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Structural Arduinomated Parking Allocation System

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Abstract - *We aimed to deploy an Arduino based RFID mechanism to allot parking facilities for two, three and four wheelers. We planned to in co-operate this system in shopping complex where the vehicles have to wait in long queue to get their respective parking slots thereby avoiding traffic. The current mechanism requires man power but we plan to implement a fully automated system. The flow will be such that all the customers coming in the complex will be provided with a rechargeable smart C-card, which has a RFID tag embedded in it. As soon as the customers scans the card through the RFID tag reader following things will be noted in the data base. If it's the customer's first visit then a message stating that a new registration number has been detected will be displayed .At the same time a permanent registration number corresponding to that card will be assigned. Entry time will also be stored so that at the time of exit appropriate amount will be deducted depending on the duration of parking. Simultaneously in the backend we plan to implement the data structures for allotment of the car parking which will be displayed in the GUI.*

***Keywords*—RFID, Arduino, Graphical User Interface, Algorithms, Linked List, Binary Search Tree, Queue**

1. INTRODUCTION

The searching of parking consumes a lot of barrels of the world's population every day. Car parking problem is a major contributor in congestion of traffic and has been, still a major problem with increasing vehicle size in the luxurious segment and also confines parking spaces in urban cities. The rapid growth in the number of vehicles worldwide is intensifying the problem of the lack of parking space as shown in Chart 1. As the global population continues to urbanize, without a well-planned, convenience-driven retreat from the car, these problems will worsen in many countries. Inefficient use of existing parking capacity and difficulties with parking regulation and pricing are some of the major reasons why we had to implement such idea.

Do not use abbreviations in the title or heads unless they are unavoidable.

2. LITERATURE REVIEW

Before going into the depth of this project we went through some research papers to bring out the uniqueness in the current system and our proposed system. As the number of vehicles are increasing day by day in rapid manner. It causes the problem of traffic congestion, pollution (noise and air). To overcome this problem, we saw different papers and different solutions to this particular problem were provided. For example, [1] A FPGA based parking system was proposed. In this paper, parking system is implemented using Finite State Machine modeling. The system has two main modules i.e. identification module and slot checking module. Identification module identifies the visitor. Slot checking module checks the slot status. These modules are modeled in HDL and implemented on FPGA. A prototype of parking system is designed with various interfaces like sensor interfacing, stepper motor and LCD.

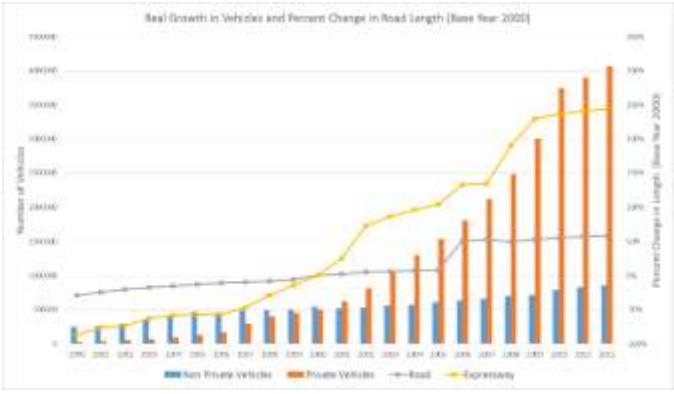

Chart -1: Stats showing growing parking problems

[2] There has been a fever researched documents which has shown implementation of multilevel driver assistance system to aid in the parking process. The development of this system is described within the iCAN (intelligent car navigation systems) project framework. A parking assistance system, parking administration system, and embedded sensor system are described. The general architecture of a driver assistance system based on path planning and human-machine interface (HMI) modules is proposed. The paper has focused on describing the parking assistance system development using this architecture. The parking possibility region-based path-planning method proposed for implementing the proposed architecture is described, as is the design of the system's HMI. A prototype of the parking assistance system based on the proposed architecture was constructed. The results of lane and row parking experiments conducted using the prototype system was accurate but considering the real-time operation of the system was not effective. Also its major flaw was implementing the architecture in large scale.

[3] Finding a parking space in most metropolitan areas, especially during the rush hours, is difficult for drivers. The difficulty arises from not knowing where the available spaces may be at that time; even if known, many vehicles may pursue very limited parking spaces to cause serious traffic congestion. In [4], we design and implement a prototype of Reservation-based Smart Parking System (RSPS) that allows drivers to effectively find and reserve the vacant parking spaces. By periodically learning the parking

status from the sensor networks deployed in parking lots, the reservation service is affected by the change of physical parking status. The drivers are allowed to access this cyber physical system with their personal communication devices.

The review proved that there are several systems available at the market but considering the cost-effectiveness and time complexity our algorithm supersedes the other systems.

3. METHODOLOGY

Our algorithm along with hardware implementation focuses on achieving real-time operation along with minimizing the time complexity of the scenario.

As the customers arrive at the parking check point they will be stopped at the barricade. With the parking card issued to the customers by the mall people, they will get it scanned by the RFID scanner situated just outside its car window screen.

The EPC (Electronic Product Code) detected by the RFID tag will be stored in integer format in the form of registered data and will be send to the GUI. For the allocation of the parking slots we have worked on data structures in the back end.

The registered data will be inserted in a queue which follows the FIFO condition. Now corresponding to each registered number a token will be issued which will signify the parking slot assigned. The registered number will then be removed from the queue (dequeue) and the token corresponding to each registered number will be inserted in the binary search tree. If at any point of time a car wants to make an exit from the parking slot, then then the respective token will be searched in the tree and removed and the remaining tokens will further be sorted in BST format.

The real-time operation of the system is carried out which can be install in areas where parking system is required. The system focuses on adapting the algorithm and utilizing multithreading concepts to achieve real-time operation thereby achieving least delay possible.

Our complete system is divided into four subsystems which are implementing of hardware for RFID allocation, implementing of algorithm for car parking allocation, implementing GUI for dataset creation and implementing GUI based real-time operation system.

4. INTEGRATED IMPLEMENTATION OF MODULE

4.1 RFID HARDWARE SYSTEM

RFID uses Electromagnetic fields to automatically identify and track tags attached to the objects, which contain electronically stored information.

Radio-Frequency Identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags.

This technology incorporates the use of electromagnetic or electrostatic coupling in the RF portion of the electromagnetic spectrum to uniquely identify an object. RFID tags contain a chip which holds an Electronic Product Code (EPC) number that points to additional data detailing the contents of the package.

The EPC code generated is further converted into a permanent registered number assigned to a customer.

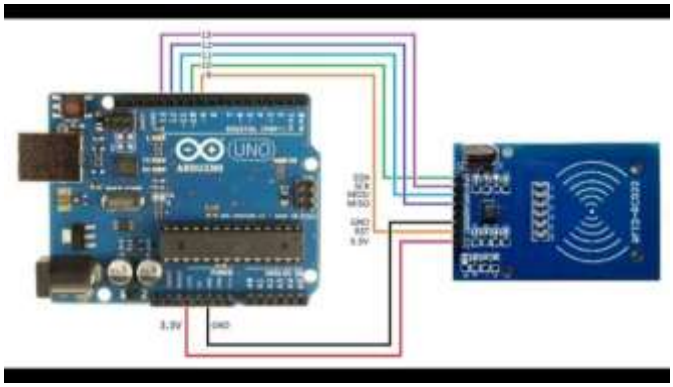

Fig -1: RFID connections with Arduino

The concept of singly linked lists is utilized in developing the hardware system for generating the EPC code during the allocation system. While checking-in, it first checks the validity of the RFID card and if valid then generate the EPC code of the same which is stored in a linked list.

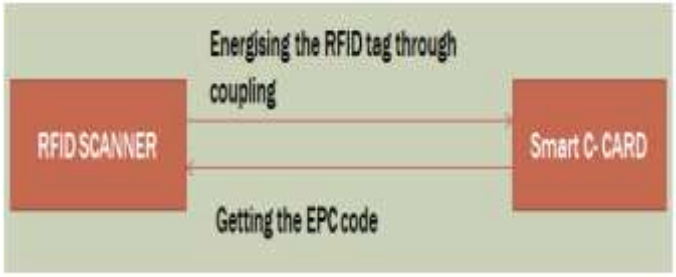

Fig -2: RFID block diagram

4.2 ALLOCATION ALGORITHM

A. Queue:

The registered card number corresponding to each vehicle will be inserted in the Queue but the parking slots will not be allotted. The reason for implementing a Queue is to avoid the traffic at the parking entrance.

B. Binary Search Tree:

Now the registered number stored in the Queue will be De-queued and inserted one by one in the Binary search tree (BST). At each node of the binary tree we will be having the token number which will indicate the parking slot assigned. Now at one particular time if any vehicle is to be removed then BST provides an easy traversal to the desired node

which needs to be emptied. The algorithm ensured the redundancy checks as well as fatal error errors like invalid input to give the necessary message based outputs.

Fig3 Indicates the base structure followed during the implementation of the algorithm. C language was utilized to write the code and prove the implementation of it. The algorithm ensures that the allocation of two wheelers, four wheelers and three wheelers are separate considering the parking structures designed has different allocation area for different types of vehicle

C. Linked List:

As explained we have assigned the parking slots in each node of BST. Now the application of linked list comes here where in each node apart from the registered data type we have two pointers i.e. the left and right pointer which contains the address of the next node.

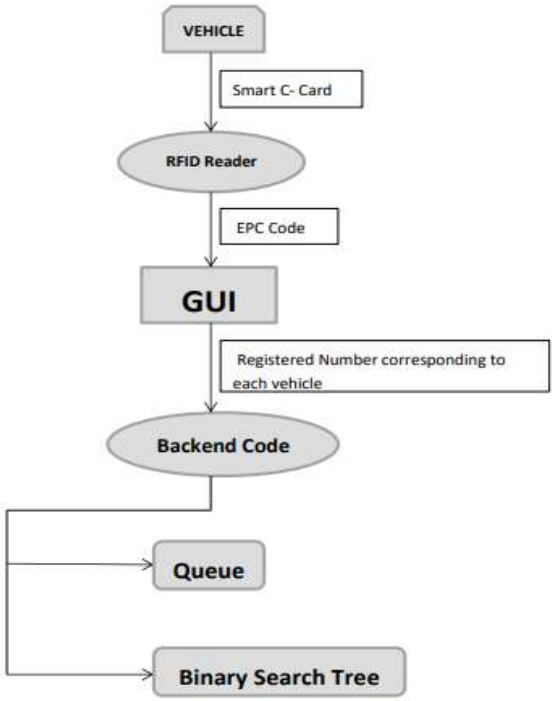

Fig -3: General Architecture of the system

D. Data base Creator GUI implementation:

Using QT designer and python the GUI implementation of the algorithm was designed. The database creator algorithm is used when a new user has made an entry in the car parking allocation system. Several user details are asked liked name, age and EPC code generated and well as the type of vehicle registered into.

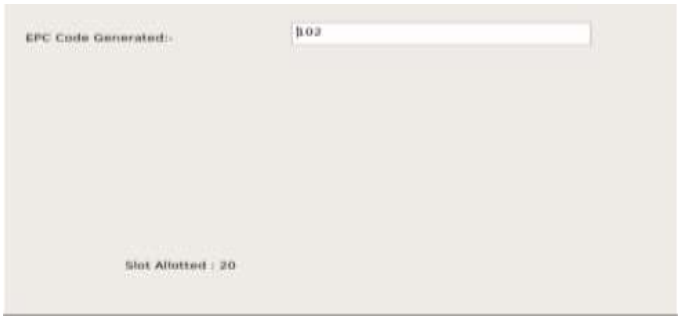

Fig -4: GUI implementation of the allocation system.

The GUI is implemented on python using QT designer and complete algorithm was re-written in python.

Fig -5: GUI implementation of the vehicle vacating system

For the real-time implementation it utilizes the concept of multithreading. Two threads are designed one for allocation using the proposed algorithm and other for extracting the EPC-code value generated by the hardware. The allocation system ensures that the allocation number generated depends on the type of vehicle and the queue in which the vehicles are entering. The algorithm also has one more thread which will calculate the time for which the vehicle has been parked in the parking area so that in commercial parking area revenue can be generated.

5. DETAILED TIME COMPLEXITY ANALYSIS

We have considered 2 cases. Let the number of vehicles be indicated by n

- Number of vehicles =4
- Number of vehicles =8

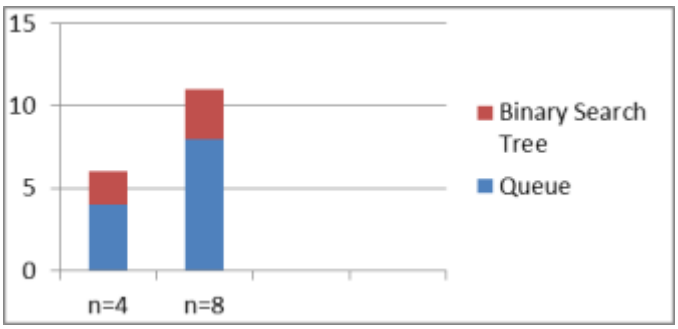

Chart -2: Time complexity Analysis

Firstly it is logical it would take more time to implement more number of vehicles which can be seen in the graph too. The entire iteration could have been achieved using Queue but we realize the time complexity of implementing Queue would have been O(n) which would have taken more time to allot the parking slots but instead we plan to using Binary search tree. Time complexity of Binary Search tree is O(log n) which results in less time and can easily be concluded from above graph.

6. RESULTS AND DISCUSSION

On integrating the listed modules we get the following outcome as per our code in the backend

Fig -6: Home Login

Fig -7: Login Screen

Fig -8: Working Window

Fig -9: Vehicle waiting for parking

Fig -10: Allocation of Parking starts and token no is distributed which indicates the parking position

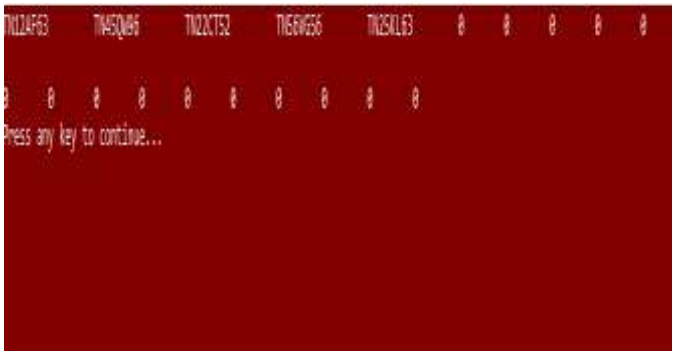

Fig -11: Vehicles successfully parked in the parking area and indicates the empty space in parking area

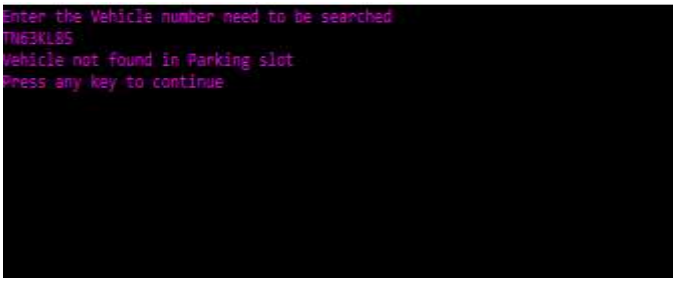

Fig -12: To see whether a vehicle is available in parking slot or not

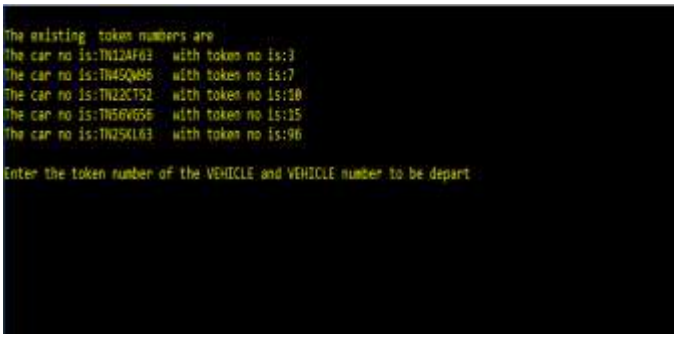

Fig -13: For departure of any vehicle

7. SCOPE/APPLCABILITY

Apart from Shopping Malls we can use this same concept in many other areas like metro stations where passengers can book their tickets and get their seats booked.

Passengers entering the railway station need to swipe the RFID tag to open the gate to enter into the concerned platform. Once the tag is placed in front of the RFID reader circuit, the latter energizes the tag and reveals the unique digital data stored in it. Then the tag reveals relevant information to the reader circuit. The RFID reader will have the internal memory, which stores the information about the RFID tag and it will also link it to the common database. The display in the RFID reader will display the source and balance information. When the customer reaches the destination, they need to swipe the card and leave the platform. If the customer has low balance in his card, there may be a "Value added Machine" available in that platform itself can added the value.

8. CONCLUSION

Implementation of various data structures gives us an idea that the time complexity will be minimum in case of binary search tree as when the same approach will be implemented with queue or array it would have taken much longer time whereas binary search tree allows us to traverse to the desired node using doubly linked list in the shortest time when a vehicle has to be vacated.

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BIOGRAPHIES

Final Year ECE Student at VIT Vellore with expertise knowledge in hardware implementation in multiple projects.

Final Year ECE Student at VIT Vellore with a knowledgeable experience in software projects involving data structures and algorithms.

Final Year ECE Student at VIT Vellore with an experienced hands-on idea in various microcontrollers.