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Advanced Car Parking System with GSM Supported Slot Messenger

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Abstract: *This paper presents a design and implementation of a smart and unique car parking system to support the modern day tedious car parking design using RFID reader and PIC controller. In the presented prototype model we describe and implement a parking tower with 2 floors and 2 slots per floor on either sides of the central lift. This prototype has a central lift where the user actually mobilizes his car and then the system designed with PIC controller automatically identifies the empty slot and parks the car at the corresponding slot. A group of Sensors, Conveyor belts, motors and software are embedded together to work as a system to transport the car to its calculated parking slot. The System embedded with a real time clock helps us to calculate the time period during which the car is parked, thus helping an automatic e-commerce system to deduct the amount for the mentioned time period from the users account. The system has a GSM add-on module which will automatically respond's to the users SMS request by letting him the available slots at a given time.*
Keywords: *PIC Controller, automated car parking, sensors, GSM and RFID.*

I. Introduction

Considering the present day car parking tedious job where not only the number of cars are increasing but also the parking space is very limited. Thus it is not only a cumbersome task to find out the available slot and this includes the car movement across the multiple slots and there by even wasting a considerable amount of fuel as well. The movement of the car along the parking slots may also damage the other cars which are parked and even resulting in the traffic slowdown and congestion. Considering the present day parking systems where the user don't even have an idea of the available parking slots though there are some available slots as we they lack the monitoring system for the same. Thus the situation where a user faces the traffic congestion in parking areas is very much obvious. Thus to solve the above problem different approaches have been used to resolve the same which includes wireless sensor network system, a vision-based system, and the multi-storied parking system[1]-[4]. Car parking system designed with multi-stored space allotment is one of the most efficient and trending approach to meet the present day space requirements.

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II. Back Ground

Considering the present day problem of parking the cars, which has become a serious problem in metropolitan cities as the rate at which the private vehicles is increasing very rapidly. Though there are some parking mechanisms which are fully automated and still does not provide any mechanism, where in the user can request for the available slots prior to entering the parking area. This really makes situation even worse as some times the user needs to navigate through the entire parking area to find a parking slot. Though some of the present day parking systems say them self as automated parking systems but still use the human resources to determine and provide the data related to the available slots. Thus, considering the above mentioned facts we can conclude that the existing parking system does not meet the modern car parking requirements and does not give enough confidence to solve the car parking solution.

The Modern day electronic sensors seems to provides us enough confidence to solve the presented problem [2] and they can sense and detect, using which we can capture and collect the information related to empty parking slots. The presented system will make use of the electronic sensors in each and every parking slot and thus they would help us in providing the information related to the status of the parking slots. Though the cost of the Sensors at each of the parking slot increases proportionally with the increase in the number of parking slots however when we consider this to the employing a human resource is an effective solution as the human resources wage is increasing predominantly. The presented system is also integrated with the GSM Module so that when a user requests for the details related to the available slots the system will send a SMS text message to the user with the details related to the parking slots and the same will send the message stating "No Slots Available for Parking". Thus with the mentioned information the user can take a wise decision whether to park vehicle or not, which in turn saves the users fuel cost. This seems to be a reliable solution to the above mentioned problem as we are not only letting the user to take a wise decision but also to choose any other parking tower.

Primarily the automated car parking system relies on the advanced technology that will use mechanical

handling to be precise to handle the lift and the conveyer belts movements along with the data processing. In the presented system the driver leaves the car in the parking module lift once his RFID is authorized and if and only if system finds any available slots at that instance [5]. However during the peak parking times the user's needs to wait as the system is busy serving others requests who are already in queue. The real time clock which gets activated once the user parks a vehicle and will stop once the user has exited the parking slot and an integrated e-commerce system will automatically deduct the corresponding amount from the user's account which is tagged to the RFID of same for that period. This not only reduces the queue for parking where in the users need not wait paying the vendor for utilizing the parking slot. Additionally the system is integrated with a parking counter which will measure the total number of vehicles that have been parked.

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III. System Design

The Automatic car parking system enables the parking of the vehicles floor after the floor in a vertical fashion thus reducing the space used. The System is controlled with software that has been implemented using a PIC controller and thus reducing the time wasted by a person to find a parking slot manually and park the vehicle.

Fig. 1. Model of the proposed multi-storied car parking system

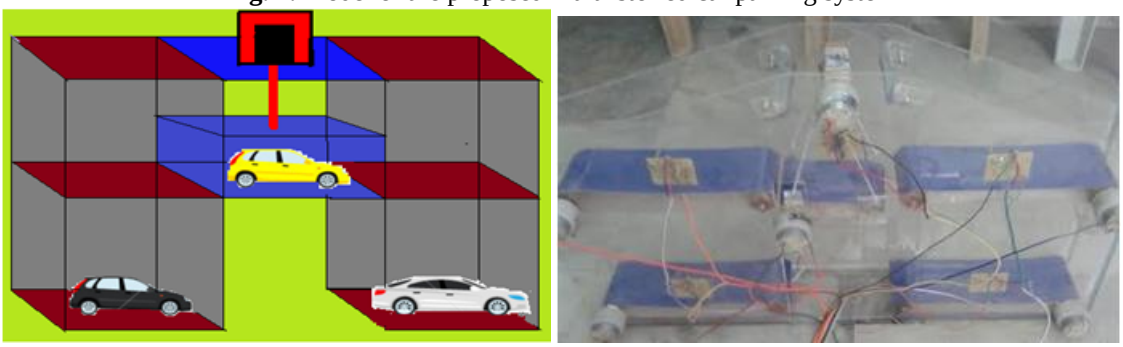

Fig. 2. Actually implemented multi-storied car parking system for simulation.

In this presented prototype, a vertical building with 2 floors, with 2 car-parking slots in each floor on either side of the central lift. It also consists of a lift to transport the vehicle to its appropriate parking level. This model was developed with DC motor drive controlled with H-Bridge and IR sensors to detect the available slot and then transport the car to its allocated parking slot. To understand the pros and cons of the proposed system it is always suggested to implement the mentioned prototype. Hence the prototype is implemented with the following hardware and micro controller based software. The hardware requirements for the prototype include PIC 18F452 microcontroller, IR sensors, relays and relay driver, DC motors, LCD display, Conveyer belts, GSM Module, Real time clock, Buzzer and other miscellaneous components.

Through the course of building the prototype we will be using the PIC C Compiler for compiling the code, which will be dumped on PIC Controller later on. MATLAB supported software will be used to capture and store the images of the Car Registration Number and Driver [6]-[7]. As a hardware tool we will use the Express PCB for designing and deploying the entire setup.

The proposed model prototype is shown in the fig.1 and 2. The LCD display at the entrance will provide the information related to the parking slots available along with the welcome messages. Each and every parking slot is assigned with an IR Sensor, Conveyer belt with transport mechanism integrated to a DC motor drive. The central lift section has a separate DC motor which will move the lift the appropriate floor and once it reaches the respective floor where the car needs to be parked, the conveyer belt will be activated to move the car from the lift to the parking slot in that floor, and thus the car is parked. Once the Car is parked the IR sensor will no longer send the free slot signal and thus the system knows which all parking slots are filled. The LCD display at the entrance will poll all the IR Sensors at the regular intervals and also when a car is parked and un-parked, so as to display the available slots.

Once the user finds any available slots in the LCD display, the user proceeds to the RFID tag reader sensor and presents his RFID card to the Sensor. Upon successful validation of the RFID the webcam present at the entrance will take the picture of the Car Registration number and Drivers image automatically and save them for further reference. The user then places the car on the entrance conveyer belt and leaves the car. This conveyer will move the car to the lift and then the lift will move to the nearest floor where the parking slot is available. The car is then parked in the parking slot as mentioned earlier and the count is increased in the LCD display and the real time clock for that parking slot will be activated. The lift will now move to the ground floor or neutral position to serve other's requests.

When the user presents the RFID Card at the entrance, system then searches for a parking slot where the car is parked using the same. Once the system finds out the corresponding parking slot the lift will move to the parking slot and then activates the conveyer belt at that location and thus the car is moved to the lift. During the same the real time clock is stopped and will send the time period during which the car is parked to the central system along with the RFID so that it can debit the money from the user's bank account. The lift will then move the car to the ground floor where the user can drive the car exit from the parking station.

Regarding the implementation of Net Banking integration, which the PIC Controller does not support directly, thus the PIC controller will just send the duration and RFID details to a central server. Once the central server receives the same it will use a software module running on the same to deduct the amount from the users account. The software module design is not discussed here and as a part of our implementation we will just use the same as a vendor. It is this software module which will request to different banks using the appropriate API to request for the amount transfer from a corresponding account.

Our prototype has a reporting feature where in a counter will be used to determine the number of cars that were parked on that day and which will be displayed on the entrance LCD system.

The System is also integrated with GSM SIM 900 Model controller [8]-[10] which will respond to a user's SMS request (Ex: A message AVAILABLE_PARKING_SLOTS sent to GSM number : 9985123456) for the empty parking slots by finding out the empty parking slots via the PIC Controller with the help of the IR Sensors fitted at the parking slots. An example message mentioning the available parking slots would be "Available Parking slots 2, 3 @ 10:30 AM of 20/4/2014" Or "Currently No Parking Slots are available". Thus the system with all these capabilities provides an accurate, efficient and reliable method for car parking for the present day metropolitan cities.

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IV. System Architecture

Architecture

Fig.3 shows the system architecture of the proposed model. It uses PIC18F452 Controller, LED indicators, LCD display screen, RFID card reader, GSM SIM 900 Module, Real-time clock and a Buzzer. A number of IR Sensors equal to the number of parking slots are connected to the microcontroller to detect whether the parking slot is empty or not. A group of conveyor belts and DC motors are used for moving the cars in and out and also to operate the lift.

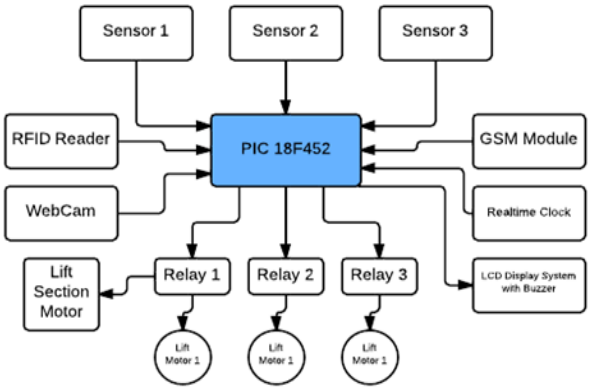

Fig.3. System Architecture of the prototype model

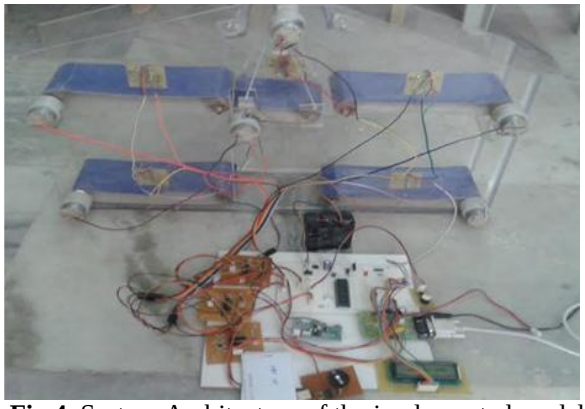

Fig.4. System Architecture of the implemented model

Execution

The presented figure can be divided into 2 parks, the first being the parking tower and the second being the assembled IC with PIC controller and other mentioned components. Once the system is initiated the central lift will be moved to the ground floor and all the IR sensors are activated to know the status of the empty slots and the system will wait for the input to the RFID Reader.

Now let us discuss the system actual execution in the details. Once the car is placed in the conveyer belt (blue colored belt) of the central lift and upon presenting the RFID, the System will read the RFID and if the same is not valid the buzzer will be blow to alert the user. However if the same is a valid one, the central lift will move the respective floor and once reaching the floor successfully the conveyer belt in the lift and the floor are activated for a desired calculated time and the car in the lift if moved from the central lift to the parking slot. Once the car is moved from the central lift to the parking slot the real time clock is activated and the time stamp is noted. Then the central lift will move to the ground floor and the details related to the car parking slot are displayed in the LCD display.

Now let us see the series of messages in the LCD display which are displayed through the course of the car parking work flow.

Fig.5. LCD display showing the message "Waiting for Vehicle" reaches the central lift.

Fig.6. LCD display showing the message "Show Tag" once the car once the system is initiated.

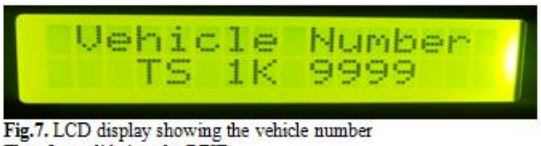

Fig.7. LCD display showing the vehicle number The after validating the RFID.

Fig.8. LCD display showing the message during Motor initialization.

Fig.9. LCD display showing the message during the period the system is sending the SMS message to the owner.

Fig.10. LCD display showing the message during the period when when the car is moved from central lift to the slot.

Coming to the car exit scenario, once the user presents the RFID using which a car is parked. The System will query its internal memory to find out parking slot and then the lift will move to the corresponding floor and after reaching the floor the conveyer belts in the slot and the lift activated to move the car from the slot to the lift. Then the lift is moved to the ground floor. During the same the real time clock will be pinged again to know the time stamp so that using the time stamp noted earlier and now the duration during which the car is parked and the same will now be sent to the PAYPAL server using the GSM SIM GET or POST HTTP method and which will deduct the amount from the users account.

Now let us see the series of messages in the LCD display which are displayed through the course of the car exit work flow

Fig.11. LCD display showing the message "Show Tag" once the user reaches the central lift for un parking a car

Fig.12. LCD display showing the vehicle number after validating the RFID

Fig.13. LCD display showing the message during the motor initialization.

Fig.14. LCD displays the message before moving The parking slot to the central lift

V. Conclusion

The effective and robust hassle-free payment integrated multi-storied car parking prototype design along with the development is presented in this paper. This presented system seems to be one of the promising solution for the metropolitan cities where the exiting parking traffic needs to wait for long while for the cash transactions related to the parking, which in-turn will cause the traffic congestion. This promising system not only reduces the fuel usage to find the parking slot and time to find a parking slot but also provides additional capabilities to the user which is nothing but the SMS request mechanism with which a user can take an intelligent decision to approach a parking station or not while he is at the home or while is on the way to the parking station. Although the current system meets the present day challenges as it has many advantages compared to others, however there are some real time implementation issues such as we are only supporting the registered RFID's and also the user needs to get the banks approval so that the system can deduct the money from the users account. The System can be further enhanced with the below enhancements.

1. Using individual lifts one for parking and one for un-parking.
2. Updating the user by sending an SMS message if the car is parked for more than a maximum limit of time.
3. Designing a UI with the help of MATLAB software

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