

# An Automated Vehicle Parking Monitoring and Management System Using ANPR Cameras

Mohammed Y Aalsalem, Wazir Zada Khan, Khalid Mohammed Dhabbah

Faculty of Computer Science & Information System, Jazan University, Kingdom of Saudi Arabia

{aalsalem.m, wazirzadakhn}@jazanu.edu.sa, re.e@hotmail.com

**Abstract--** Car parking has become a serious problem of everyday occurrence for educational institutions with the decreasing parking supply, increasing enrollments and high percentage of vehicle ownership, in result causing congestion, time and money wastage. This problem is getting worse and more frustrating in Jazan University due to the fact that majority of students, faculty and staff members own cars and drive through them to the University. The most common problem is to find out people (evidence) who are responsible for the damages (hitting, scraping, scratching and dents) to other cars. Another problem is the blockage of car due to wrong car parking which takes much time to locate the owner of the car. Moreover, another difficulty that is often faced by the students/faculty is to locate their cars on forgetting their car park location. The existing cameras located at the parking lots are only for video surveillance and cannot help in such situations as there is a lack of proper car parking management and guidance system. To remedy the above mentioned problems and to ensure a better parking experience by accommodating increasing number of vehicles in a proper convenient manner, we propose an automated car parking management and monitoring system (CPMMS) which employs Automatic Number Plate Recognition (ANPR) cameras to efficiently manage, monitor and protect the parking facilities of the University. We have also conducted a survey to analyze the parking problems around the University campus faced by the students, faculty and staff members.

**Keywords--** Car Parking Management, Monitoring, License Plate Recognition, Locating Car, Mobile Computing.

## I. INTRODUCTION

With the growing number of vehicles, Car Parking problems at University campuses upsurge which not only result in confusion, annoyance and wastage of time but also the information about the responsible persons for damaging (like scratches, dents, scraps etc.) other people's cars inside a campus remain anonymous. The problem is getting more severe day by day due to the fact that a the number of student enrollments is increasing year by year and a huge percentage of students and faculty own cars with the limited number parking lots.

An important issue in car parking is that people while parking their cars improperly may block the other parked cars in the parking lots. Due to this, the blocked car owners cannot find the responsible persons and remain stuck and

frustrated until they get the car out of the parking lot. The security guards at the parking lots are unable to help in this regard because of the lack of any monitoring and management enforcement systems and policies. Due to this, it takes much time in pursuing the responsible person which consequently results in the wastage of precious time of students as well as faculty and staff members. Another critical problem (that arises due to the reserved and limited number of car parking lots) is that students (for whom no reserved parking is available) may damage other parked cars while improper and wrong car parking. The damaged car owners remain unsuccessful in finding out the responsible persons for damaging their cars and no one can help out in this concern because there is no proper monitoring system that can keep record of the in and out information (i.e. entrance and exit) of the vehicles and parking information (like parking location, parking duration) of vehicles. Moreover, students, faculty and staff members often forget where they have parked their cars in the parking lots. So, finding out a car in such a scenario without any automated management system is a difficult and time consuming task which finally results in anger, exasperation and wastage of time.

The existing car parking management system at the university is fully manual which only allows the authorized vehicles that are registered by having the entrance sticker. The whole university area including entrance and exit gates, academic area, administrative and parking zones are all under video surveillance. But this can only serve for video capturing and storing and are not connected to any proper management and monitoring systems.

To overcome the above mentioned problems encountered while car parking in the parking area of the University campus, we propose an Automated Car Parking Monitoring and Management system called (CPMMS). Our proposed system has strong hardware and software components. This system can assist the security department to handle the parking problems more effectively such as locating the car if a person forgets its exact parking location or to locate and pursue the liable person for damaging or blocking some ones car while wrong car parking in the parking lot.

A survey based on a quantitative questionnaire is also conducted to investigate the problems encountered by the students, faculty and staff members. The survey's results provide a confirmation of the above mentioned problems that the students, faculty and staff members are facing and thus our proposed system fulfills all the requirements that

need to be addressed by providing appropriate solutions of these problems.

## II. AIMS & OBJECTIVES

The proposed system aims to provide an appropriate solution for all the above problems which have been identified by analyzing the conducted survey. The aims and objectives of the proposed systems are as follows:

- We aim to implement a car parking management system that will not only automate the existing parking management system by keeping all the in/out information and parking information of vehicles but also facilitate the security department in assuring the safety and satisfaction of the students, faculty and staff members while parking at the University campus.
- We aim to develop an android application which will facilitate in reducing the frustration and annoyance of those who often forget the exact parking location of their cars.

## III. EXISTING PARKING MANAGEMENT SYSTEMS

The existing car parking management system at the university is fully manual which only allows the authorized vehicles that are registered by having the entrance sticker. Security department provides three types of stickers for entering into the University, which are for students, faculty and staff members. The whole university area including Entrance and exit gates, academic zone, administrative and parking zones are all under video surveillance. But this can only serve for video capturing and storing and are not connected to any proper management and monitoring systems. In case of any acute incident, a sequential video search is required which is time consuming and unfruitful process. There are reserved (by name) parking lots for most of the staff members and dedicated areas (on first come first serve basis) are available for students and the faculty members.

The available Car Parking Management Systems in the literature are either sensor based [1-3] or RFID [4-6] based and they mostly address the issue of finding a vacant parking location in the parking lot. These systems are only helpful in determining the occupancy status of parking space but are unable to figure out the solutions for the above mentioned problems like the information about responsible persons who either block or damage other cars while parking their own. So of the parking problem encountered at universities campuses are studied in [7].

The existing Sensor based Parking Management Systems have a problem as mostly sensors are unable to detect obstacles that are not visible because of their flatness to the ground level and thus they cannot distinguish pedestrians or objects from the vehicles of interest, in result have more false positives. Another challenge in Sensor and RFID based systems is that they are prone to many attacks [8] like denial of service attacks (DoS)[9], selective forwarding attack[10-

11], node replication attack[12-14], Sybil attack[15-16], wormhole attack[17], black hole attack[17] and Signal or Radio Jamming attack [19-20] etc. RFID based systems are also suspect to many attacks like [21-22].

## IV. DESIGN & WORKING OF THE PROPOSED SYSTEM

In this section we propose an Automated Car Parking Monitoring and Management system called (CPMMS). Our proposed system will consist of both hardware and software components.

- The hardware component will consist of Automatic Number Plate Recognition (ANPR) cameras which are mounted on the entrance and exit gates and parking lots of the campus.
- The software components will include a parking management system and a mobile application.

Contrary to the existing sensor or RFID based car parking management systems we choose to leverage ANPR cameras for capturing the license number plates of the vehicles as they are more advantageous than other technologies. ANPR cameras are known with different names like ALPR (Automatic License Plate Recognition), LPR (License Plate Recognition), CPR (Car Plate Recognition) and AVI (Automatic Vehicle Identification). It provides faster traffic management at parking areas, ability to automate access control systems with a setup of ticket free systems providing new and more effective law enforcement. ANPR cameras are suitable in all weather conditions and can be mounted at higher mounting locations to assure a wider field view of the whole parking lot.

The authorized vehicles will be registered in the parking management system along with their owner information. The information about the parking zones and parking lots will already be stored in the system with the other related information (e.g. which camera is monitoring the parking lot with their physical locations (x & y coordinates).

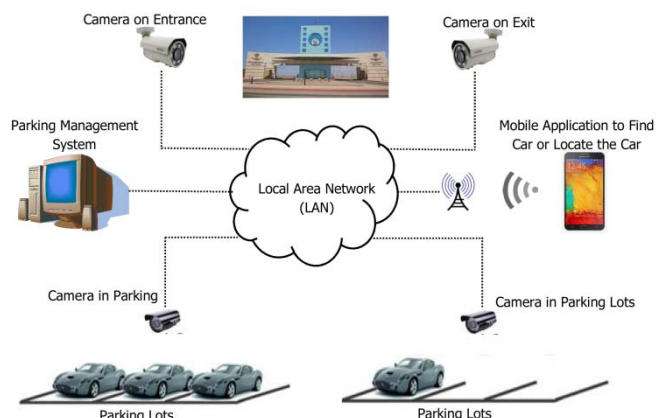


**Figure 1.** Design of the Proposed Automated Car Parking Management and Monitoring System (CPMMS)

The ANPR cameras will capture and store the vehicle License Plate number on entering/exiting of the vehicles at

the gates and parking of the vehicles at the parking lots. A mobile application has two features. First, it is responsible for locating the car if a person forgets its exact parking location. This feature is for general purpose and can guide all the persons who are parking in the parking zones of the University. Second, it can assist the mobile security units to locate and pursue the liable person for damaging or blocking some ones car while wrong car parking in the parking lot. This feature is specifically built for security purposes that can aid the security department to ensure the safety of the students, faculty and staff members while car parking. A complete design of the proposed system can be illustrated by Figure 1.

The working of the ANPR cameras can be easily comprehended by the flow chart in Figure 2. It shows that the ANPR cameras that are mounted on the entrance and exit gates of university and placed as well in all the parking lots will first capture the License plate number while entering/exiting/parking of the vehicles and then store it in the database. The ANPR cameras are integrated with the Vehicle Parking Management System which contains the records of entrance and exit timing information of the authorized vehicles along with the parking location and their owner's information. In case when any parked car is damaged by the some other car, the information about the vehicle and liable person for damaging the parked car in the parking lot can be found by the system records. This can be done by searching out the information about the timing and parking location of the cars nearby the damaged car/vehicle.

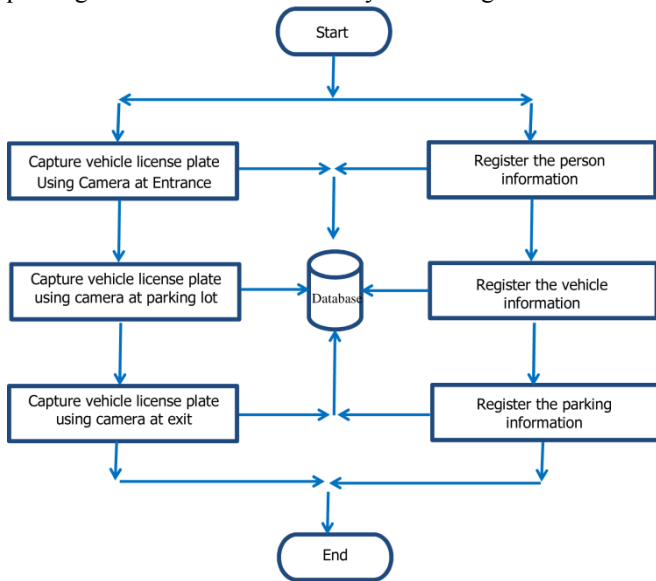


**Figure 2.** Flow Chart for the working of ANPR Cameras integrated with vehicle management system

The working of a mobile application can be shown in the form of a flow chart as in Figure 3. This mobile application can assist the security manger to handle two problematic situations during car parking in the university campus. In case if any car is blocked by wrong car parking then this application can locate the owner of the car who has blocked

the other parked car. This application can also help the persons who often forget the exact location of their parked cars. This mobile application keeps the personal information about the vehicle owners as a secret and only the security department personnel are able to see that information.

For developing the prototype mobile application J2ME is used and for parking management system the database is developed in SQL Server and the User interface is developed in C#.

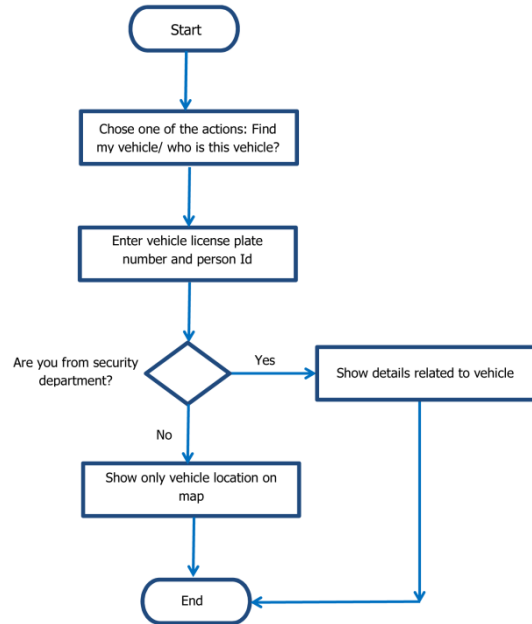


**Figure 3.** Flow Chart for the working of the mobile application

## V. SURVEY STATISTICS

We conducted a survey from 26th of October to 30th of October 2014 by filling out a quantitative questionnaire. A total of 88 persons participated in the survey out of which 53 were students and 35 were faculty and staff members. A number of questions were asked from the participants. Figure 4 shows the percentages of the different age groups of the participants.

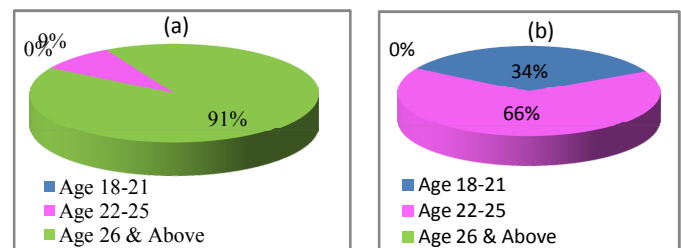


**Figure 4.** Percentages of different age groups of the participants

Figure 5 shows the percentages of modes of different transportation for reaching the University campus.

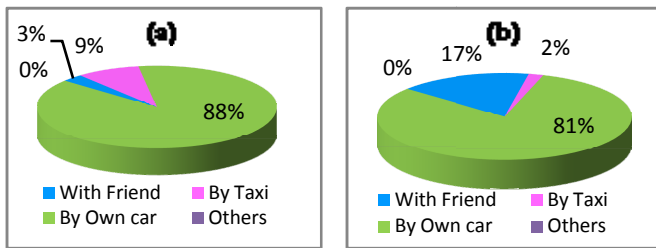


**Figure 5.** Percentages of modes of different transportation

Figure 6 shows the percentages of those whose cars have been damaged by other cars while wrong parking.

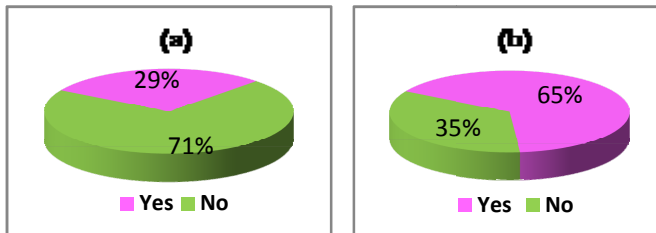


**Figure 6.** Percentages of vehicle damages during car parking

Figure 7 shows the percentages of those whom are able to find the responsible persons for damaging their cars in the parking lot.

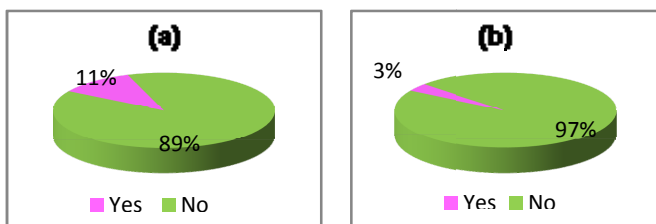


**Figure 7.** Percentages of persons who have found responsible persons for damaging other cars

Figure 8 shows the percentages of those whom cars are blocked by others cars that are parked wrong.

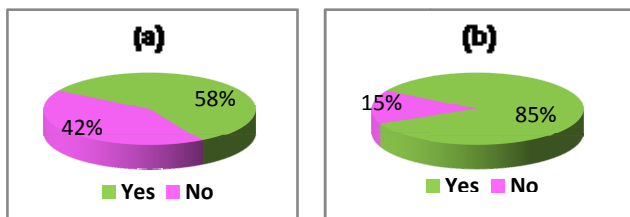


**Figure 8.** Percentages of car blockage

Figure 9 shows the percentages of time taken to clear the blockage cars.

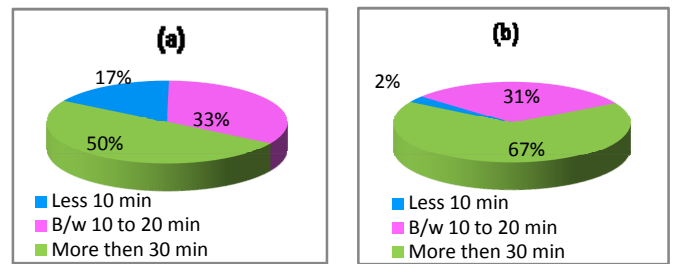


**Figure 9.** Percentages of time consumed due to car blockages

Figure 10 shows the percentages of those who have found difficulties in finding their cars in the matter of forgetting the location where they parked their cars.

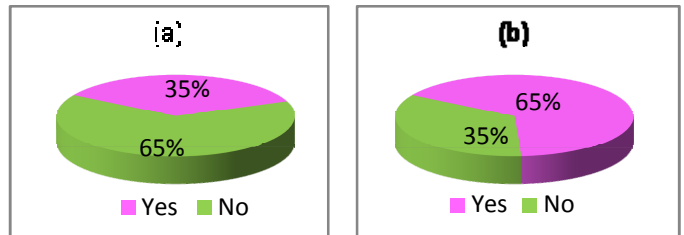


**Figure 10.** Percentages of participants forgetting the location of their parked cars

## VI. CONCLUSION AND FUTURE WORK

Car Parking problems continue to prevail and have become a major concerning issue in the University campuses. This paper proposes to develop an automated Car Parking Management and Monitoring System called (CPMMS) for Jazan University whose students, faculty and staff members are facing parking problems while parking their cars in parking lots of the University. The key concern of our proposed system is to automate the existing manual parking management system with efficient and effective use of the parking lots. This system contributes to reduce the frustration and annoyance of the students, faculty and staff members while car parking in the University parking zones. We have also conducted a survey by distributing the questionnaire to the students, faculty and staff members. The results of the survey confirm the car parking problems faced by the participants. Our future research includes the real-time implementation of our proposed system with additional features like searching for vacant parking spaces in an effective manner.

## REFERENCES

- [1] Jung-Ho Moon, Tae Kwon Ha, "A Car Parking Monitoring System Using Wireless Sensor Networks", International Journal of Electrical, Robotics, Electronics and Communications Engineering Vol. 7, No. 10, 2013.
- [2] Hongwei Wang and Wenbo He, "A Reservation-based Smart Parking System", The First International Workshop on Cyber-Physical Networking system, IEEE, pp 701-706, 2011.
- [3] Yang, Jihoon, Jorge Portilla, and Teresa Riesgo. "Smart parking service based on wireless sensor networks." IEECON 2012-38th Annual Conference on IEEE Industrial Electronics Society. IEEE, 2012.

- [4] Pala, Zeydin, and Nihat Inanc. "Smart parking applications using RFID technology." RFID Eurasia, 2007 1st Annual. IEEE, 2007.
- [5] Rahman, Mohammad Shaifur, Youngil Park, and Ki-Doo Kim. "Relative location estimation of vehicles in parking management system." Advanced Communication Technology, 2009. ICACT 2009. 11th International Conference on. Vol. 1. IEEE, 2009.
- [6] Anthonyson, Robert B. "Automated vehicle parking system." U.S. Patent No. 5,414,624. 9 May 1995.
- [7] SHANG, Huayan, Wenji LIN, and Haijun HUANG. "Empirical study of parking problem on university campus." Journal of Transportation Systems Engineering and Information Technology 7.2 (2007): 135-140.
- [8] C. Karlof, D. Wagner, "Secure Routing in Wireless Sensor Networks: Attacks and Countermeasures", In: Proc. of first IEEE international workshop on sensor network protocols and applications, May 2003.
- [9] A. Wood, J. A. Stankovic, "Denial of Service in Sensor Networks," IEEE Computer, 3 (10):54-62, October 2002.
- [10] Wazir Zada Khan, Yang Xiang, Mohammed Y Aalsalem, Quratulain Arshad, "Comprehensive Study of Selective Forwarding Attack in Wireless Sensor Networks", IJCNIS, vol.3, no.1, pp.1-10, 2011.
- [11] C. Hartung, J. Balasalle, and R. Han, "Node Compromise in Sensor Networks: The Need for Secure Systems", Technical Report Technical Report CU-CS-988-04, Department of Computer Science, University of Colorado at Boulder, 2004.
- [12] W. Z. Khan, M. Y. Aalsalem, N. M. Saad, and Y. Xiang, "Detection and Mitigation of Node Replication Attacks in Wireless Sensor Networks: A Survey," International Journal of Distributed Sensor Networks, vol. 2013, Article ID 149023, 22 pages, 2013. doi:10.1155/2013/149023.
- [13] W. T. Zhu, J. Zhou, R. H. Deng, and F. Bao, "Detecting Node Replication Attacks in Wireless Sensor Networks: A Survey," Journal of Network and Computer Applications, vol. 35, no. 3, pp.1022-1034, 2012.
- [14] Wazir Zada Khan, N.M. Saad, Mohammed Y. Aalsalem, "Scrutinizing Well-known Countermeasures against Clone Node Attack in Mobile Wireless Sensor Networks", International Journal of Grid and Utility Computing (IJGUC), 4 (2), 119-127, 2012, (ACM, Scopus).
- [15] John R. Douceur, "The sybil attack." In Peer-to-peer Systems, pp. 251-260. Springer Berlin Heidelberg, 2002.
- [16] James Newsome, Elaine Shi, Dawn Song, and Adrian Perrig. The sybil attack in sensor networks: analysis & defenses. In IPSN '04: Proceedings of the third international symposium on Information processing in sensor networks, pages 259-268, New York, NY, USA, 2004. ACM.
- [17] Chris Karlof and David Wagner. Secure routing in wireless sensor networks: Attacks and countermeasures. Elsevier's AdHoc Networks Journal, Special Issue on Sensor Network Applications and Protocols, 1(23):293-315, September 2003.
- [18] Wassim Znaidi, Marine Minier, and Jean-Philippe BABAU. Detecting wormhole attacks in wireless networks using local neighborhood information. In In IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Cannes, French Riviera, France, September 2008
- [19] A.D. Wood, J.A. Stankovic, and S.H. Son. Jam: a jammed-area mapping service for sensor networks. Real-Time Systems Symposium, 2003. RTSS 2003. 24th IEEE, pages 286297, 3-5 Dec. 2003.
- [20] Wenyuan Xu, Ke Ma, W. Trappe, and Yanyong Zhang. Jamming sensor networks: attack and defense strategies. Network, IEEE, 20(3):4147, May-June 2006.
- [21] Van Deursen, Ton, and Sasa Radomirovic. "Attacks on RFID Protocols." IACR Cryptology ePrint Archive 2008 (2008): 310.
- [22] Van Deursen, Ton, and Saša Radomirović. "Algebraic attacks on RFID protocols." In Information Security Theory and Practice. Smart Devices, Pervasive Systems, and Ubiquitous Networks, pp. 38-51. Springer Berlin Heidelberg, 2009.



Dr. Mohammed Y Aalsalem is currently Dean Faculty of Computer Science and Information System, Jazan University, Kingdom of Saudi Arabia. He received his PhD in Computer Science from Sydney University. His research interests include real time communication, network security, distributed systems, and wireless systems. In particular, he is currently leading in a research group developing flood warning system using real time sensors. He is Program Committee of the International Conference on Computer Applications in Industry and Engineering, CAINE2011. He is regular reviewer for many international journals such as King Saud University Journal (CCIS-KSU Journal).



**Wazir Zada Khan** is currently with Faculty of Computer Science and Information System, Jazan University, Kingdom of Saudi Arabia. He received his MS in Computer Science from Comsats Institute of Information Technology, Pakistan. His research interests include network and system security, sensor networks, wireless and ad hoc networks. His subjects of interest include Sensor Networks, Wireless Networks, Network Security and Digital Image Processing, Computer Vision.



**Khalid Mohammed Dhabbah** is pursuing his bachelor degree in Computer Science at Faculty of Computer Science and Information System, University of Jazan, Kingdom of Saudi Arabia. He is also Head of Student Council.