 2011) shows that: vehicle crime is a highly organized criminal activity affecting the whole world. It has been clearly established and often linked to organized crime and terrorism. Interpol shows that vehicles are not only stolen for their own sake; sometimes they are trafficked to finance other crimes. They can also be used as bomb carriers or in the perpetration of other crimes (http://www.interpol.int/Public/Vehicle/Default.asp, 2011). The Interpol General Secretariat has developed the Automated Search Facility-Stolen Motor Vehicle (ASF-SMV) database to support police in member countries in their fighting against international vehicle theft and trafficking. End of December 2010, the database held more than 7.155 million records of reported stolen motor vehicles as in table 1. Close to 152 countries use the database regularly, of whom 129 countries share their national stolen vehicle database records with INTERPOL.

Table 1: Number of stolen cars in world –Interpol statistics.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
No of stolen Cars	2600227	2641369	2702700	3236685	3296263	3677898	4247396	4641014	6222314	7155279

As this research project done in Malaysia so we have to study the car theft in this country. Figure.1 shows number of stolen cars in Malaysia about 20 thousands in 2009 (Kadar Jenayah, 2011). Based on our analysis on news archive for previous years, we can highlighte the following important points: It was reported that 8 vehicles were stolen every hour in Malaysia and less than 30% stolen cars were recovered annually. Most popular cars being stolen are Proton Wira, Perodua Kancil, and Luxury cars (Toyota Harrier, Mercedes and BMW)(Regis and Bates, 2001; Le Bodic Gwenaël, 2003). Stolen cars will be export either as full unit, break

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into parts for locals and foreign market, modified and sell for locals or ride and deserted somewhere else. There are several ways to steal the cars, most commonly use are smashing the window and unlock the door, removing key slot from the boot and file a new key, using steel ruler and insert it between the rubber lining at the door to unlock central locking system and finally using tow truck to tow the car away. Among the factors contributed to stolen vehicles are inadequate/unreliable alarm system installed in the car, careless user and syndicate activities.

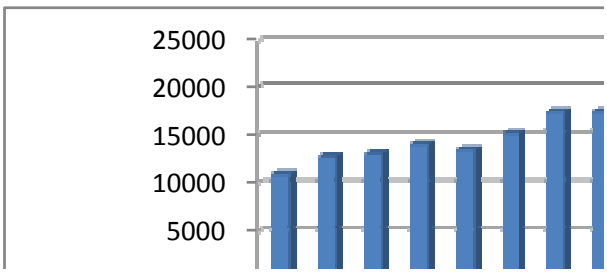

Fig. 1: Number of stolen cars in Malaysia (2000-2009)

The L.R and analysis for car stolen and security situation shows that there are several alert and monitoring products for car such as: CARALL Multi Function Alarm System with Build in Key (Clare Churcher, 2007), 2-Way Car Alarm with LCD Monitoring Pager (Clare Churcher, 2007), GSM-Video Alarm C (Ben Forta, 2007), GPRS/CDMA Wireless Surveillance Image Transmission System (Simpson and Young, 2003), CCTV safe Video Alert System (Product review, 2009), Security System for an Automobile via Mobile Phone (Gurevich, *et al.*, 1997), Autonomous Vehicle Monitoring and Tracking System (Product review, 2009), GPS/GSM/GPRS Vehicle Locator (Emily, 2007). More details related to LR and specifications of security systems and components used in this project are described in references (Erme and Hasmawati, 2004; Carl, 2002; Ariffin And Abd Wahid, 2007; Bodic, 2005; www.nowsms.com/documentation/ProductDocumentation/overview.htm, 2009;Shaoji,andHaggman,1999;http://garefowl.manufacturer.globalsources.com/si/6008825952750/pdtl/Mobile-wireless/1003820826/MMS-GPRS-Modem.htm, July 2009). The analysis of the capabilities of such products are summarize in research paper (Shihab and Hameed, 2010). The summary of the review of alarm system products with their specifications are shown in table 1.

Table 1: Alarm system products and its specifications

No	Products	Alarm System	Remote Control	Sensor/s	Tracking System	Camera	SMS	MMS
1	Normal Alarm System	Yes	Yes	No	No	No	No	No
2	2-Way Car Alarm with LCD Monitoring	Yes	Yes	No	Yes	No	No	No
3	GSM-Video Alarm C	Yes	Yes	No	No	Yes	Yes-via GSM Modem	Yes
4	GPRS/CDMA Wireless Surveillance Image Transmission System	Yes	Yes	Yes	No	Yes	Yes	Yes
5	CCTV safe Video Alert System	Yes	Yes	Yes	No	Yes	Yes	Yes
6	Security System for an Automobile via Mobile Phone	Yes	Yes	Yes	No	No	Yes- via RF transceiver	No
7	Autonomous Vehicle Monitoring and Tracking System	Yes	Yes	Yes	Yes	No	Yes	No
8	GPS/GSM/GPRS Vehicle Locator	No	Yes	Yes	Yes	No	Yes	No

This research project is step toward overcoming car theft problem. The proposed solution is to design and build a prototype for an effective and cheap car monitoring and tracking model (CMTM) with mobility, multimedia and database facilities CMTM.

Proposed Cmtm Model (Components):

The proposed car monitoring and tracking model (CMTM) consists of two parts; first part installed inside the car while the second part installed outside the car. The main components of proposed CMTM model are shown in "Fig.2", which includes the following:

A. Sensors:

System should be completed with an accurate sensor. There are a lot of sensors now available in the market, for this project we decide to use two sensors; infrared sensor and magnetic sensor. Infrared will be most suitable for the car due to its efficiency, availability and low cost. The magnetic sensor consists of two magnetic bar coupled together between the doors and a wire is connected to the microcontroller to detect the changes in voltage. When the door is closed, there is a constant flow of current in the wire due to perfect magnetic field.

When the door is being opened, there will be change in voltage. Thus, this will trigger the alarm (http://www.ecplaza.net/tradeleads/seller/4765700/magnetic_contacts_magnetic.html, July 2009).

B. Microcontroller PIC-18F4520:

Microcontrollers are often low-power devices. A microcontroller is often small and low cost. The components are chosen to minimize size and to be as inexpensive as possible. PIC is a family of Harvard architecture microcontrollers made by Microchip technology. PIC 18 has much more programmable memory and high performance (http://www.cytron.com.my/index.asp, July 2009).

C. GSM/GPRS Modems:

GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access. GPRS data transfer is typically charged per megabyte of traffic transferred, while data communication via traditional circuit switching is billed per minute of connection time, independent of whether the user actually is using the capacity or is in an idle state. GPRS is a best-effort packet switched service, as opposed to circuit switching, where a certain Quality of Service (QoS) is guaranteed during the connection for non-mobile users (Noldus and Rogier, 2006).

D. GPS Receiver:

A GPS receiver receives radio signals from 24 satellites orbiting the Earth. If the receiver can receive a signal from at least 3 satellites simultaneously, it can calculate its own location, usually accurate to within a few feet. At this point, this location information must somehow be transmitted to a base station to be displayed on a computerized map(www.pegtech.com/rfgps.htm, 2009). The GPS module can boot up in one of three modes: Hot Start, Warm Start or Cold Start. The Time-To-First-Fix (TTFF) depends on the startup mode, with cold starts giving the longest TTFF. The almanac contains satellite's orbit information and allows the GPS receiver to predict which satellites are overhead, shortening acquisition time. The GPS receiver must have a valid almanac to be capable of booting up in warm or hot start modes (www.ikegps.com/downloads/TTFFstartup.pdf, 2009). The receiver must have a continuous fix for approximately 15 minutes to receive a complete almanac from the satellites. Once downloaded it is stored in nonvolatile memory. Execution of a cold start will automatically result in a new almanac download. Ephemeris data contains precision corrections to the almanac data and is required for accurate positioning.

E. Mobile phone:

NOKIA 3200 or other model that has user friendly interface. This model is chosen to complete for the system because it is the cheapest color mobile phone integrated with VGA camera module available in the Malaysian market. Since the project highlights low cost monitoring and tracking system, then a mobile phone integrated with camera and capable to support MMS function is the best choice.

F. Database:

A database is a structured collection of data which is managed to meet the needs of a community of users.A computer database relies upon software to organize the storage of data. This software is known as a database management system (DBMS) (Ben Forta, 2005). The database files hold all data related to the cars, cars owners, security organization and police, thief data.

G. RakanCop:

RakanCop (Malay: Friends of Cops) is the Malaysian community police cops which was launched by Royal Malaysian Police in Kuala Lumpur on August 9, 2005 to help combat crime in the city and any situations around Malaysia. It allows the public to have two-way communication with the police via SMS, hotline, Multimedia messaging (MMS) and email if they have information on criminal activities. The central co-ordination is based at the 24-hour Police Control Centre.

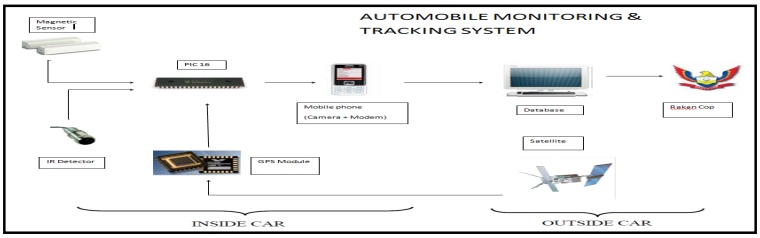

Fig. 2: CMTM model (Components)

Amtm Implementation:

In this section we will give a brief description for the CMTM flow of work and the main function implemented.

This CMTM is in charge of executing the following operations:

1. Sending alert message to the owner of the car through SMS.
2. Supervising the conditions inside the vehicle using MMS facilities.
3. Tracking the movements and the positions of the car via GPS.
4. Collecting and storing required information in the database.
5. Translating received GPS coordinates into KML file and viewing it through Google Earth application.

Figure 3 shows the main flowchart for the car monitoring and tracking model CMTM.

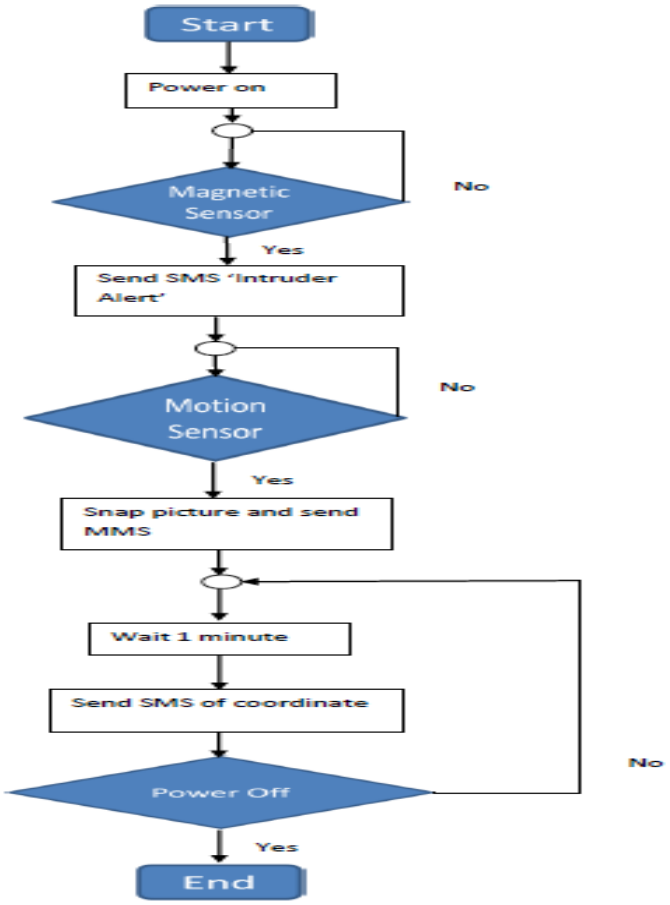

Fig. 3: CMTM flowchart.

The CMTM alarm system circuit will power up only when the user locked the car. We have placed magnetic and infrared sensors at specific places inside car. The sensors will act as a detector and give high voltage when they are being triggered. When the door is being opened illegally, the magnetic door sensor will detect it. Thus, it will turn on the infrared to detect any movement inside the car. When the infrared detector is being triggered, the PIC microcontroller will send signal to relay that in turn will operate the mobile (Nokia 3200 or other model). The system first will send SMS to the owner to inform that there is an attempt for car theft to his car and will open camera application to capture the picture. Then, it will send the picture through MMS to owner through GSM provider (MAXIS, CELCOM, DIGI, etc.). The owner needs to confirm the event by replying the MMS. After receiving confirmation reply of theft event by the owner, the hand phone will send the same MMS picture to MMS modem which is located at the control centre. By using RS232 cable, the MMS modem will be connected to the PC which contains database of information regarding the car (etc; color, plate number, name of owner, and information from GPS.). For tracking purposes, a GPS receiver will be installed in the car. The receiver will be integrated to PIC microcontroller which will send text massages (SMS) to the database. So, the control centre can pinpoint car location using mapping software .Finally, the control centre will retrieved all the information needed and send to Police (RakanCop server) through the email.

A. SMS car alarm:

This project has been emphasizing on the benefits of using IR sensor for detection in the alarm system for car. Furthermore, the major part of this project was the employment of SMS system for alerting. The alert SMS will be sent to the owner mobile phone saying that their car has been intruded.

B. MMS alarm using predefined JPEG pictures:

The main objective is to send photos using GPRS modem to mobile phones. The microcontroller is programmed with a C code to send the commands to the GPRS modem so it will send the MMS alert to the database and end users.

C. Car Security Database:

The other part is the database which is programmed using MySQL and contains all information about users and their cars, the PC that contains this database is connected to a GPRS modem which receives the MMS from the car part and save its information in a MS-Access small data file, we programmed a small graphical interface to deal with the GPRS modem and to receive the MMS and store it in the PC. The project also analyzes the delay it takes to receive MMS massage and retrieved information by computer.

D. Integration:

This project has been emphasizing on the monitoring and tracking. Furthermore, the major part of this project was the low cost application. The PIC has been programmed to 'press' the keypad to execute capturing picture, send MMS and text position coordinate of the unit. Adding the GPS on board can improve tracking capability. The prototype can perform monitoring and tracking efficiently. The outside unit consists of MMS modem and database. Figure 4 shows the prototype build for CMTM.

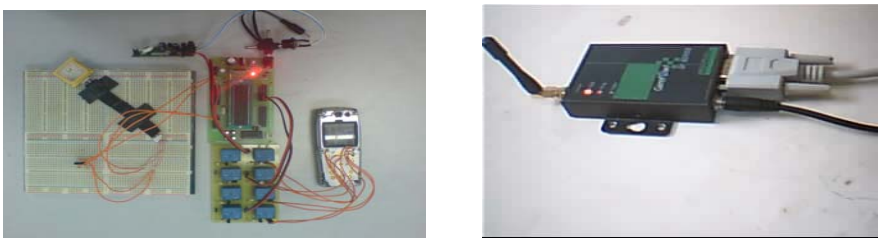

Fig. 4: Prototype for CMTM Model (Inside & Outside the Car)

The database is programmed using Microsoft Access tools and contains all information about users and their car. The database offer the ability to create new tables, insert new record such as car or owner, update the data within the database tables or delete it. The PC that contains the database is connected to MMS modem which receives the MMS from the car and save its information in a MS-Access small data file. A small graphical interface was built to receive massages with the MMS modem and to receive the MMS and store it in the PC. The SMS massage from the car containing GPS coordinate can be link with mapping software to pinpoint the location. Figure 5 shows the graphical interface for the database where the intruder picture and other related information such as car information and tracking location, etc.

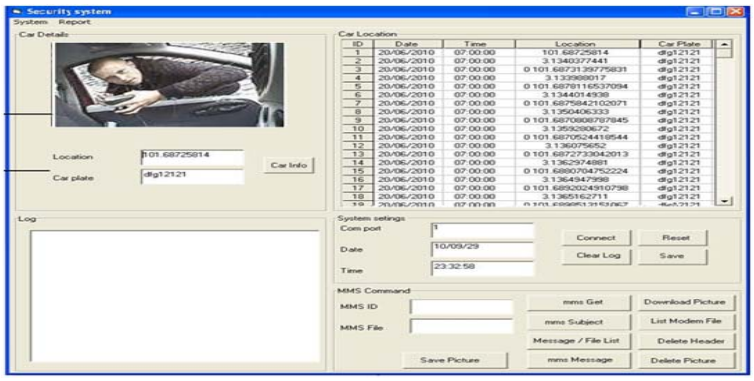

Fig. 5: Database graphical interface.

RESULT AND DISCUSSION

To have a successful security system is to have a fast alert mechanism that can initiate an immediate response. Thus, since the prototype will use GSM network for MMS and SMS transmission to user and to database, a delay analysis of message transmission among different service providers was conducted. SMS transmission more or less has a same delay and can be tolerable but MMS transmission need a careful study. The test was conducted in IIUM environment.

To show the tracking of the car; KML file will be created and linked to Google Earth. Based on available coordinates, at each time there is new latitude and longitude update, a point will be placed on Google Earth using KLM format and by having several points, this will allow us to trace the car. Thus, the database can link the GPS Coordinate to Google Earth for real-time tracking. Figure 6 shows the**.**kml file uploaded in Google Earth with all related information.

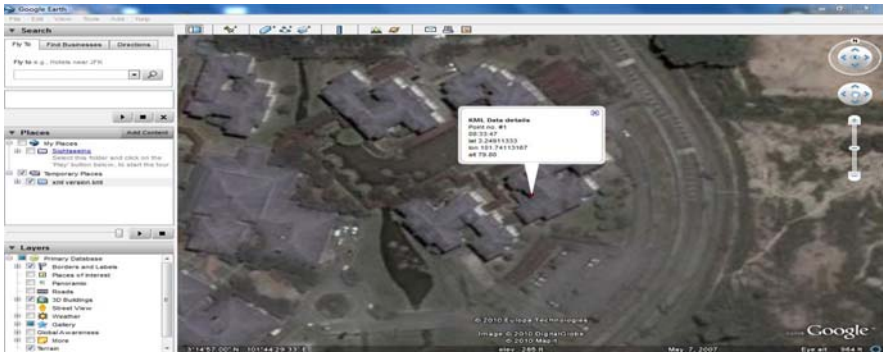

Fig. 6: .kml file uploaded in Google Earth.

To show the result of tracking a car using CMTM model that integrated with the google earth; figure 7 shows the full report for the tracking path.

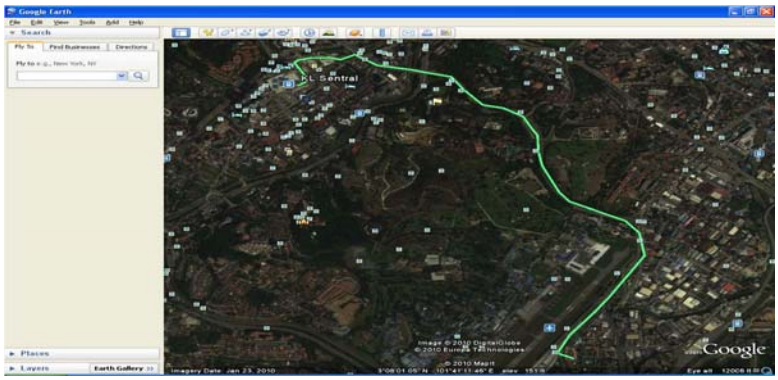

Fig. 7: Generate Google Earth KML report.

Car's owner will be alerted with an email that includes all the information about the robbery. The owner of the car will immediately login into his email account in order to view and follow up with his/her case. The information that will be reported is:

- Attached picture of the thief.
- Attached KLM reports.
- Attached file of the car details.

The owner will have a clear idea about the location of his car by opening the KLM file which will help him in following up with the local authorities (Police/Security department). Figure 8 shows the car rob report. A copy of the report will be send to police by using the menu report/send to police.

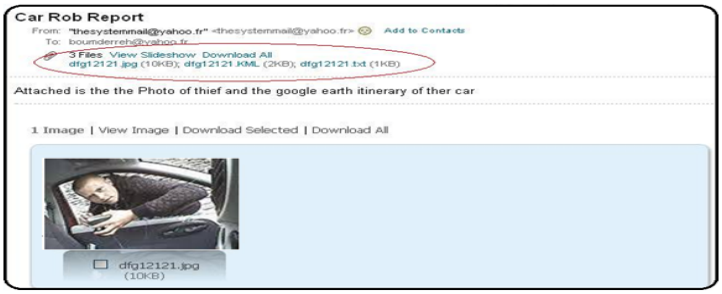

Fig. 8: Car Rob Report.

In term of accuracy we test the time to first fix TTFF vs accuracy. From figure 9 we can determine that the accuracy of the GPS coordinates is improving after 15 minutes, the reason is that after 15 minutes the GPS receiver will be communicating to more number of satellites.

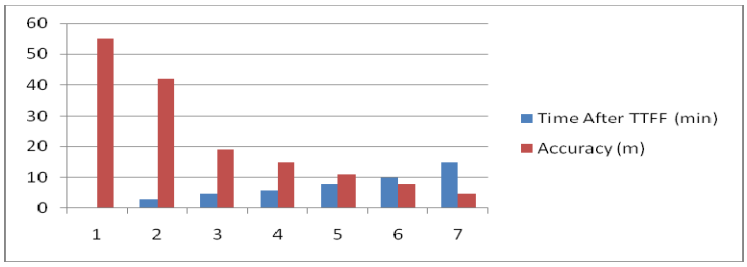

Fig. 9: Accuracy vs. Time.

From the test data we can notice that the total system time is between 3 to 4 minutes. A summary of fix delay in the CMTM is shown in the following table.

Fix delay in the system (s)	
Delay to type SMS alert	32
Delay to build MMS message	25
Wait for 1 minute to initialize GPS	59
Delay to type GPS coordinate	55
TOTAL	171

Hence, 171 seconds are the system delay due to programming and hardware implementation that had to be compensated in the overall system. Both data are the MMS transmission delay from in car unit to user hand phone and user hand phone to MMS modem accordingly.

In term of the cost the prototype we build is cost about 250-300 USD, which is very cheap compare to the facilities and specification of the CMTM. The cost can reduce when we has industrial product since we buy item from the normal market.

Conclusion:

Within the increasing number of car locally and internationally; car theft is increasing rapidly although there are many car alert or security products. The proposed car monitoring, alert, and tracking model presents the good easy-to-build system possible. It is an effective model in the sense that it uses mobility capabilities like SMS, MMS for alerting the owner; as well as developments of database part that offers suitable data related to car and its owner to support CMTM. CMTM model presents a effective and cheap solution for many related problems such as, organizing the stolen cars cases, notification speed, data and information storage and accuracy.

The implementation and testing results for the CMTM were good, the process of sending SMS, MMS messages was successful, the process of receiving the SMS, MMS by the end users or owner and the database was successful also, and it took an average time about 40 seconds to get alerted the car owner. This short time is mostly enough for the owner to reach his car before the intruder toke the car, especially if the owner is nearby his car. The database will receive the intruder photo within 3- 4 minutes, which is very helpful for the security and police to take action against the intruder. The tracking part is work properly and CMTM offer easy interface for users or police to follow the stolen car as well as a full report about the car and photo for intruder. It offers an accurate positioning or locating for the stolen car. CMTM implementation will leads to reduce car theft cases and increase the possibility to find stolen cars and intruders.

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