Intelligent Car Parking Management System On FPGA

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Abstract— Car parking has become an immense issue, especially in big cities. There are two main reasons: Firstly, the growth in population, secondly, the security. Moreover, the car theft has become an evil art haunting drivers. In this paper, we provide an interface and a software/ hardware module for Intelligent Car Park Management System (ICPMS). The ICPMS will provide an extensive management for vehicles including parking facilities and security. The ICPMS is validated using a test case scenario and extensive experimentation proves the feasibility of the approach.

Index Terms—Car park management system, Verilog HDL, wireless sensor network, FPGA.

I. INTRODUCTION

Due to the technological innovations man is leading a comfortable life. But at the same moment these advancements have at times become troublesome. The number of people using their own cars has increased exponentially in the past ten or fifteen years. The car parking has become an immense issue especially in big cities. Two main reasons can be cited for this. One reason is the growth in population and the other is the security. Car theft has become an evil art nowadays. Now the question arises, is it possible to introduce such a system that would solve all these issues and will be intelligent too. We have provided an interface and software/ hardware module which is validated using a test case scenario. The extensive experimentation proves the feasibility of the approach. ICPM solves all the issues related to car parking such as finding free parking slots, improved invoice system and certainly the security issues. The work is aimed at providing such a system that would be feasible in the third world countries like Pakistan. Our approach is cost effective and it covers all the features of a complete intelligent car parking management system.

The central idea of the project came from the troubles we face in parking our cars in our daily routine. The inspiration was always there but it required a rock-solid approach. The nuisance of parking cars is escalating day by day. Indeed a good design was required. For that a literature survey was done so as to confirm that that this effort should not be a repetition of anything accomplished before. The reference paper [1] is about the Car-Park Occupancy Information System. This is implemented in Matlab and used cameras for finding the free parking slots. With this system, images captured by a surveillance camera were processed in real-time to identify the occupancies of the parking lots. This occupancy information is further processed by a central control unit and distributed to display panels located at strategic locations at the parking area. The drivers can easily find a vacant parking lot based on the information displayed on the panels. An approach using WSN (Wireless Sensor Network) based intelligent car parking system [2], in which wireless sensors are deployed into a car park field, with each parking lot equipped with one sensor node, which detects and monitors the occupation of the parking lot. The status of the parking field detected by sensor nodes is reported

periodically to a database via the deployed wireless sensor network and its gateway. A camera based surveillance system [3], uses sensor nodes equipped with low-cost microphones to localize acoustic events such as car alarms or car crash sounds. [4] Presents another parking scheme for the car parking management systems, it uses the vehicular communication for finding the free slot in a congested car park and theft prevention. It provides real-time parking navigation service and also helpful in theft prevention and provides the drivers parking information. Dusan et al. [5] proposed a technique for car park management based on combination of fuzzy logic and integer programming techniques provided an online mechanism for the acceptance and rejection of car driver's request for parking. Firstly it developed a number of best parking strategies for different situations and then used learning algorithm to choose best solution a specific situation based on the training data. A parking system for guiding the drivers to an appropriate parking using the PGI (Parking Guidance Information) signs and the arrival time estimation at the park was based on driver characteristics, trip patterns, car park attributes and the car park availability [6]. The underlying assumption of this model is that the choice of the car park does not change after entering the city even if the statistics are changed then the initially perceived. This model does not provide any security and theft prevention. Shuo-Yan et al. [7] proposed an intelligent agent system that helped in selecting the optimal price car park. Bong et al. [8] used an image based parking system for finding out the vacant parking lot in a congested car park. Security surveillance cameras were used for acquiring the images. This background study has provided us an in-depth knowledge of the current existing car parking systems around the world.

II. ALGORITHM

We have divided the proposed ICPMS into following different modules.

A. Car Entering Module

In Car Entering Module, as the car enters the lot, it is detected by the IR Sensors. The IR Sensors provide the pulse to the FPGA which assumes that an input is detected and thus the car is entered into the parking lot. Now as the car enters the lot, the car is directed to park in the first empty slot available. This is an important feature because the user doesn't need to search for the empty slot rather it is directed to park in the empty slot number. Thus our parking system's approach is to provide ease to the users.

B. Car Exiting Module

In Car Exiting Module, as the car leaves the lot, it is detected by the IR Sensors. The IR Sensors provide the pulse to the FPGA which assumes that an input is detected and thus the car is exited out of the parking lot. A significant task here is to keep track of the slot number from which the car leaves. This slot number should be tracked so that at exit we can display the right invoice and the security code, which the user will provide, is correctly matched. As the car exits, it is shown an invoice depending upon its stay in the lot. Similarly, the user is asked to provide the security code which was assigned to it initially at the time of entering. As he enters the code, it is matched via the Security Code Module and if found correct, the car is allowed to exit.

C. Security Module

In Security Code Module, as the car enters the lot, it is assigned a security code. Now the user needs to keep this code with him at a safe place because when he will go out of the lot with his car, the Car Parking

Management System will ask for that code. He will be only allowed to leave the Parking Lot, if the given code is correct. Looking at the implementation point of view, the Security Code needs to be saved in a memory for further usage or requirements. Each slot number should have its own Security Code to distinguish between the slots and this code generation should be random and tough to crack because this code is the basis of all the security our system is providing. The type of code is an issue. We can have numbers or alphanumerical values or bits. We have chosen the bits as our code type, as they are difficult to crack.

D. Invoice Module

In Invoice Module, as the car exits the lot, it is shown the invoice or the bill. In other words the payment details are displayed to the user, who leaves the car park. If a day was passed, then the invoice changes accordingly. We have developed a procedure to calculate invoice. This formula keeps track of the time spent by each car in the Parking Lot.

III. DESIGN AND IMPLEMENTATION

In the design section the most significant was to outline the algorithm. Simplest possible algorithm was adopted. Fig. 1 is the flow chart of Entering module When the car enters the Car park the sensors at the main entrance detects the arrival of the car, After detecting the car's arrival by the sensors the capacity of the car park is checked, if there is a free slot in the parking lot, the car is allowed to enter the car park and a security token is assigned to it, otherwise it is shown that the park is full. After assigning the security token the car is allowed to park in specific location which is shown on the display. As our intelligent Car Park System keeps track of all the parked cars, free locations and the location where the next car should be parked so when the car is parked the corresponding values are updated, the free locations or free slots are decremented by one and the allotted slots values are incremented by one. And if this was the last free location in the lot then it is displayed that the park is full. At the end a counter is started to create invoice for it.

Fig. 2 shows the flow chart of Exiting Module. Initially the car is in the parked state, when it exits, the sensor in the slot detects it. After detecting the car the security token assigned is checked. If it is found correct the car is allowed to go to the next state which is the invoice payment, otherwise it is not allowed to exit. As our Intelligent Car Park Management System keeps track of all the parked cars and free locations, the corresponding values are updated. The free locations or free slots are incremented by one and the allotted slots values are decremented by one. The invoice is displayed to the car leaving the lot according to its stay in the Parking System.

IV. PRACTICAL REALIZATION

We have implemented the ICPMS using FPGA: Though we can realize the CMS on Microcontroller. However, the ICPMS is intended to be a modular system. In the next phase, we plan to integrate image based solution, therefore, the amount of data to be handled will be huge. A simple microcontroller is therefore not an option. Moreover, the intercommunication between the vehicles and the ICPMS will require a feasible solution and FPGA provides such an interface. The uniqueness of the ICPMS is mainly due to the target hardware i-e FPGA and splashing of the empty slot's number for a new user entering in the car park system. In this way the troubles of finding empty slot in a gigantic parking lot are resolved. Displaying the free slots available in the parking lot in different parts of a city is also an innovation in itself. The ICPMS was tested for 16 spaces.

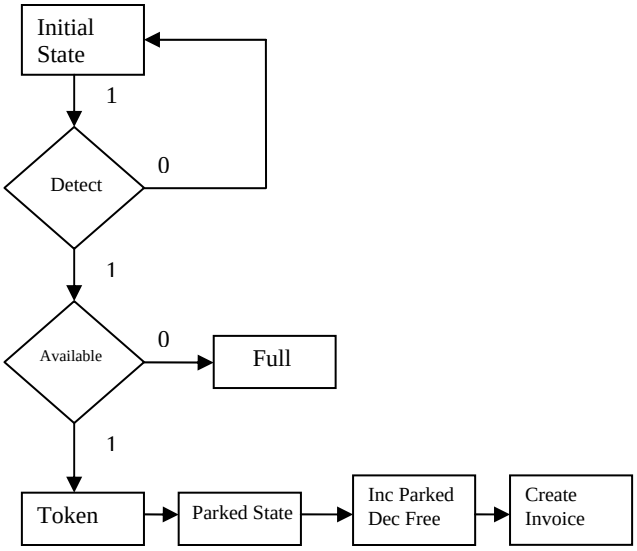

Fig.1 Flow Chart of the Entering Module

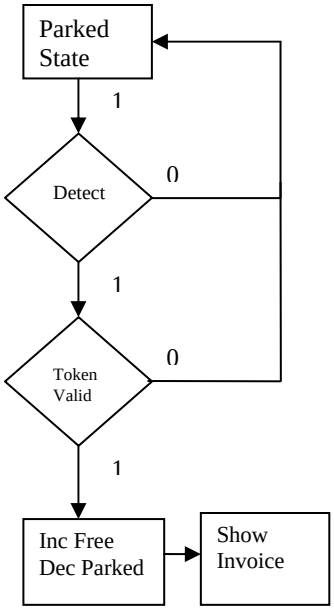

Fig.2 Flow chart of the Exit Module

Number of spaces can vary according to the capacity of a parking lot. The parking lot will sense or detect car's arrival or departure. As soon as a car enters the lot, a space is reserved for it and the space number flashed on the Display. This would guide the user to the allotted space in the lot. The system monitors the in and out traffic and updates the available spaces. When the parking lot is full, this information is flashed on the electronic boards. The system also monitors the spaces that are parked and are free. It has the knowledge about the number of cars parked, number of free slots in the Parking Lot at any instant. It creates Invoice for each entering car and splashing on the screen the net invoice whenever a car leaves. It also keeps track of the time a car stayed in the parking lot. For the security purpose, a security code is assigned to the arrived car and it is checked at the exit time, ruling out any thefts or security lapses.

V. RESULTS

After thoroughly analyzing the algorithms and design features, the programming code was written in Verilog HDL and implemented on FPGA. A hardware model of the project was accomplished. It was a complete Intelligent Car Parking Management System Model, which was tested and deployed in a parking lot. It was tested for 16 spaces. Number of spaces can vary according to the capacity of a parking lot. External hardware was interfaced with the FPGA. All the above mentioned features were checked and the project was thus acknowledged as a success. The security code feature, accurate calculation of invoice, space reservation for a newly arrived user in the parking system are the worth mentioning triumphs of our work.

VI. CONCLUSIONS

Our approach for finding the free parking slots is simpler as we don't need any camera and there is no involvement of image processing. Feeding data to a database can complicate the design even though will provide more services but we can achieve those features even without using it. Similarly WSN is an expensive and complicated technique when compared with

FPGA. We have used IR sensors for the detection of car's arrival and for the car's departure avoiding the expensive wireless sensors. Our design is simple yet it yields the desired result. It is cost effective and can be practically implementable even in countries like Pakistan. The idea was to keep it simple and innovative so that the parking system is cheap and at the same time provides the functionalities as per the constraints set at the time of designing. The automation of the project avoids any theft or mishaps which are very much probable in a common car park. Security has become a concern in our age and at the time of designing such ideas it should be scrutinized to the extent of avoiding it to the fullest. Such kind of Car Park Systems together with the security feature is really the need of the hour.

VII. FUTURE WORK

There is always room for improvement and our work can be modified and improved further. The pressure sensors can be used which are expensive but will yield accurate results. Every slot will have a separate sensor to detect the car's presence and will send the signals at the time of car's departure. Another feature that is number plate recognition can also be added to enhance the security of the Parking Lot. As mentioned in [1], cameras can be used to take the pictures of entering cars' number plates and then applying different algorithms for matching it with the originals at the time of exit. A surveillance system can be added to the system to make it more powerful. Feeding data to a database and keeping track of the frequent users visiting the parking lot and can give them discount. Many other ideas can be merged with the original project to improve its functionality and attain the perfection which is always desirable in works like these.

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