DESIGN AND DEVELOPMENT OF TRANSVERS CAR PARKING MECHANISM

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Abstract - *The modern society of India has created many problems one of the challenging ones being car parking which we confront almost every day. Besides the problem of space for cars moving on the road, greater is the problem of area for a parked vehicle considering that private vehicles remain parked for longer duration. While residential projects still far away with designated parking, the actual problem lie with commercial spaces, all the time it overcome by taking extra open land spaces to park. So we came up with new idea that is to park the car transversely on the side of the road which will reduce the extra space required in front and backside of the car.*

Key Words: car parking, space, vehicle, transversely, road

1. INTRODUCTION

With the rapid increase of the automobile use in India, parking has become an integral part of the modern urban society and an important land use. Today, parking related problems are no longer considered to the city center; they extend throughout the urban region. Parking contributes to the looks of city and suburbs; affects traffic jam and traffic operations; and is an essential component of the urban street and transportation systems. Its availability can effect the choice of mode and route of travel, affecting the feasibility and competitive posture of commercial space. A lot of research work reported in the literature confirms that angular parking is more harmful than parallel. The principal problem in angular parking is the lack of proper visibility for the driver during the back-out activity. Additional problem results from the drivers who stop suddenly upon seeing a vehicle ahead while backing out. Many studies have compared the crash experience of angular and parallel parking and reported crash rates for parallel parking as from 19 to 71% lower than those for angle parking. When on-street parking is considered necessary, it must be of parallel rather than angle type. My project moto is to make on-street parallel parking easy and more beneficial into society. We make a prototype exhibit the transverse car parking mechanism. This mechanism can be fixed in a modern car. This mechanism has pneumatic or hydraulic system which can lifts the car on small auxiliary four wheels. Auxiliary wheels have a perpendicular angle with respect to longitudinal axis of car. The auxiliary wheels can also flip inside the car space when the mechanism is not in use. It can also work as a built in-jack for lifting the car for replacing tires or repairing works.

2. Data Collection for Parking Traffic Evaluation

a) Counting Available Parking Spaces

Manually count the number of available parking spaces in the studied site for each type of parking (on street, surface, or garages). In case there are no marking for parking spaces, then the number of parking spaces could be obtained by dividing the existing lengths / areas for parking by the minimum dimensions allowed for parking indicated in the Parking Specifications published by the Ministry (6.5 meters for parallel parking and 2.5 meters for perpendicular parking. This length is variable for diagonal parking according to its angle)

b) Determining Counting Time and Period by Experimental Counts

Generally, data collection is an expensive activity. This is particularly correct for collecting parking data, because it requires the efforts of trained enumerators for long working hours, and in absence of an automatic device to collect such data since it is difficult to depend on recording entering and exiting vehicle registration plates using video cameras. Therefore, in order to obtain reliable data, and reduce the efforts of data collection process, and minimize its time period and cost, the survey duration is determined such that it must cover the peak hours and peak days of parking demand. This is ensured through experimental counts for a number of entering and exiting vehicles (in periodical intervals of half an hour for every hour, and for a duration that covers the expected parking peak), to determine daily and weekly peak time, and in order to carry out the detailed traffic count at weekly peak (in the day and time in which parking demand at the study site is the highest). After that it is possible to specify time period for carrying out counting. The period and timing of the count depend mainly on the nature of the served land use and the concentration of human activities. Governmental agencies, for example, are mostly crowded in the morning. Therefore parking counts are conducted for the entire working hours. While for residential areas and markets, evening peak is prominent. The counting period is generally determined on the basis of the experimental counts 7 so that it may cover the peak period completely, and it is good to coordinate with the owners and users of the parking to determine these peaks.

After determining timing and duration of parking count, the field work is performed.

c) Performing Traffic Count for Subject Parking Spaces

The count is performed according to the following steps:

Immediately before commencing detailed traffic counts at a given site, information of registration plates of existing vehicles must be recorded using the form shown in Exhibit-1 attached in the Appendix. Those vehicles shall be considered later as entered at the start of the count. Gates are numbered (or blocks, in the case of on-street parking) or any parking access to differentiate between them. Detailed traffic count is performed by using the FORM (shown in Exhibit-1 in the Appendix) by the trained enumerators. If the subject parking location is off-street, the enumerators are distributed in the parking area so that each one of them records the registration plate of all entering or exiting vehicles together with time at their specified location.

In case the gate was designated for both entering and exiting, it is advisable that a person be appointed to record entering vehicles data and another person to record exiting vehicles data.

In the processes of data collection, data entry and analyses, consideration shall be given to separate the data of each type of parking (surface, garages, on street) through the use of separate data collection form. This is done by distributing the enumerators in a manner that ensures obtaining entering/exiting vehicle data for each type of parking separately so that it becomes possible to analyze each type of parking individually and accurately to identify the utilization of each type of parking.

In case of on-street parking (no gates) a number of adjacent parking spaces are allocated (10 to 15 parking spaces, or it is possible to divide the area into blocks compatible with the building blocks at the study site) to each enumerator so that he may monitor them and record the data of each vehicle that enter / leave the parking area.

3. DETAILS OF COMPONENT

a) PNEUMATICS

Pneumatics is a section of technology that deals with the study and application of pressurized gas to produce mechanical motion. Pneumatic systems that are used extensively in industry and factories are commonly plumbed with compressed air or compressed inert gases. This is because a centrally located and electrically powered compressor, that powers cylinders and other pneumatic devices through solenoid valves can often provide motive power in a cheaper, safer, more flexible, and more reliable way than a large number of electric motors and actuators. Pneumatic systems in fixed installations, such as factories, use compressed air because a sustainable supply can be made by compressing atmospheric air. The air usually has moisture removed, and a small quantity of oil is added at the compressor to prevent corrosion and lubricate mechanical components.

b) GROUND CLEARANCE

Ride height (also called ground clearance or simply clearance) is the amount of space between the base of an automobile tire and the underside of the chassis; or, more properly, to the shortest distance between a flat, level surface, and any part of a vehicle other than those parts designed to contact the ground (such as tires, tracks, skis, etc.). Ground clearance is measured with standard vehicle equipment, and for cars is usually given with no cargo or passengers.

c) LEADSCREWS

A lead screw (or lead screw), also known as a power screw or translation screw, is a screw used as a linkage in a machine, to translate turning motion into linear motion. Because of the large area of sliding contact between their male and female members, screw threads have larger frictional energy losses compared to other linkages. They are not typically used to carry high power, but more for intermittent use in low power actuator and positioned mechanisms. Common applications are linear actuators, machine slides (such as in machine tools), vises, presses, and jacks.

d) CHAINDRIVES

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, USA. This has inverted teeth.

4. WORKING

The system contains a battery of 12 V, Pedestal Bearings, Lead screws, Geared motors. In this type of mechanism auxiliary frame is attached with a cylinder piston. Flap plate is fixed with the auxiliary frame such that it will rotate only 90^0 which have four auxiliary wheels attached to it making 90^0 with longitudinal axis of car. For fixing auxiliary frame centre of gravity is located in CAD model. After pressing the controller buttons the pneumatic cylinder (Double Acting) having 5/2 directional control valves is activated due to which the whole auxiliary assembly comes down. The flapping of auxiliary wheels can be controlled by controller. The flapping of mechanism is controlled by lead screws movement. When the pneumatic cylinder pushes the auxiliary frame the whole car is lifted and the car is ready to move in transverse direction. The transverse movement of car is controlled by controller. The controller activates 30 rpm auxiliary wheels motors. In order to provide stability to auxiliary wheels lead screws are helpful.

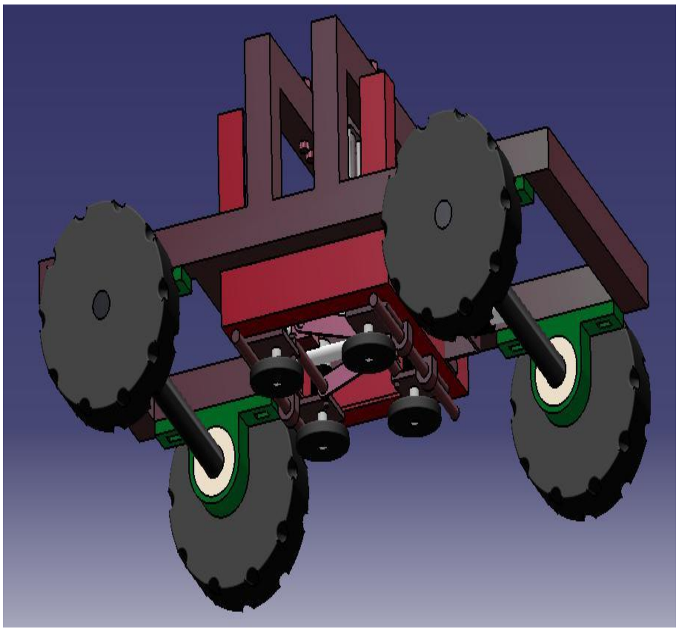

Fig 1: Completely Assembled Model

5. CALCULATION

5.1. PNEUMATICS CALCULATIONS

Cylinder Thrust

F= Cylinder thrust in kg.

D=Diameter of piston in cm.

d= Diameter of

piston rod in cm.

P= Operating

pressure in bar.

Double acting in forward stroke:

$F = 3.14/4*D^2*P$
$3.14/4*3.2^2*2.75$
22.11 N

Double acting in return stroke:
$F = 3.14/4*(D^2-d^2)*P$
$3.14/4*(3.2^2-1^2)*2.75$
19.95 N

Free air consumption for forward stroke:

$C = (3.14/4*D^2*(P+1)*L)/1000$
$(3.14/4*3.2^2*(2.75+1)*5)/1000$
0.15 Liters.

Free air consumption for return stroke :

$C = (3.14/4*(D^2-d^2)*(P+1)*L)/1000$
$(3.14/4*(3.2^2-1^2)*(2.75+1)*5)/1000$

0.136 Liters.

For one complete cycle free air consumption:

One complete cycle free air consumption = Free air consumption for forward

stroke + Free air consumption for return stroke,

= 0.150 + 0.136

=0.286 Litres.

Cv Calculations:
Cv = Cyl. Area x stroke x M x compression factor/475 x stroke time in sec.

3.14/4 *3.2*2.2*0.062*4/475*1

0.419

Inlet Pressure	Compression factor	"M" constant
1	2.0	0.092
2	3.0	0.072
3	4.0	0.062
4	5.1	0.054
5	6.0	0.049
6	7.1	0.045
7	8.0	0.042
8	9.2	0.039
9	10.3	0.038
10	11.2	0.036

From the above table we have taken inlet pressure

3bar which is nearly equals to 2.75bar= 40Psi.

So we have taken compression factor= 4, 'M' Constant=0.062

5.2. CALCULATIONS FOR CENTRE OF GRAVITY

Center of Gravity Height Formula	Definition of Variables
CGH= WB/TW*FWc*Tan ϴ	**CGH -** Center of Gravity Height =15mm
	WB - Wheelbase (inches**)**= 50mm **TW -** Total weight = 25kg **FW1 -** Front weight LEVEL = 25kg **FW2 -** Front weight RAISED = 38kg **FWc -** W*Cos(ϴ)= (change in weights) =13kg **Tan(ϴ)** Tangent of angle = 60degree

5.3. FORCES ON AUXILIARY AND MAIN WHEELS

When a car is parked on level pavement, the normal force, Fz , under each of the front and rear wheels, Fz_1 , Fz_2, are
$Fz_1 = ½*mg*a_2/L = ½*25*9.81*300/600 = 61.31$ N

Fz_2 =1/2*mg*a_1/L = ½*25*9.81*300/600 = 61.31 N
L= a_1 + a_2 = 300 + 300 = 600mm
Where,
m= is the weight of the car = 25kg
a_1 =is the distance of the car's mass center = 300mm
C, =C.G from the front axle,
a_2 = is the distance of C from the rear axle = 300mm
L = is the wheel base. = 600mm

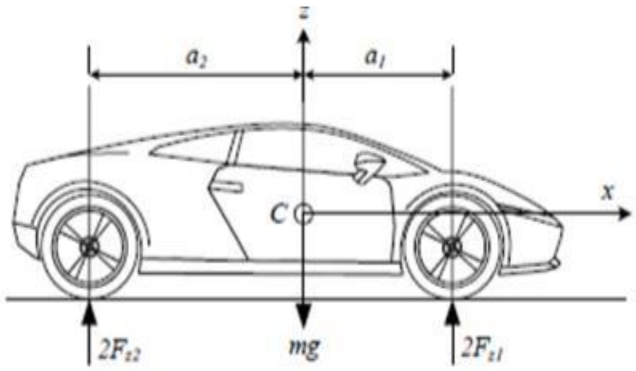

Fig 2: Parked car on level pavement

5.4. CALCULATIONS FOR LEAD SCREW

P=PITCH OF THE SCREW =3mm d=MEAN DIAMETER OF SCREW=12mm
HELIX ANGLE=4.59°

P=EFFORT APPLIED AT THE CIRCUMFERENCE OF THE SCREW TO LIFT THE LOAD=6.37N
W=LOAD TO BE LIFTED= 5KG =5×9.81=45.09N
μ=0.05=COEFFICIENT OF FRICTION

1) TORQUE FOR OVERCOME FRICTION BETWEEN SCREW AND NUT

T1=(P×d/2)=6.37× (12/2)=38.22Nmm
M.A. = W/P
49.05/6.37=7.7

2) TORQUE REQUIRED TO LOWER THE LOAD

P = w× tan (− α)
49 .05×tan (4.54-2 .86)
1.4386N

3) TORQUE FOR OVERCOME FRICTION BETWEEN THE SCREW AND NUT

T1 = P× (d/2)
1.4386×(12/2)
8.63N-mm

Efficiency = M.A. /V.R.
=tan α/ tan (α+φ)
η=61%

5.5. CALCULATIONS OF CHAIN DRIVES:

Where,
P_d = Design power
F_T = Tooth Load
V_P = Pitch line velocity
N_1 , N_2 = Speed of driver and driven sprocket.

Design power:
P_d= P_R *K_L=12 Watts

Tooth Load:
F_T = P_D/ V_P = 0.472 N

Pitch line velocity:
V_P = 3.14*D_P *N_1/60 = 25.38 m/min

Power capacity:
P= p^2 {V/104 - $V^{1.41}$ /526*(26 -25*COS 180/T)}*K_C = 7.87 Watts

Length of chain:
L_P = (T_1+T_2/2) +2C/P + p(T_1-T_2)/40C = 21.51 mm

Pitch diameter of sprocket:
D_{P1}= P/SIN(180/T_1) = 22.18 mm
D_{P2}= P/SIN(180/T_2) = 26.11 mm

Wear Load:
F_w = 0.35*p^2 = 13.67 mm

Width of sprocket:
t_o = 0.58P - 0.15 = 3.35 mm

Transverse pitch:
A= 1.1525*P = 7.20 mm

Corner relief:
e = 0.125P = 0.781 mm

Chamfer Radius:
r = 0.54P =3.375 mm

Outer diameter:
D_{O1} = P*[0.6 + COT(180/T_1)] = 25.03 mm D_{O2} =

P*[0.6 + COT(180/T_2)] = 29.01 mm

Bottom diameter:
$D_{R\,1}$= D_{P1} - 0.625P = 17.26 mm
$D_{R\,2}$= D_{P2} - 0.625P = 21.19 mm

6. ADVANTAGES

1) Comfortable parking at busy roads and in narrow space.
2) This type of car may be easily taken through traffic jam.
3) This type of mechanism eliminates the requirement of screw jack in the vehicle.
4) Space requirement for parking may reduced up to 20%.
5) Such type of mechanism may reduce accidents on high-way.
6) Time require for parking will be reduce.
7) Mental stress of driver during parking will be minimizing.
8) Overall fuel consumption for parking will be reducing.

7. CONCLUSIONS

The design and development of a prototype of the Transverse car parking mechanism has been done under the scope of a B.E. mechanical engineering project. Auxiliary wheels, DC motors are used to provide motion to the vehicle in the parking system. Pneumatic system is used to lift the main frame. The main advantages of this mechanism is to reduce the space requirement during on-street parallel parking, efforts required to park the car are minimum, Time required to park the vehicle is reduced. Main advantage of this mechanism is to reduce fuel consumption. And this mechanism can be use like built-in jacks. With the help of transverse car parking mechanism vehicle can be taken out easily from traffic jams which are the biggest problem on Indian roads.

8. REFERENCES

1) Sanjay Kumar Singh and Ashish Misra, “Road Accident Analysis: Case study on Patna city” published in “Urban Transport Journal2 (2) 60-75, July 2002.
2) Zeenab Aneez “Parking Space in Kochi: Issues and Solutions” published in “Centre for public policy research” in Nov 2010
3) Kv Krishna Rao “ Problems of Parking & solutions” published in “IEEE Journal”, in May 2006
4) Vishnu Garg“Accident Prevention Based on Automatic Detection of Accident.
5) Prone Traffic Conditions: Phase I” published in “Intelligent Transportation Systems Institute
6) Center for Transportation Studies University of Minnesota”, in Sept 2008.
7) S.Sarayu ‘’Design and Fabrication of Prototype of Automated Smart Car Parking
8) System using Programmable Logical Controllers (PLC)” International Journal of Scientific Engineering and Technology (ISSN: 2277-1581), in Sept 2013.
9) Houman Hatami “Hydraulic Formulary” Handbook for selecting pneumatic valves
10) Zamri Mohammad “Prediction of Car Ground Clearance” published in “Malaysian Technical Universities Conference on Engineering and Technology June 20-22, 2009, MS Garden,Kuantan, Pahang, Malaysia”
11) Ashwin. R. Shah “Selection guidelines” Handbook selecting pneumatic systems
12) Hamada R. H. AI-Absi “Vision-Based Automated Parking System published in “10th International Conference on Information Science, Signal Processing and their Applications (ISSPA 2010)”, in Sept 2010
13) Jazar R.N “ Forward Vehicle Dynamics” published in Nov 2008
14) Anumita Roychowdhury “Parking: Multi-level dilemma in Delhi”published in“ Centre of science and environment”, Apr 2012.
15) Hongwei Wang “A Reservation-based Smart Parking System” published in “IEEE Journal”, in March 2011.
16) Jose Ian Wilson , Fernandez, Facial feature detection using Haar classifiers, Journal of Computing Sciences in Colleges, v.21 n.4, p.127-133, April 2005
17) V.W.S. Tang, Y. Zheng, and J. Cao, "An Intelligent Car ParkManagement System based on Wireless Sensor Networks," Proceedings of the 1st International Symposium on Pervasive Computing and Applications,pp. 65-70, Aug 2006.
18) Sheng-Fuu Lin, Yung-Yao Chen , "A vision-based parking lot management system"., 2006 IEEE Conferenceon Systems, Man, and Cybernetics. Peter. C, pp. 2897-902, Oct. 2006.
19) Q.Wu, C. Huang, SyuWang, W. chen Chiu, and T.Chen. Robust parking space detection considering interspace correlation. In Proceedings of IEEE InternationalConference on Multimedia and Expo, pages 659-662,2007.
20) N. True. Vacant parking space detection in static images. University of California, San Diego, 2007.
21) Phillip Ian Wilson , John Fernandez, Facial feature detection using Haar classifiers, Journal of Computing Sciences in Colleges, v.21 n.4, p.127-133, April 2006.
22) Rainer Lienhart and Jochen Maydt. An Extended Set of Haar-like Features for Rapid Object Detection. IEEE ICIP 2002, Vol. I, pp. 900-903, Sep. 2002.
23) Proceedings of MUCEET2009 Malaysian Technical Universities Conference on Engineering and Technology June 20-22, 2009, MS Garden,Kuantan, Pahang, Malaysia.
24) “Reassessing On-Street Parking” by Wesley E. Marshall, Norman W. Garrick and Gilbert Hansen in 2008.
25) Pneumatic Application & Reference Handbook by Bimba Manufacturing Company.
26) Simplified Valve circuit guide: A guide to understanding Pneumatic Directional control Valves.
27) Management of Parking Spaces in the Walled City of Jaipur Sample study of Jauhari Bazaar and Bapu Bazaar by Riddhima CCS Working Paper No. 245 Summer Research Internship Programme 2011 Centre for Civil Society.