

# The establishment of a stolen-vehicle tracking management information system

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**Abstract.** This study establishes a stolen-vehicle tracking management information system (MIS) combining information technology (IT) equipment in a wireless local area network (WLAN), personal digital assistant (PDA), and charge couple devices (CCD) camera with vehicle license plate recognition (LPR) technology. First, the police setup CCD cameras at fixed locations or in police vehicles to monitor every moving vehicle and fetch plate information to match retrieved plate information compared with stolen-vehicle databases. Second, when a stolen-vehicle is detected, the system communicates real-time warning signals to PDA held by on-duty police to intercept the stolen vehicle. The real-time information delivery and communication provided by this system not only help the police to solve serious criminal cases and protect public life and property, but also increase management effectiveness and lower manpower costs.

**Keywords:** Charge couple devices (CCD), license plate recognition (LPR), management information system (MIS), personal digital assistant (PDA), Real-time, Stolen-vehicle, wireless local area network (WLAN)



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## 1. Introduction

Due to economic recession and business migration to China, the high unemployment dilemma has caused a high crime rate. Especially, crime of stealing automobiles and motorcycles is the most serious. The stealing incident has become a potential concern in public security in that vehicle thieves use stolen-vehicles to commit serious crimes such as robbery, homicide, and drugs. Thus, it is urgent to develop a real-time stolen-vehicle tracking MIS.

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When a stolen-vehicle incident occurs, after the owner reports it to the police station, the report will be delivered to the 110 Duty Center (The emergence phone in Taiwan is 110) and kept on record. This incident will then be keyed into the stolen-vehicle databases in the National Police Agency (NPA). The databases will gather and organize all the stolen-vehicle information from the entire country and send to each police station routinely. This process takes more than 24 hours for the back and forth transmission of stolen-vehicle information. During the 24-hour gap, vehicle thieves have left the crime location and may have used stolen vehicles to commit other serious crimes. This vehicle is also possible that the stolen vehicle will be disintegrated into parts for sale within 24 hours. This is a serious threat to public life and property. Besides preventing vehicles from being stolen, it is more important to create a real-time MIS to communicate real-time information about stolen-vehicles to on-duty police. To efficiently solve automobile crimes, advanced IT equipment needs to be purchased to track vehicle-thieves and monitor stolen-vehicle information.

This study used a CCD camera and WLAN in framework and applied LPR technology and portable PDA equipment to create a real-time stolen-vehicle tracking MIS. This system can solve the 24-hour gap problem in existing management system to increase crime-solving rates and management efficiency.

## 2. Literature review

### 2.1. Wireless local area network (WLAN)

The overall market for WLAN grew more than 200% from 2000 to 2002, and will continue to grow at a compound annual growth rate of 23% until 2007 [10]. The rapid development of WLAN and the maturity of portable devices such as notebook and PDA have made WLAN a popular industry recently [2]. WLAN applications enhance mobile workers' productivity through improved decision making capabilities, less paperwork, and reduced cycle times for transactions and billing [11]. Furthermore, WLAN technology provides users with "anytime, anywhere" access to Internet; it also offers excellent application tools for controlling internal resources and retrieving rich information from the World Wide Web (WWW). Consequently, both independent individuals and team members can gain the required information instantly and optimize their decision-making. Research shows that WLAN

can save individual users an average of 70 minutes of daily work hours and can increase productivity by 22% [2]. WLAN has the following advantages [11,14]:

- improved decision making capabilities;
- less paperwork;
- reduced cycle times for transactions and billing;
- no cable construction;
- easy implementation and maintenance of cable;
- high mobile flexibility; and
- low cost.

Some mobile places, for example, hospitals, warehouses, and restaurants, need to access information instantly and at anytime, and also need to retrieve or update data for real-time services. Under these conditions, WLAN is the best tool for use under these conditions [15]. Therefore, WLAN combines related equipment (including PDA and Mobile phones) to provide real-time information to those mobile places.

### 2.2. License plate recognition (LPR) technique

First, the digital images of license plates captured by CCD cameras need to be recognized in the image pre-treat and then processed by edge detection algorithm (EDA) to differentiate colors. Second, the line extraction algorithm (LEA) locates the license plate position to extract the license plate from the image. After normalizing the license plate image, it can simplify the procedures of character recognition algorithm. The process of license plate recognition is shown in Fig. 1.

### 2.3. Personal digital assistant (PDA)

In the current highly mobile world, users require access to important information without constraints of time and space. Information real time and fast reactions in unforeseen situations are crucial factors. Mobile phone, PDA, and smart phones can serve as permanent companions used for ad hoc and spontaneous up-to-date and online information access [1]. Consequently, personal digital assistant (PDA) is becoming a popular portable device [12]. PDA is designed to support various tasks such as word processing, numeral computation, e-mail, and web browsing [12], and is rapidly becoming an indispensable information management tool [8]. Mobile drivers are applied in many areas including education [13], healthcare [5,6], medicine [3,7], and retail and manufacturing [11]. The main advantage of PDA is mobility and flexible access to information. Because of the prevalence of WLAN, PDA

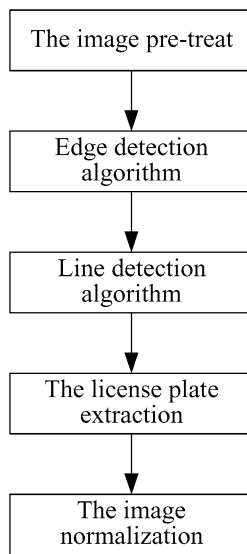


Fig. 1. The step of algorithms for searching the license plate.

have become an important device for instantly transmitting information. Many MIS, which use PDA, take advantage of the WWW by using PDA, including controlling and managing PDA based information, and enhancing system usage to promote efficient information retrieval. Advantages of PDA [6]:

- mobility and flexible;
- real-time access to information;
- cost-effectiveness;
- easy communication;
- integration function; and
- enhanced productivity.

### 3. The stolen-vehicle tracking management information system

#### 3.1. Stolen-vehicle reporting process

As mentioned in the introduction, when a vehicle is reported stolen, the slow back and forward transmission of stolen-vehicle information caused that on-duty police lost the timing to solve auto crimes and catch vehicle thieves. The existing stolen-vehicle reporting process is shown in Fig. 2. In order to communicate the real-time stolen-vehicle information to on-duty police to intercept stolen vehicles at the first timing, it is urgent to apply IT equipments into real-time stolen-vehicle MIS. To achieve real-time communication of stolen-vehicle information, the best tool needs to combine WLAN and PDA. This study applies the hospitals

application framework [4] into a police stolen-vehicle management information system. First, it is necessary to create a Web-based management center to run the stolen-vehicle MIS.

#### 3.2. Establishing Web Page management center

A MIS Web Page is established in the stolen-vehicle management center to show the functions. This Web Page not only simplifies development processes and is convenient for users to operate, but can also cross different platforms for retrieving data in servers by using Web browsers. Adding wireless functions to Servers improves their operation processes and expands their original functions so they are no longer restricted to fix cables range. Thus, the management center can increase communication efficiency and service quality. Wireless especially promotes mobile user efficiency. The management information center is located in the NPA. The main Server's operating system uses a Microsoft Windows 2000 Advanced Server with Microsoft Internet Information Servers as a Web Server and Microsoft Access 2000 as a database system. Programming languages include C++, active server pages (ASP), and HTML. The complete system combines a Web-based MIS and LPR technique.

#### 3.3. Operation process of stolen vehicle tracking system

After the Web-based management center is established and WLAN is combined into the system, the stolen-vehicle tracking system can be used to track stolen vehicles. The process is described below [9]:

- (1) This system uses the CCD camera with night shot 0 lux system, which is equipped in the patrol car to capture the vehicle image and recognize the vehicle license plate.
- (2) When the CCD camera shoots the moving vehicles, it captures the image automatically.
- (3) This system connects the image-captured system with the computer and records the vehicle image.
- (4) This system automates license plate detection and compares it with the stolen-vehicle database.

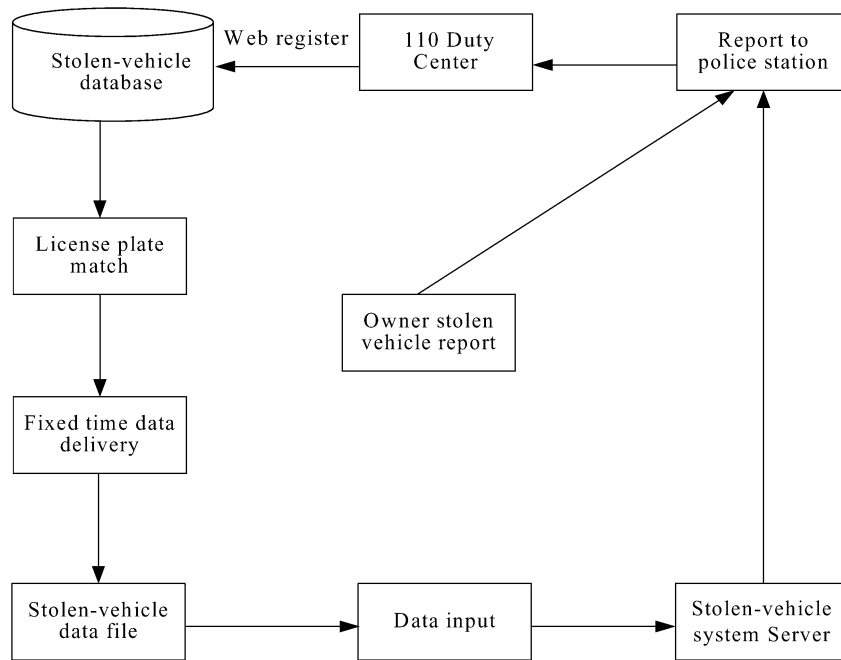


Fig. 2. The existing stolen-vehicle reporting process.

(5) When the license plate data is recognized as the same as that stored in the computer, it gives a warning signal, and shows the passing vehicle to be a stolen-vehicle. The warning signal is transmitted through the WLAN framework. The information notifies on-duty police with PDA to trace the nearby stolen-vehicle. The stolen-vehicle tracking system framework is shown in Fig. 3. This system can be divided into two categories:

- fixed method CCD cameras are set up in the highway tollbooths or important roads to monitor vehicles.
- mobile method CCD cameras are set up in police vehicles. Their locations can be adjusted as needed.

The comparisons of fixed method and mobile method are shown in Table 1.

### 3.4. This system benefits

The existing management system with a 24-hour gap problem does not have the real-time communication function. This study will first create a Web-based management center and WLAN structure and then combine PDA convenient functions. Using this system, on-

Table 1  
The comparisons of fixed method and mobile method

Items	Fixed method	Mobile method
Speed limits	0–200 KM/H	70 KM/H
Recognition time	0.6 Sec/One vehicle	0.7 Sec/One vehicle
Manpower	Few	Many
Recognition rate	95%	90%
Mobility	Passive, cannot change location	Good
Extendibility	High extendibility with combining other functions	Poor
Performance	High performance in 24-hour continually filtering vehicles	Poor
Cost	High construction and maintenance costs	Low

duty police will obtain the real-time information to intercept suspects and stolen vehicles. Not only will this system deliver real-time information about stolen vehicles, but it can also add new functions into the system. For example, creating a criminal database with previous crime records. When doing check-ups, it is easy to find out if suspects have previous crime records by entering their ID numbers. The database prevents missing opportunities of catching criminals. The benefits of this system are:

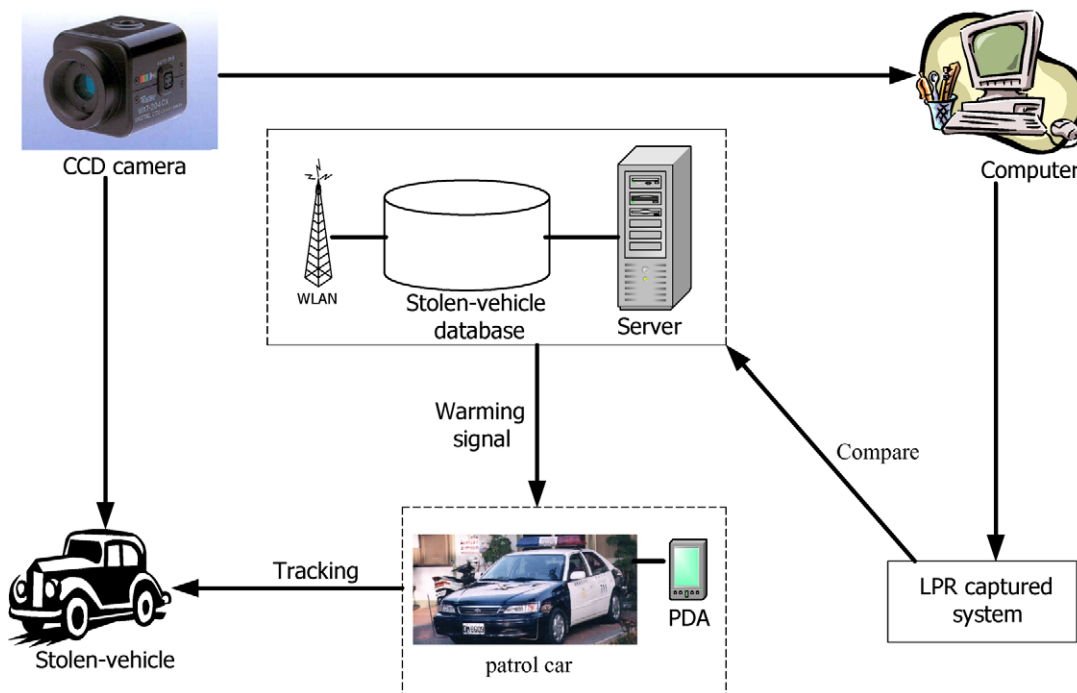


Fig. 3. The framework of stolen-vehicle tracking system.

- real-time update and communication of stolen-vehicle database;
- real-time accurate stolen vehicle information;
- simple installation and high stability;
- reasonable establishment costs and low maintenance costs;
- saves manpower and management costs;
- adds new functions as needed, has high flexibility, and has obvious benefits; and
- increases crime-solved rate and protects public properties and lives.

#### 4. Conclusion

WLAN has been applied widely in commercial platforms. With the breakthrough of WLAN technology and the maturity of portable information products, businesses have been using these technologies to present their complete competitiveness. The mobility of PDA gives users the capability to access real-time information anytime and anywhere to make the best decision-making. However, IT has been applied more completely in business than in government organization. With successful application of this system, its structure can also be applied to parking space in commercial buildings for entry control or cargo fleet man-

agement. The authors of this study believe that applying this system to other organizations can have excellent benefits.

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#### References

- [1] D. Balfanz, J. Schirmer, M. Grimm and M.R. Tazari, Mobile situation awareness within the project map, *Computers & Graphics* **27** (2003), 893–898.
- [2] Cisco Web Site, *Search wireless possible of WLAN*, <http://www.cisco.com/global/TW/networking/wireless/news.shtml>, 2005.
- [3] P. Fontelo, M. Ackerman, G. Kim and Locatis, The PDA as a portal to knowledge source in a wireless setting, *Telemed. J. e-Health* **9**(2) (2003), 141–147.
- [4] Y.H. Lin, I.C. Jan, P.C. Ko, Y.Y. Chen, J.M. Wong and G.J. Jan, A wireless PAD-based physiological monitoring system for patient transport, *IEEE Transactions on Information Technology in Biomedicine* **8**(4) (2004).

- [5] B. Lin and J.A. Vassar, Mobile healthcare computing devices for enterprise-wide patient data delivery, *International Journal Mobile Communications* **2**(4) (2004), 343–353.
- [6] Y.C. Lu, Y. Xiao, A. Sears and J.A. Jacko, A review and a framework of handheld computer adoption in healthcare, *International Journal of Medical Informatics* **74** (2005), 409–422.
- [7] T.G. McLeod, J.O. Ebbert and J.F. Lymp, Survey assessment of personal digital assistant use among trainees and attending physicians, *J. Amer. Med. Inform. Assoc.* **10**(6) (2003), 605–607.
- [8] J. Swarts, PDAs in medical Settings: The importance of organization in PDA text design, *IEEE Transactions on Professional Communication* **48**(2) (2005), 161–176.
- [9] TCPB (Taichung County Police Bureau) Web Site, License plate recognition system of stolen cars, <http://www.tcpa.gov.tw/web/mobile/mobile.htm>, 2005.
- [10] A. Vance, WLAN: trends and analysis, <http://www.webtorials.com/abstracts/WLAN%20Trends%20And%20Analysis.htm>, 2003.
- [11] U. Varshney, A. Malloy, P. Ahluwalia and R. Jain, Wireless in the enterprise: requirements, solutions and research directions, *International Journal Mobile Communications* **2**(4) (2004), 354–367.
- [12] Y. Yang, Z. Wu and Z. Ma, Real time user authentication system for PDA, in: *2004 IEEE International Conference on Systems, Man and Cybernetics*, 2004, pp. 439–443.
- [13] S.C. Yuen and P.K. Yuen, PDAs as educational power tools, *Tech. Directions* **62**(9) (2003), 14–17.
- [14] Y.Z. Zheng, *Wireless Network*, Xbook Marketing Press, Taipei, 2002.
- [15] S.H. Chen, C.C. Yang and J.Y. Shiau, Equipment management in higher education using a WLAN framework, *Human Systems Management* **24**(3) (2005), 190–196.