

Compact Smart Parking System Based On Autonomous Trolley And RFID System

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Abstract- A method of parking a vehicle in a vacant parking Space in a parking facility requires more parking Spaces. This requires very large place and creates traffic jam problems. It discusses a project which presents a miniature model of an automated car parking system that can regulate and manage the number of cars that can be parked in a given space. The automated vehicle parking system includes one parking facility structure including a number of vehicle stacks, a vehicle entrance/exit arrangement, and a vehicle transporting mechanism. The automated parking system operates on a card swiping method via RFID system. The entire system is underground system and hence on the area on single vehicle, we can park multiple vehicle in underground using fully automated system. An automatic car parking system comprised of a parking stack and one car lifting feeder/Lift. Parking space of various vehicle are arranged on a stack. And at last the vehicle transporting trolley is operated via stepper motor and lifted using hydraulics system.

Keywords- Smart Parking, Hydraulics System, Compact Parking, Omni Wheels, RFID System, Autonomous Vehicle Transporter, etc.

I. INTRODUCTION

A method of parking a vehicle in a vacant parking Space in a parking facility requires more parking Spaces. This requires very large place and creates traffic and jamming problems. Vehicle parking systems are quite common nowadays as they facilitate parking of a large number of vehicles in a large space. It is very difficult to park a car between 2 cars and hence improper car parking situation comes under topic. However, a major problem associated with the vehicle parking systems is waiting time associated with pick up of a vehicle. It is likely that some users have to wait for their vehicle when there are many vehicles parked in the storage area to remove or park our vehicle. Hence too much area is required to park ample of vehicles. In downtown area, because of very expensive land price, it is very difficult to build sufficient, parking slots for parking motor vehicles. In order to fully utilize the limited land space type of parking slots is a good way to park motor vehicles into spaces with

minimized land space occupation. There is a time gap between handling two successive vehicles. When a number of vehicles report simultaneously for parking as it happens. Vehicles reporting for parking have to wait in queue causing irritation to clients besides creating traffic congestion. We have also seen that during the removal of the vehicle some persons park the vehicle in front of the vehicle or nearer to us very closely so that the either our door doesn't open or we can't go inside the vehicle. The another problem involved is even due to complicated parking there this may result into the damage to the car such as scratches, dashes, etc. so it become more difficult to remove the car from that complicated area. Even the another thing Is if we are in hurry, and we have got the top floor slot for parking then we have to park the vehicle by our self on that floor and then come out of the building which is time consuming. In order to remove this problem automation is require which automatically remove the car from parking slot or to automatically park our vehicle in the parking slot. One more problem we have seen in conventional parking system that we have to pay the caretaker of the parking slot by cash which also results into the time consuming and difficult to pay those cash if you don't have the cash.

In order to overcome this set of problems for the busy person we present the said invention to provide an automatic car parking system which can automatically carry motor vehicles into parking spaces and greatly reduce land space occupation. Moreover equipped with the automatic money paying system and slot booking system.

We know that the average weight maximum weight of the car is from 7000 to 8000 kg. So on the basis of this we have designed the system with the different size and weight limit for the cars. With the help of the autonomous guiding system and RFID system this invention is brought into utilization.

II. LITERATURE REVIEW

Currently the RFID Based Automatic Parking System is in prototype stage and works with a limited number of sensors and on a limited scale. However it is scalable and can

easily accommodate more IR sensors to monitor a far greater number of parking slots. Thus its scale can be easily adjusted to the needs of the specific customer. Also it can be modified to add more features to suit specific needs or to adjust its cost-Benefit ratio. Efforts are also being made to advance from the prototype stage into a more finished and polished product that will be suitable for demonstrations and promotion. All these aspects are currently being considered in detail to decide future course of the system. [1]

2) To make use of underground space, it is beneficial to the city and the decedent. We have suggested one of the solutions for the smart city. Design of suggested model is Easy, permanent and effective. Even though initial cost is high in long run, the cost of the project can be recovered. The design process and fabrication of the model is detailed in this paper. For automation controller has been used. Sensor sense the vacant space and it is easy to park the vehicle. [2]

As soon as parking place is found to be empty it is detected using ultrasonic sensors which report it further. We achieved this by programming the sensors and Arduino. Pushing the data to webpage gives us tabular output which shows availability of parking places. The project aims at fast results so that anyone can easily find place for parking and save time in doing so. As Arduino is the latest technology, using it gives uniqueness to our project. [3]

III. FLOW CHART

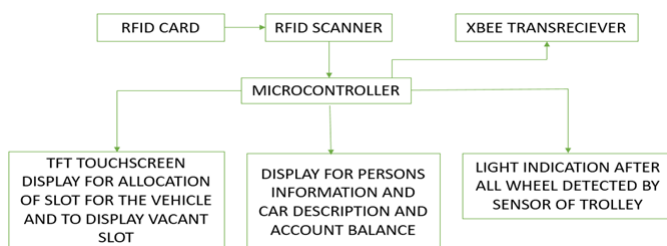


Figure 1 Main System of User at the Starting stage

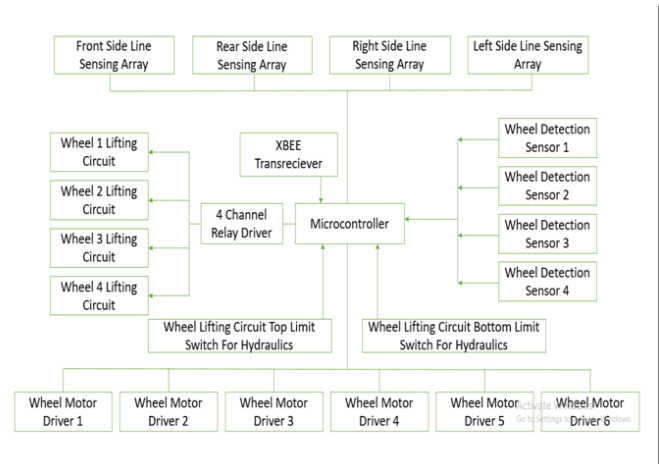


Figure 2 Detail Working of Trolley

IV. WORKING OF THE SYSTEM

At first the RFID scanner scans the RFID card, these RFID scanner convert the RFID signals to the electronic form. This electronic signals are then transferred to the microcontroller. This microcontroller then read the persons information saved into the system previously or if the information is not available then the controller ask them to create one. Then as soon as the profile is read then the controller allots the slot to the car in to the house. As soon as the slot is allotted then this allotted slot is been displayed on to the TFT display. This TFT display is the touchscreen display which is then used when the system does not allot the slot to the car i.e. in extreme condition. The TFT display also displays the vacant position to the caretaker. Thus when the slot is displayed on to the TFT display then these controller opens the gate and allows the driver to enter the car into the cabinet. Whereas caretaker tells driver to park the car to the marked zone. As soon as the car parked in to market zone the light indication is given and then the driver can get out of the car and leaves the car there. As the driver leaves the cabinet the signals is been send via XBEE module to the trolley where the Main function is started. This whole functioning is been told in the figure 1 as a flow chart.

In the above flow chart figure 2 there the main controlling unit is Arduino Microcontroller. At first the XBEE module which is installed as a Transreciever there receives the signals from the main system. This signal tell trolley the allotted slot and location. This trolley then automatically goes under the car via tracing the line. As soon as the trolley goes under the car it detects all the wheels and started the piston extension this extension is first detected by the bottom limit switch which records the signal then as soon as the piston reaches nearer to the axel where the trolley needs to attached the jack there the intermediate limit switch detect the position and record the position. This microcontroller then receives this

captured position which at first actuate the clamping mechanism and then slows down the piston speed. And linearly allows the piston to move forward. Then as soon as the piston lifts whole car to its maximum position then top limit switch detect the position and stops the flow from the hydraulic pump. This then lifts the car and started moving forward. This trolley then follows the line and act accordingly where if the slot is allotted to the first layer then it follows the line into the lift where the lift automatically stops at the first layer. Then the car goes into the allotted cabinet with the help of trolley. This trolley as soon as detects the destination by the program fit into it releases the clamping mechanism and allows the piston to retract its position. Thus in similar way the function of the limit switch is carried out and as the piston reaches to bottom position then the bottom switch detects it and stop the flow of oil. The Line sensing array is been attached to each corner of the trolley. This LSA sends and receives the signals to the microcontroller. By using the UART communication. Then the trolley again follows the same path and comes back to its original position. And ready to pick the next car. As whole this system is underground and hence this system is reliable and does not require any space and multiple cars can be parked in an array with multiple stacks arrangement. In advancement this the whole system is also used with the help of mobile application by which we can book the slots and also tell to the company to remove the car the stacks before the driver reaches there so as to save the drivers time.

V. PART DISCRPTION

Design of the trolley is been shown into the figure 5, 6, 7.

From figure 5

Part 1 is the specially designed wheels used for the translation motion. In X as well as Y direction. I.e. in forward as well as in side direction because of its specially fitted roller.

Part 2 is the high torque stepper motor used for brings the rotation motion of the wheels.

From figure 6

Part 3 is the piston used for lifting the car. This pistons are arranged into specific pattern. To produce the maximum power and brings the stability to the trolley while travelling.

From figure 5

Part 4 is the clamping mechanism used to clamp the axel during the travelling and allows the stability to the trolley. This clamps is does allows the car to fall down by holding the axel tightly.

Part 5 is the chassis of the trolley which is the supporting element of the trolley. Made up of mild steel and robust enough hold at least two cars at a time. Thus the factor of safety of the trolley chassis is more than required.

Figure 7 is the hydraulic circuit used in this project so that the lifting motion takes place.

XBEE module is used are Transreciever module used sends the signals up to 100 meters.

Weight lifting circuit in the figure 2 is the hydraulic circuit shown in the figure 7.

Relay shown in the figure 2 is four channel and electromechanical based relay. Where its main function is to bypass the voltage from battery to the DCV as the DCV activate on 24 v and our microcontroller works on the 5 v. thus for bypassing this relay is used.

Wheel detection sensors shown in the figure 2 are the inductive proximity sensor used to detect the rim of the wheel.

The motor driver shown in the figure 2 is used to drive the stepper motor and provide a high current. With voltage. As the motor works in the 24 v supply this driver provides the supply with regulated voltage.

Line sensing array shown in the figure 2 is used to the line and follow the path as required. This array is specially designed to differentiate between any two colors. And also having 8 sensors mounted on it. This sensor is much more reliable in any condition. The most important part of tracing the track is done with the help of the line sensor. Thus proved reliable output and also is easy to handle.

The system is also equipped with the MOBILE APP where the driver can book the slot without wasting the time in swiping the card. Thus this system becomes user friendly and also economical in design. In INDIA which is densely populated country the demand for this product is much more and thus the payback period for this system is much less. Area required is also less and does not require any skill labor to handle the system.

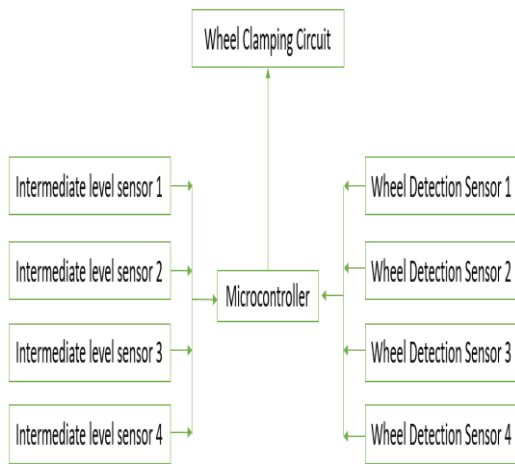


Figure 3 Clamping Actuation System

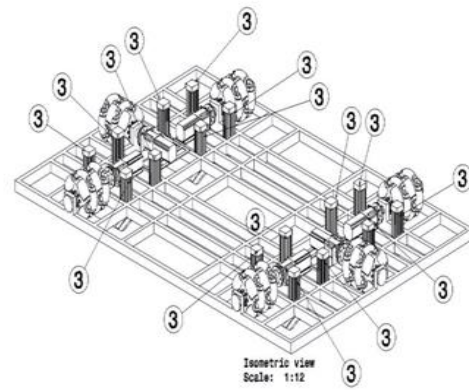


Figure 6 Isometric View

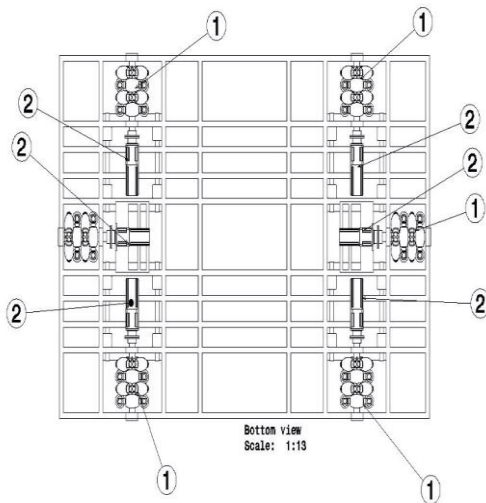


Figure 4 Bottom View

VII. CIRCUIT DIAGRAM

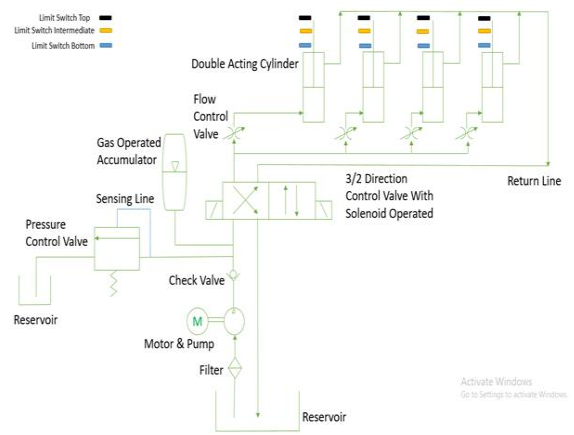


Figure 7 Hydraulic Circuit

VI. CAD MODELING

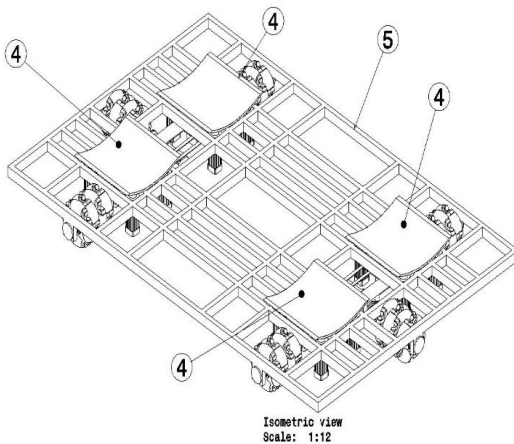


Figure 5 Isometric View

In hydraulic circuit the Pump is used to create the pressure up to 150 bars. Before allowing the fluid of the system flows through the pump the fluid first passes through the filter in order to remove the dirt and foreign material. High power specially designed compact motor is used to rotate the motor. After pumping the fluid the fluid then passes through the check valve where the check valve does not allows the reverse the flow back to the pump. This check valve is used because the Gas operated accumulator is used in the line for fast lifting of the piston and bring about the motion. A pressure control valve is been used in the system in order to bypass the fluid just in case the pressure of the line goes above a certain limit then the bypassed fluid then goes in to the reservoir back. A 3/2 direction control valve is been used to change the direction of the fluid this 3/2 valve is solenoid operated and controlled with the help of the relay driver and microcontroller. As the diagram shows the forward stroke. Then the fluid id passed through the flow control valve at each entry of the piston because all the pistons are connected in the

parallel manner. Where the in certain cases fluid does not enter into the piston in equal amount if the flow control valve is not connected. Then this flow control valve is also used to control the speed of the piston by just controlling the flow inside of the piston. The other end of the piston is then connected to the direction control valve in parallel manner where the direction control valve is sends the flow back to the reservoir using return line.

This system is used to lift only one pivoted point of the car where if required to lift the all four point such four system is been used in to operation. There the limit switches is connected in the path of the stroke of the cylinder to detect its real time position. And also the limit switches is connected to the microcontroller to perform the necessary operation such as the change the direction of the fluid through the DCV, also stop the system, etc. limit switch in black mark is top limit switch used to detect the top position or extended position of the piston, the yellow marked limit switch is intermediate switch used detect the where the flow of the fluid into the piston is slow down. Thus the blue marked limit switch is used to detect the retracted position of the piston or the bottom most position of the piston. This system is designed to perform the necessary operation and does not weight much as all the parts used are compact in size and easy to handle.

VIII. CALCULATION

8.1. Chassis Load Distribution Calculation and Assumptions

Considering the critical situation for load.

We know that in cars SUV (Sports utility Vehicle) is consider to heavy cars. And is also called as the medium level vehicle.

The average weight of that king of vehicle is in between the range of 5000 kg to 6000 kg.

Now as we are dealing with the critical situation,

Assume that the Average weight of the vehicle is 7000 kg.

Thus in our chassis we are using 6 Specially Designed Omni wheels which are having load carrying capacity of 300 kg per stack. Thus over all we are 4 stakes for 1 wheel. Thus the total load carrying capacity for the one wheel is,

$$300 \times 4 = 1200 \text{ Kg.}$$

By Assuming the total load on to the chassis as uniformly distributed load, we can say that the all the wheels are taking the loads equally.

Thus,

$$\text{Total Load On Each Wheel} = \frac{\text{Total Load}}{\text{No. Of Wheels}}$$

$$= \frac{7000}{6}$$

$$= 1166.66 \text{ Kg}$$

Thus we can Say that the,

Available Load < Load Carrying Capacity of the Wheels.

Thus Selection of the wheels are safe

8.2. VEHICLE LIFTING CALCULATION

Now the vehicle is lifted by the four point method, i.e. the vehicle is lifted from the axel point nearer to the wheels.

As we have consider the load as uniformly distributed load we can say that the total load is again distributed uniformly on all the pivoted points. From that we can calculate the load on to the each pivoted point.

Total Load on to One Pivoted Point

$$= \frac{\text{Total Load}}{\text{No of points}}$$

$$= \frac{7000}{4}$$

$$= 1750 \text{ Kg.}$$

Assuming that the pressure supplied by the hydraulics pump to the cylinder is 150 Bars.

$$150 \text{ Bars} = 15 \frac{\text{N}}{\text{mm}^2}$$

In our design we have taken that one pivoted point is again supported by the four cylinders. Thus we can say that the 1750 kg. Load is again divided in to four points as this load is Uniformly Distributed Load.

$$\text{Load Carried by the one piston} = \frac{1750}{4}$$

$$= 437.5 \text{ Kg.}$$

Thus Over all One Cylinder lifts the Weight of 437.5 Kg.

Thus after approximating the value to whole no we Get, 450 Kg.

Thus to total force in terms of newton is,

$$F = 450 \times 9.81$$

$$= 4414.5 \text{ N}$$

Thus we have the formula as,

$$\text{Pressure} = \frac{\text{Force}}{\text{area}}$$

$$\text{Area} = \frac{\text{Force}}{\text{Pressure}}$$

$$\text{Area} = \frac{4414.5}{15}$$

$$\text{Area} = \frac{\pi}{4} \times D^2 \frac{\text{N}}{\text{mm}^2}$$

$$\text{Area} = \frac{4414.5}{15} = \frac{\pi}{4} \times D^2$$

$$D = 19.36 \text{ mm}$$

$$D = 20 \text{ mm}$$

8.3. BUCKLING LOAD CALCULATION

Now,

The Piston act as a column and we have to find out the buckling load so that the piston will not buckle.

Thus,

$$F = \frac{\pi^2 E I}{L^2}$$

$$L = \frac{l}{2} \text{ As the both the ends are fixed}$$

$I = \text{Moment of inertia}$
 $E = \text{Youngs Modulus Or modulus of elasticity}$
 $l = \text{Length of the Coloumn}$

$$I = \frac{\pi \times D^4}{64} = 7850 \text{ mm}^4$$

$$E = 201000 \frac{\text{N}}{\text{mm}^2}$$

$$L = 300 \text{ mm}$$

$$F = \frac{\pi^2 201000 \times 7850}{\left(\frac{300}{2}\right)^2}$$

$$= 220197.733 \text{ N}$$

Thus the Column will buckle at the load of 220197.733 N which is far greater than the applied load.

Thus the selection of the piston diameter for the lifting the load at 150 bars is safe.

IX. CONCLUSION

The automatic car parking system using RFID System is used to manage our time and vehicles can be parked easily. Automatic car parking system is very good substitute for car parking area. Since in modern world, where space has become a very big problem and in the era of miniaturization it become a very crucial necessity to avoid the wastage of space. Hence need of automatic car parking is arises by using RFID System. The main advantages are space optimization, cost effectiveness and security. It also used to display the slot where the space for parking is available on an LCD. The driver or user can book their parking Slot at home by using booking app. This can reduce the time of the user to searching the vacant parking slot. As the system is based on the RFID the system is fully encrypted and risk-free. The whole system is autonomous with obstacle avoidance system pre-installed. Thus the car won't have risk of damage and the driver can fully trust the company for parking.

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