Design and Development of Sensor Based Multilevel Parking System

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Abstract. The purpose of this paper is to create a sensor based multilevel parking system which will assist the vehicle to directly proceed to the desired place or to the nearest parking location. As the vehicle population is increasing in our country the parking facilities for the vehicles have become troublesome. Due to this the parking arrangements and layout in huge buildings need to be improved. Thus, this system plays an important role in the smooth functioning of parking of vehicles by eliminating human errors which lead to accidents and ensuring the vehicle to reach its destination space without wastage of time and congestions. The system consists of a controller Arduino Mega 2560 which will receive the vacancy data from the IR sensor of the various levels once a human input is been given to the system. The data of vacancies will be displayed on the LCD and the system will check for nearest vacant area based on the algorithm to the destination and guide them to the available space to park. The system will also determine the parking time based on the entry and exit of the vehicle and the person will be charged accordingly.

Keywords: Design, Arduino, Sensor, Parking and Building

1. Introduction

The ever-increasing population had led to a tremendous increase in the vehicles. Thus, creating parking issues. People spend their valuable time on searching parking slots to park their vehicles and it is indeed a tedious job to find a parking space. Many issues arise during parking such as parking at uneven places, disturbance in large parking areas, human error to guide the vehicle etc. Thus, the aim is to eliminate these problems by developing a sensor based multilevel parking system which is affordable and efficient. The system functions because of the inexpensive IR sensors that are utilized in the multi level car parking where each parking slot has an installed sensor which detects and monitors to present the vacancies of the parking slots. The information acquired by the sensor is stored into the database and is displayed on the LCD screen. The database is for execution of various functions of this application such as locating the number of vacancies in the parking area, the entry and exit time, the parking fees. Based on human input of the required level, the system will allot the user a particular vacant slot. And if there is no vacancy on the user desired level, the system will automatically allot a slot which is nearest to our desired input level. This system will be beneficial for vehicles to directly move towards their assisted parking area on the required floor without having the driver to search for a parking lot. Thus, ensuring saving time and avoiding any congestion. The system can also charge the parking fees based on the time for parking determined by the entry and exit of the vehicle.
Automobiles have been a means of convenience since ages, assisting humans to travel from one place to another. Thus, increasing in number and giving scope to improvements in the vehicle parking sector. Hence the wireless sensors have attracted large attention to be used for the betterment of the autonomous parking technique [1]. Previously, various wireless sensor networks have been proposed and tested with different sensors for maximum efficiency [2-5]. The use of cameras have been observed in few techniques to acquire the parking space knowledge, however they have drawbacks of cost and transmission of such large data produced by video [6]. The method of collecting information has various possible techniques and similarly the transfer of data too can be classified using different methods. One such method is by using Zigbee which enables cost effective data transfer through the high-level communication protocols however this method exhibits low data transfer rate [7]. Road side parking has been considered as a prime witness to congestion and incorrect manner of parking, thus, availability of the parking slots on the roadside is recognized by image analysis [8]. Along with different methods and techniques that can be implemented, the infrastructure of the confined parking area is also considered as a factor for the smart parking system [9]. It is deduced that wide area architecture is better for sensing networks. The need of parking survey is a must for the improvising of system, the old method of manual survey where the vehicle plate numbers were noted has been advanced by the modern survey technique to give results efficiently [10-13].

The purpose of the paper is a smart multileveled parking system is vital for the furtherance of the car parking.

2. Design of sensor based multilevel parking system
The most crucial aspects of the project are to identify the most ideal sensor for the application and ensuring the practicality of the entire system. The system should produce reliable outputs at any given instance and the data should have sufficient resolution so it can be examined and analysed correctly. To ensure these parameters were adhered to, the following considerations were made; Figure 1 shows the conceptual flowchart including the LCD.

![Conceptual Flowchart including the LCD](image)

2.1 Selection of Sensors
Choosing the correct sensor was by far one of the most important aspects of the project. To ensure this, several sensors were analysed. Infrared technology is widely utilized and this type of technology is specifically benefitted for wireless application. The main areas are sensing and remote controls. Thus, IR sensor was selected for the detection of an object for this system. The IR sensor principle and working as an object detection sensor is explained using the figure2. An IR sensor consists of an IR LED and an IR Photodiode and together they are called as photo coupler or opto coupler.

An important aspect for the sensor is the position of the IR LED and the IR receiver. The LED is placed in front of the IR receiver, this method is named direct incidence setup and, in this condition, almost all the radiation from the LED falls on the receiver. The infrared transmitter and the receiver follow a line of sight communication. Thus, if an obstruction is witnessed, it restricts the radiation from reaching the emitter by reflecting the radiation or absorbing the radiation. When traffic density is lower, sensors and the system will switch to standby mode for reducing the energy consumption.

2.2 Controller selection
Numerous controllers are readily available in the market, thus, choosing the most ideal
controller was an important task. The system required a controller with thirteen analog pins. Therefore, it was decided that Arduino Mega 2560 was the most suitable microcontroller for the initial prototyping. The Arduino mega provided a sufficient number of analog pins and can be easily programmed through the Arduino IDE. Moreover, the Arduino platform has ample support in the form of forums and discussion platforms in case of the need for troubleshooting. The sensors are integrated to the pins of the controller Arduino and the pins are defined in the IDE platform. The algorithm of the system is built in IDE.

2.3 LCD module (2X16 characters)
Dot matrix LCD modules is used for display the parameters and fault condition.16 characters 2 lines display is used. It has controller which interface data’s and LCD panel. Figure 2 shows the LCD is connected with the controller and the output data which in this system is the number of vacancies’ is displayed on the screen for Floor 1, 2 & 3. Since LCD consume less power, they are compatible with low power electronic circuits, and can be powered for long durations.

![Figure 2 LCD -Floor display](image)

2.4 Software/application development
An application is developed in Java netbeans and the database is stored in SQL. The vacancies of the slots are displayed in the application with the help of the algorithm and the data is stored, it is refreshed every 3 seconds. The entry and exit time of the vehicle is noted and stored in the database which helps the vehicle to be accurately charged for the parking time. This application will be displayed online for any individual to check and book an empty slot for the vehicle parking.

3. Results and discussion
Figure 3 shows the CAD design prototype model. Thus, developed, successfully displayed the vacancies of the parking lot based on the sensor output. When the driver arrives and gives the input to the system, the system will detect the vacancies of the parking lot as per driver’s requirement or the nearest vacancy. The system will allot the empty slot to the driver. The system developed in efficient and the parking information keeps on updating every three seconds in the backend as well as on the web interface. The prototype model is a replica of the CAD model created in Solidworks. After several iterations it was finalized and developed into a working model.
Figure 4 shows the parking system model with IR sensor placed in every parking slot.

The parking system model with IR sensor placed in every parking slot determined the object, the vehicle, and Thus, the vacancies of parking was shown on the screen which helped the driver to choose the desired parking lot according to the drivers requirements. The main screen displays the parking information, showing no of slots free in each level. This data is detected by the sensors, Netbeans Java displays this backend data and the database is updated and stored in SQL.

Figure 5 shows the backend data where we can interpret the level number and the vacancies slot. S1,S2,....,S8 stands from the slot number and A stands for absent, stating no vehicle is present in these slots.
The two methods for allotting the parking slot to vehicles are pre-booking and instant. The pre-booking of parking slot can be selected by the owner through the online portal. The online portal will display the availability of the slots and the customer can pre-book their slot according to their requirement. The payment for pre-booking will start 30 minutes before the entry time till the vehicle exits the parking slot which will be detected by the sensor. Then the application calculates the total time period of parking and accordingly charges the customer. This will ensure that the specific parking is secured for the owner. The other method is instant parking where the customer can book a slot on the moment itself based on the number of vacancies available at that time. The parking charge is based on the in-and-out time of the vehicle. The data obtained from this system is helpful for the drivers to park their vehicles in the assigned slot. This ensures that the parking spaces are allotted to the right owner depending on their entry time and the availability of the parking slots. The database stores the entry as well as exit time and thus, from this data, the time duration is found out and the vehicle is charged accordingly the parking fees.

4. Conclusion

Thus, a system as such will increase the efficiency, reducing the amount of time spent on finding a parking location nearest to the destination. This system will reserve a parking slot for the vehicle without any extra charge. However, there were many hurdles while executing the prototype. Selection of sensors was a hard decision and after conducting many tests the decision of using IR sensors was made. The transfer of parallel data from the Arduino to the software platform also had its own complications and after regressive work the problem was solved. Parking in India continues to remain very labour intensive. The most popular method is pay on exit, and the majority of parking systems use simple manual ticket issue at entry, with a flat rate for all day parking and payments made in cash. Electronic handheld ticket issuing machines are also becoming popular. One future improvement; the parking slot can be secured by barricades which can be automatically opened by scanning the RFID which will be produced when the vehicle slot is booked. Prepaid RFID card will make the entry and exit hassle-free and cashless. This can cause tremendous convenience in terms of change, exit time etc. Similarly, all our parking lots are insured to ensure that consumer and the vehicle are protected in the parking lots. The system will remove the human errors for parking in individual slots. This system will remove the traffic congestion at the multilevel parking’s.

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