Expandable Modern Automatic Car Parking System

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Abstract:

The current systems in the world deploy immense monetary funds in developing huge infrastructures in car parking. However they are immutable and static, meaning that, they have limited number of parking spaces. Once these spaces are full, the system cannot be thereafter used to park some more cars. This means they are rigid in nature in terms of expansion. Our present system solves this drawback of rigidity by exploring an interesting solution of telescopic expansion of the infrastructure!

It also aspires at solving the issues which are currently faced in the already existing car parking system round the globe; principally which include rigidity in structure, meagre illumination, poor space utilization, misreckoning of the bill, etc. Using smart concepts like RFID, automatic car wash, automatic calculation of the bill using RTC, centralized surveillance, fire alarm, and use of solar energy it can be made modern and futuristic yet simple at the customer end.

Keywords: *RFID, RTC, telescopic expansion.*

I. Introduction:

The growing population combined with globalization has created many problems. One of the cardinally intriguing is car parking which we confront almost every day. Roads are being built for cars to ply; but are we also giving the vehicles enough space to park is the question that still remains unanswered.

The issues like pollution (air and noise both inclusive) which cause nuisance to the society can be directly or indirectly solved using some smart, efficient, and comprehensive parking schemes. While residential projects still escape with designated parking; the real problem lies with commercial spaces, many a time which is overcome by taking extra open spaces to park.

The increase in the standard of the people which is the direct consequence of globalization has increased the purchasing power of the people and made it easy for the common man to buy a new automobile every now and then. Out of which majority of the market is captured by cars.

As per a recent survey conducted, it has been found that there are over a billion cars running on road. Naturally, they will in turn cause some serious parking issues in case of unavailability of space. Usually in day to day life we do not primarily focus on this issue but when it comes to a common ground, it is the need of the hour to find some serious solution. To add to it, tremendous rise in price of urban land poses difficulty in constructing infrastructure which is modern yet sustainable and gives good returns.

Traditional car parks which were implemented earlier comprised of some deadly curves and ramps which were difficult to manage. Now-a-days, though automated parking systems have become common, still we intend to implement a system which will eliminate the shortcomings of existing systems. Our prime focus is on maximum utilization of the available space and energy, a major factor scampered in many parking systems.

This is sufficient to imply that it is essential to develop some robust car parking system which is:
1. Free from deadly blind curves and ramps.
2. Efficient in terms of energy and space utilization.
3. Safe, attractive and easy at the customer end.
4. Which also has a future scope for substantial expansion without demolishing the existing structure and which can be erected on a very short notice in case of more demand.

Our project aims at satisfying all these basic needs in the most efficient way by making optimum use of the modern architectural traits combined with the concept of green and clean energy, securing the system by using centralized monitoring, making it safe and reliable. The system is also pliable in terms of the design which connote that more parking lots can be added afterwards which also makes it futuristic.

II. Background:

The inception of the car parking solutions dates back to 1920's but it was later in this 20th century where it really took shape and later these structures went on to pioneer the new ones. Shortly it was realized that to make sure more number of parking spaces are made available without consuming much lateral space, it would be wise to build tall instead of building wide. Henceforth, the most popular

concept of multilevel car parking came into existence. With the advent of new building traits it became easy to go further up and parking systems went on to become more sophisticated and safe.

Over the past few years big infrastructure companies like Whor, Tal manufacturing ltd, Claus, Pari parking solutions, Dae – Duck engineering, etc. emerged as pioneers in providing these automatic car parking systems.

III. Motivation:

Following are the types of existing car parking systems:

A. Stacker Type Parking System.
B. Horizontal Circulation Type System.
C. Puzzle Parking System.
D. Tower Parking System.
E. Chess Parking System.
F. Rotary Parking System.
G. Turntable Parking System.
H. Cart-Type Parking System.
I. Pit Lifting Parking System.

We closely studied the problems in these existing car parking systems and tried to remove them.

For example the *stack type car parking* can be dependent or independent with respect to the stacks.

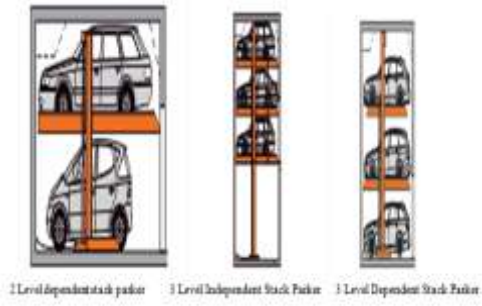


Fig. 1 Stacker Type Parking System

Dependent one depends on the movement of the other stack and hence poses problems. Independent on the other hand requires more vertical space, most of which remains unutilized and occupies unnecessary vertical space. So instead, it can be modified by making the system underground which is done in *pit lifting parking system*.

Fig. 2 Pit Lifting Parking System

It consists of three spaces namely top, middle and bottom which are united and lifted together. While the middle and bottom spaces are underground in the pit, the top level is in the same line with the ground floor parking. Advantages include saving land area, low noise, easy maintenance and protection of the middle and bottom levels from dust, rain and theft.

Horizontal circulation type parking system saves up to one third of the space since car is driven by chains and conveyors without the need of any external driveways. But malfunctioning of any one of these conveyors may jam the system. This problem can be tackled by *cart type parking system* which is preferably used in longitudinal parking areas.

Fig. 3 Cart Type Parking System

This fully automatic system has multiple entry and exits and has a inbuilt mechanism called cart which moves every parking floor.

Turn table system allows the car's direction to be easily changed by any angle to drive out as required.

Fig. 4 Turn Table System

The system helps to turn car all over 360 degrees and it requires a space of just 5 meters.

However all these systems restrict the movement of car in vertical direction. This drawback is removed in the *puzzle type car parking system* in which system on its own keeps on manipulating the movement of each car in all directions and system works like a puzzle. But this in turn comes at the cost of increased complexity and operational noise. Some other drawbacks include that generally only 2 or 3 cars can be parked in the space for one, therefore there is no space saving really. Since this system works on a one slot empty basis, hence to retrieve or park one car, multiple cars have to be shifted thus it increases the access time. Due to the number of pallets (cars) that have to be moved for parking or retrieving a single car

the number of moving parts increase and hence the operation and maintenance expenses increase.

These drawbacks are further removed by *chess type parking system* which is futuristic and it ensures maximum utilization of the floor space without the need of drive ways and space for movement of mechanisms. It has floor mounted roller bed system which can allow the crisscross movement of the pallet and the car. It has separate lifts which act as entry & exit points. Preferably installed on RCC floors, it can be designed for 800 to 1000 cars or even more and can be used in longitudinal & square areas.

In *tower type system*, emphasis is given on constructing vertically.

Fig. 5 Tower Type System

But its tall structure poses some serious issues.

In *rotary car parking*, 12 -14 cars can be accommodated in a vertical height of 14 m and area of 30sqm.

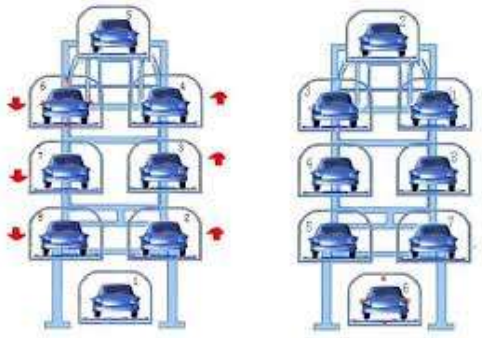


Fig. 6 Rotary Car Parking

The system works like a merry-go-round where an empty pallet to park a car or a loaded pallet with a parked car, is brought down to the ground level at the touch of a button. The average time taken after the button being pressed is 2 minutes to 2.5 minutes. This system however is very rigid and operates only for a fixed number of cars.

Shown below are pictorial representations of few of the existing systems which are needed in order to reengineer new one.

Fig. 7 Car Parking System With Off Aisle Lift

Fig. 8 Crane Parking System

Fig. 9 Shuttle System With End Of Aisle Lift

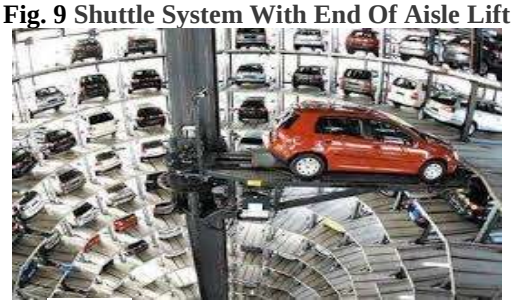


Fig. 10 Circular Car Parking System

Combining the merits of all of these, we came up with a unique parking system which focuses on giving maximum efficiency, safety, reliability durability, sustainability with least possible cost and infrastructure.

IV. The X Factors:

The system is divided into numerous modules such as:

A. Controller.
B. Conveyor System.
C. The Parking Mechanism.
D. RFID Unit.
E. Automatic Car Washing System.

F. Zone Occupancy Module.
G. Floor Expansion System.
H. RTC.
I. Surveillance System.
J. Solar Panels.
K. Fire Alarm.
The master controller proves to be the real workhorse governing these. Let us have a look at these modules briefly.

A. The Controller:

Controller is undoubtedly the brain in almost any electronic system. So it was utmost important to select a robust controller. We have used ARM7 LPC 2148 TDMI controller. The various features like UART, built in RTC, serial interfaces from USB, fast GPIO, etc. were essential for this project and this controller proves ideal as far as incorporation of all this is concerned. Apart from this, key features like in-system programming and real time programming are also supported by this controller which makes it useful from designing point of view.

B. Conveyor System:

Two sepearte conveyors will run between the entry and exit points upto the system. One of the conveyor belt will carry the cars into the lobby where they will be washed and then subsequently they will be taken onto the plank which will then park them; whereas the other one will drop the cars from parking area till the exit point. Separate conveyor belts run in and out of the entire system which certify carefree automatic manuverance of cars.

C. The Parking Mechanism:

It consists of plank which is responsible for lateral movement of car and moves the car to and fro for parking. It is supported by hoist which is responsible for vertical movement. The entire assembly is then again supported by guideways which moves it from one side to the other. Hence, this mechanism requires three motors for these three movements.

Fig. 11 The Parking mechanism

D. RFID Unit:

The radio frequencies for identification purpose have been in this industry since long time. They have edge over the manual entry counterparts because of their ability to load the data in the system quickly and that to with great deal of accuracy. The loading-unloading time of the cars can also be reduced to great extent by this automatic documentation with the help RFID's. It will be only once that the manual operator will be required to feed the data into the system using GUI, but once for all it is done, the rest is mere a cakewalk. RFID will take care of all the details like fare details, vehicle registration number, its model, colour, in time, owner's name, etc. and the same can very well be monitored from the back end.

E. Automatic Car Washing System:

This consists of an infrared sensor indicating the presence of car. Once it is detected, the water jets sprinkle water all over and car is washed automatically.

F. Zone Occupancy Module:

The zone occupancy module, as the name suggests, indicates presence of car. The front end of this is an infra-red sensor module which is interfaced with the microcontroller and the output from the same is shown on computer with help of GUI. So it becomes easy to monitor and control the system.

G. Floor Expansion Module:

The floor expansion is cardinally the most important aspect of our system. This module serves the very basic idea behind making the system flexible. It helps in providing extra space by telescopic expansion of the columns without consuming horizontal lateral space which is a factor overlooked in many existing systems. Moreover, the height controlled expandable columns ensure that apart from the shorter cars like sedans or hatchbacks; the taller cars like SUV's can also be effectively parked.

H. RTC:

The real time clock will prove helpful in automatic calculation of the bill. Fare details which includes fixed charges, hourly charges, washing charges, in and out times of car shall ensure transparency throughout. The RFID module working in tandem with the RTC ensures error-free billing.

This will not only save the cumbersome paper work but it will also be easy to manage.

I. Surveillance System:

Safety is one of the most important features taken into consideration while designing. To ensure smooth functioning of the same and to avoid any mischiefs we have secured our system with centralised cameras for monitoring purpose. The output can also be sent over internet protocol which makes it easy to keep a watch even when miles away.

J. Solar Panels:

The maximum utilization of the renewable energy is one of our prime focuses. Using solar panels will not only trim down the energy requirements but also affirm that we have a secondary source of energy in case of power failure.

K. Fire Alarm:

It works on simple principle of thermal expansion. When fire is detected, temperature hike makes the metal to expand which completes the circuit and thus trigger the alarm. Accordingly, many sensors are available in the market. The system can be further supplemented by integrating smoke alarms with it.

V. Methodology and Working:

The standardized dimensions of some typical vehicles are as follows:

A. Car: 2.4 metres x 4.8 metres

B. Light Vans: 2.4 metres x 5.5 metres

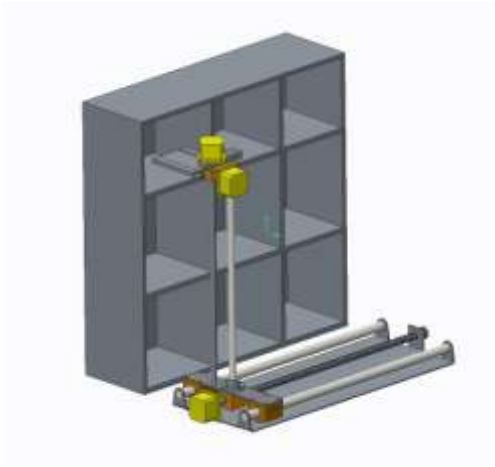
C. Rigid Vehicles: 3.5 metres x 14.0 metres

D. Articulated Vehicles: 3.5 metres x 18.5 metres

E. Coaches (60 seats): 3.5 metres x 14.0 metres

Accordingly, they can be added with some extra clearance for safety. We have scaled down the system by a factor of 25. The system thought of will be capable of parking 4 cars in each levels. We are planning to erect 2 permanent levels which can further be added up with few extra levels amounting 3-4 levels of parking in total. We have provided a space for erecting columns on four corners of the structure which will support it as well as will be responsible for expansion purpose.

Shown below is the partial pictorial representaion of our prototype which illustrates about parking process.



This system can be made much more efficient in terms of space and energy utilization using solar panels and other renewable forms of energy. The RTC section will note the in and out times of the respective car and will be responsible for real time, fast and accurate billing.

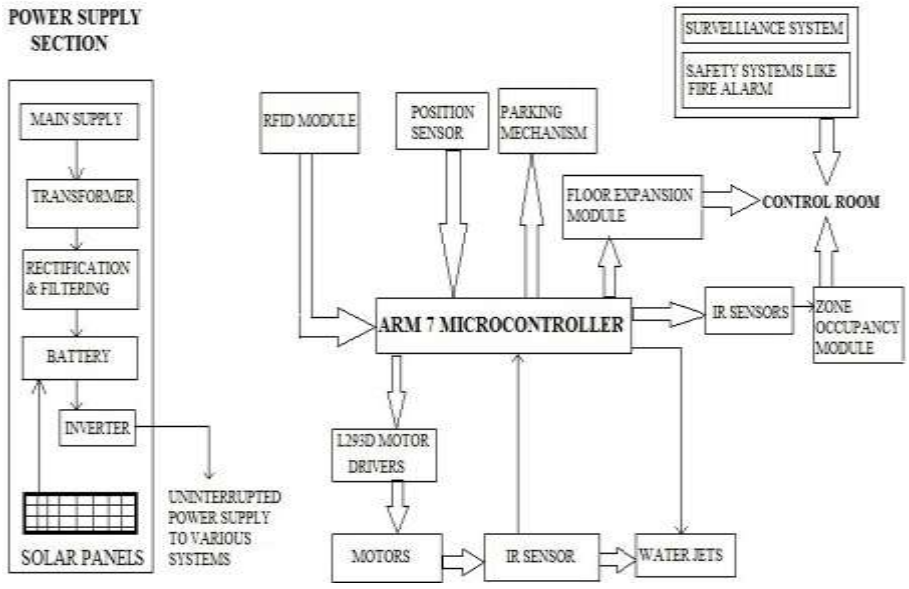


Fig. 12 Block Diagram Of Automatic Car Parking System

The implementation is carried out in two cases.

Case 1)

While Parking a Car:

The car enters the lobby through conveyor belt, its in time is noted in the processor. Meanwhile it is washed before entering the lobby. After that, it is placed on a device called as hoist which is responsible for proper parking of the car. The system will be monitored by real time graphical user interface which will also give detials at various stages.

The zone occupancy module will indicate the void spaces. If they aren't there, then floor expansion module will come into picture which will bring in more void spaces by erecting some more floors. During the entire process, the cameras and sensors will continuously monitor the system. Brief information about each and every car like its registration number, model number, in time, etc will be noted so as to ensure that no mischief ever happen.

Case 2)

While Removing a Car:

While removing a parked car, the hoist and plank will pick it up and will be made available to the customer. As soon as the car is picked up from the respective parking space, the absence of the car will be shown onto the zone occupancy module. The RTC will note the out time of the car and will calculate the parking fare based on the in-out timings of the car.

VI. Results and Discussions:

After the entire implementation, following results were found:

A. Flexibility:

All new futuristic concept of expansion ensures that system is flexible. In case of rush, this can prove to be a boon for public where still more cars can be managed. This takes absolutely no time as compared to constructing a new infrastructure in total. The topmost floor of the system can be expanded to various heights. This makes it possible to park the cars of different heights. Taller cars like SUV's can be parked here.

B. Real Time Monitoring:

The modern traits like real time centralised surveillance, RTC based billing, RFID based monitoring makes it easy and safe at controlling end and at the customer end as well.

C. Safety:

One of the major factors influencing any system is primarily its safety. Various safety features like centralized surveillance, fire and smoke alarms make system secure and safe.

D. Energy Consumption:

The controller itself can be used in various power saving modes. Apart from this, use of energy efficient components such as LED's can reduce consumption. Solar panels can be installed on the rooftop which will prove useful in deriving maximum renewable energy and prove to be an alternative source apart from the conventional main supply.

E. Efficiency in Terms of Space Utilization:

It has been observed that space utilization is one of the most important performance parameter of any system. For getting proper returns for the huge infrastructure which requires immense monetary funds, it is almost necessary that a system is well planned and erected in such a way that it has maximum utilizable area. Hence it is implicit for any system to have proper floor planning.

As compared with the multilevel circular car parking systems which are nowadays becoming popular, our system proves to be the best in terms of space utilization. Due to the rectangular structure, it eliminates floor area wastage which is a major issue in circular parking systems. Following graph illustrates the floor wise cumulative parking efficiency of a typical circular car parking system.

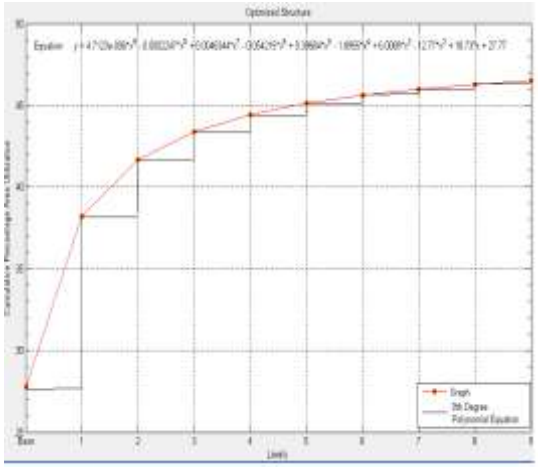


Fig. 13 Cumulative Parking Efficiency Of Circular Car Parking

It can be very well observed that the typical parking efficiency lies in the range of 40-50%. However, proper planning can increase it to 70-80%. This is extremely important where area is an issue.

VII. Conclusion:

The main aim of this report was to study the problems faced by the existing systems and help remove those. The implementation of an Automated Car Parking system is successfully discussed.

The components used for the implementation of the system provide efficient output at various stages of implementation.

The system discussed is efficient in terms of space utilization without compromising on the safety aspects. Use of expandable – contractible columns has given this system an innovative look altogether which makes this system dynamic.

The interfaces established between various components provide an effective communication across the overall working of the system.

In future, certain changes can be incorporated as per the requirements of the organizations implementing the system. It is designed in such a way that it copes up with the future parking problems effectively.

Moreover, with the advancement in the technology every now and then, this system can be made more and more robust by adding new features like online booking of slot, live streaming of the data at the user end, online payments, etc. Thus, the system functioning is efficient and is recommended for commercial implementation.

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