Review on Different Types of Car Parking Systems

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ABSTRACT

The product of ever- increasing number of cars and scarer places to put them in many cities. In the past four decades, the number of registered vehicles has been risen nearly 70%. India's urban population is currently around 30% of its total population. Parking is one of the major concerns in terms of space occupation in these places. Presently demand for cars going up at the rate of 15% per annum. Presently approximately 15 lakhs cars are being sold every year. Making roads more expensive than parking infrastructure. Cars being parked on roads causing traffic causes traffic congestion and pollution. So, it is mandatory to develop and design car parking system which can be solve the problem of parking.

Keywords: Automated parking system, Car parking system, Infrastructure, Lift, Modes of parking, Multistoried parking, Multi-level car parking, Parking space, , Pollution, Safety ,Traffic congestion, Transportation

1. INTRODUCTION

Parking is the act of stopping a vehicle and leaving it unoccupied for more than a brief time. Parking on one or both sides of a road is commonly permitted, though often with restrictions. Parking facilities are constructed in combination with most buildings, to facilitate the coming and going of the buildings' users. Parking lots are feature of every city and suburban area, shopping malls, stadium and similar venues often feature lots of immense area. The product of ever-increasing number of cars and scarer places to put them in many cities. In the past four decades, the number of registered vehicles has been risen nearly 70%.The growing population of India has created many problems - one of the challenging ones being car parking which we confront almost every day. Parking occupies large areas, sometimes the area is even larger than the building for which it serves.

Fig. 1 Open space parking

According to the statistics the rate of increase in the number of vehicles is very high as compared to that of the rate of population and the length of road. Due to the proliferation in the number of vehicles on the road, traffic problems are bound to exist. The key causes of traffic congestion in cities are as below:

- Increasing private vehicles & rickshaws
- Parking
- Vehicle breakdown
- Accidents
- Potholes/ under construction activities & repairs
- Lack of driving discipline

This is due to the fact that the current transportation infrastructure and car park facility developed are unable to cope with the influx of vehicles on the road. In India, the situation are made worse by the fact that the roads are significantly narrower compared to the West. Therefore, problems such as traffic congestion and insufficient parking space inevitably crops up.

Fig. 2 Traffic scenarios

Various measures have been taken in the attempt to overcome the traffic problems. To alleviate the aforementioned problems, the smart car parking system has been developed [1].

1.1 Modes of parking

(1) Parallel parking

(2) Perpendicular parking

(3) Angle parking

1.1.1 Parallel parking

With parallel parking of cars, these are arranged in a line, with the front bumper of one car facing the back bumper of an adjacent one. This is done parallel to a curb, when one is provided. Parallel parking is the most common mode of street side parking for cars. It may also be used in parking lots and parking structures, but usually only to supplement parking spaces that use the other modes [2].

Fig. 3 Parallel parking

1.1.2 Perpendicular parking

With perpendicular parking of cars, these are parked side to side, perpendicular to an aisle, curb, or wall. This type of car parking is more scalable than parallel parking and is therefore commonly used in car parking lots and car parking structures. Often, in car parking lots using perpendicular parking, two rows of parking spaces may be arranged front to front, with aisles in between. If no other cars are blocking, a driver may perform a "pull through" by driving through one parking space into the connecting space to avoid having to reverse out of a parking space upon their return.

Fig. 4 Perpendicular parking

Sometimes, a single row of perpendicular car parking spaces is marked in the center of a street. This arrangement eliminates reversing from the man oeuvre; cars are required to drive in forwards and drive out forwards [2].

1.1.3 Angle parking

Angle parking, known as echelon parking in Britain, of cars is similar to perpendicular parking for these vehicles, except that cars are arranged at an angle to the aisle (an acute angle with the direction of approach). The gentler turn allows easier and quicker parking, narrower aisles, and thus higher density than perpendicular parking. While in theory the aisles are one-way, in practice they are typically wide enough to allow two cars to pass slowly when drivers go down the aisles the wrong way [2].

(a)

(b)

Fig. 5 Angle parking

1.2 Different types of parking system

(1) Multistoried parking
(2) Automated parking system
(3) Valet parking
(4) Net parking.
(5) On street parking
(6) Underground parking

The different types of parking system are described below.

1.2.1 Multi storied car parking system

It is a building which is designed specifically to be for automobile parking and where there is a number of floor or levels on which parking takes place [2].

Fig. 6 Multistoried parking

1.2.2 Automated car parking systems

It is also known as robotic parking system. It is the most advanced parking system. The automated car parking systems are also sub classified as follows:

a) 2-Step car parking system
b) Puzzle car parking system
c) Elevator car parking system
d) The multi floor parking system
e) Rotary type parking

(a) 2 Step stacker type parking

This system features a pallet that is lifted up then after the car is loaded. Thus additional parking can be made available in the space below the loaded pallet. Both indoor and outdoor installation is possible. Installation can be done on simply flat area with no additional architectural work. These systems are electromechanically or hydraulically operated. Preferably these systems are valet parking system.

Fig. 7 Step stacker type parking

(b) Puzzler type or modular parking

This system can have more than two levels of parking. Its design has a structure that enables use of all parking entrances and exits on ground level. The parking pallet moves left, right, upward, and downward and has always a minimum of one empty slot for movement. Car parker can have multiple levels above, pit style below, or a combination of both.

Fig. 8 Puzzler type or modular parking

(c) Elevator type or tower parking

The elevator type often called the Parking Tower, is designed to automatically move the vehicles on a pallet vertically on the elevator, it then transfers it horizontally left or right for storage. Very fast retrieval time is accomplished in less than two minutes. This system is suitable for medium or large scale buildings. It can also be used as a standalone tower for a parking garage business. Since it is controlled by an integrated computer system, the overall operation can be viewed with one screen and its operation is very user friendly.

Fig. 9 Elevator type or tower parking

(d) Multi floor parking type parking

The Multi Parking system has been designed to automatically move the vehicles by lift which then transfers it to a waiting cart on one of the multi levels. The carts then travel horizontally and place the vehicle in its appropriate slot. This system is suitable for middle and large scale buildings as well as independent public parking garage. The Multi parker can accommodate as little as 20 vehicles to several thousand units. It is therefore suitable for large scale projects. It can move more than 2 vehicles at the same time for maximum efficiency.

Fig. 10 Multi floor parking type parking

(e) Multi floor parking type -circulation parking

After entering the vehicle in the parking garage, the parking system is designed to move the vehicles vertically with elevators on each end. The garage consists of several levels where the vehicles are moved horizontally which rotate the pallets in conjunction with the elevators. The multi floor circulation type is suitable for small and midsized buildings because of its high space efficiency.

Fig. 11 Multi floor parking type- circulation parking

(f) Rotary type parking

The perfect solution to park the maximum number of cars in the least amount of space. The design enables you to park either 7,8,10, or 12 vehicles in the space of only 2. There is no need for a parking attendant, just insert the key and press your parking space number and the pallet will rotate either clockwise or counter clockwise. It will automatically sense which way to rotate by space number.

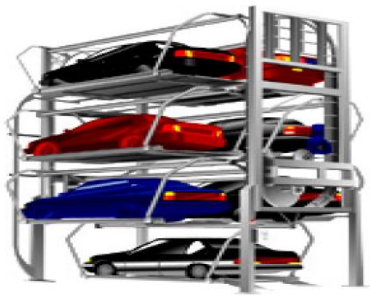

Fig. 12 Rotary type parking

Technical Specifications for Proposed Development

There are two types of technology available in automatic car parking lift. i.e., Hydraulic and electro mechanical systems. The suitable options in automated multi-level car parking can chose based on the site conditions, budgetary constraints, traffic scenario, capacity, etc. [13].

(a) Hydraulic type

A hydraulic cylinder is used to operate this type of lift. Due to the limited length of the cylinder, however, the hydraulic type of lift is limited in terms of height. It is generally appropriate for the parking systems with less than four levels. The

hydraulic type of lift requires less pit area and no balance weight, and features a quiet and stable operation.

(b) Wire rope type

The wire rope type of lift provides fast operations and features an extended elevation height that is taller than that of the hydraulic type. It is suitable for parking systems with more than four levels. However, this system requires more pit area than the hydraulic type since the balance weight should be secured.

1.2.3 Valet parking

(a)

(b)

Fig. 13 Valet parking

In valet parking, the driver leaves the keys to an attendant who arranges vehicles so as to maximize the number of vehicles that can be parked in the lot. Such arrangements are known as attendant parking. When the lot or facility is provided to serve the customers of a business, it is considered as valet parking [2].

1.2.4 Net parking

It is a web based technology through which parking reservations can be done [2].

(a) (b)

Fig. 14 Net parking

1.2.5 On street parking

On street parking spaces are monitored and enforced by the city and privately-owned lots and garages are monitored by their operators [2].

Fig. 15 On street parking

1.2.6 Underground parking

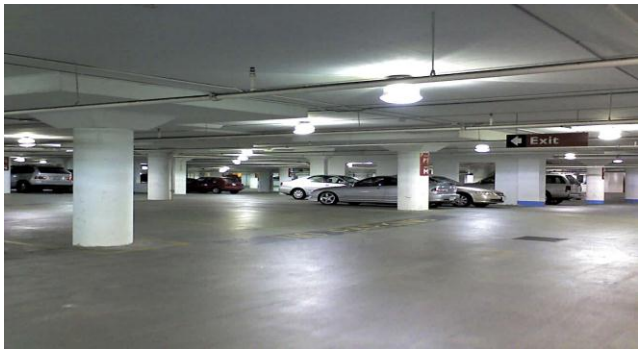

Fig.16 Underground parking

There may be speed limits, stop signs and crosswalks for pedestrians in large parking lots. There are often one or more parking spaces for handicapped people [2].

1.3 Need for multi-parking facility

Car sales, close to 8 lakh units a year, are growing at an average rate of 10 percent while two wheeler sales at 5 million are expected to grow 14-15 percent. In order to accommodate the large volume of vehicles, cities and towns must develop their infrastructure - roads, flyovers, car parks and other facilities. One solution for such a growth is multi-level car parking system to maximize car parking capacity by utilizing vertical space, rather than expand horizontally. So far three types of mechanized car parking systems - puzzle, tower and mini have been operating in India. In each of these, the car is always parked or retrieved at one level only, and the stationary vehicle is carried to different levels in steel pallets. The number of vehicles in metros is fast increasing. The demand for car parks is an integral part of a residential or commercial complex, rather than an independent commercial venture. It

may take a long time before parking fees in India reach a level at which the investment in these systems and their maintenance cost can be recovered from parking fees alone. A multi-level car parking system will be a feasible in commercial layouts. It has to be clubbed with ad revenues or with some other alternatives like commercial activities so that the revenue keeps flowing to the owners who implement car parking systems [14].

1.4 Multi-level car parking

A multilevel vehicle parking system ensures not only safety to the vehicles parked within it, but also ensures creating a total pollution free environment. It provides a clean, environmentally friendly operation and assures high safety and security for passengers, vehicle and contents. A modern multi-level parking system offers minimum movement of parts and noise. It provides effective maintenance with aircraft type efficiency and reliability at easy and cost-efficient operation. Full exploitation of land usage up to 90% is ensured compared to 67% in other comparable systems and other advantages such as makes best use of available space above and below ground with less environmental impact it reduces opportunities for theft and burglary.

Automated parking is a method of automatically parking and retrieving cars typically using a computerized system of shuttles, lifts, and carriers. Advantages are,

- The hassle of searching for an empty spot would be eliminated.
- Designed to decrease the risk of car theft, vandalism, and physical assault.
- Eliminate the issue of fender benders and car door dents.
- Drivers can retrieve their vehicles from a secure waiting area and are less likely to risk their personal safety.
- Ideal for individuals with limited mobility or special needs.

Automated Parking allow for flexible usage of land space, which means that the footprint can be reduced to one third of the land required by conventional car parking solutions. It requires little power lighting and can be built where a typical conventional car park would not fit. Cost effective on a number of fronts, automated parking also offers significantly improved service to the customer, the automated parking is reliable technology is manufactured to high tolerances and has few moving parts making maintenance costs low. It is economically beneficial to the environment. It would reduce the problem of pollution because the vehicles are not driven through the system, meaning there are fewer emissions. Automated Parking would drastically reduce noise and disruptions. The ground space saved would enable more space devoted for greening the cities and allow automated parked systems to be unseen [13].

2. LITERATURE REVIEW

The present project report on design and analysis of two post car parking system is an essential requirement of current trends of vehicle parking system. Day by day number of vehicle is increasesd but the land require for parking is same. Literature review is divided into four category. First part is a historical development of lifts. Second part is of multi level car parking system. Third part is of kinematic analysis, dynanic analysis and synthesis of mechanism and fourth part is of FEA analysis.

2.1 Historical review of the lift

Primitive lifts were in use as early as the 3rd century BC, operated by human , animal, or water wheel power . From about the middle of the 19^{th} century, power lifts, often steam-operated, were used for conveying materials in factories, mines, and warehouses.In 1853, American inventor Elisha Otis demonstrated a freight lift equipped with a safety device to prevent falling in case a supporting cable should break .This increased public confidence in such devices. Electric lifts came into use toward the end of the 19th century. The German inventor Werner Von Siemens built the first one in 1880. The increase in the numbers of high and medium rise buildings since the Second World War has been a challenge to the lift industry [4].

Koppensteiner (1985), designed a lift buffer, which is in the form of a plate attached to a rail that moves vertically in housing. The housing includes a brake, which rubs on one side of the rail; on the other side, there is a roller. A leaf spring is positioned between the housing and the roller. When the rail moves vertically in one direction, the roller is pushed progressively harder against the rail. This squeezes the rail against the brake, creating a braking force on the rail that increases, to maximum, in relation to distance the rail moves. This arrangement may be used as a buffer for a lift cab or

counterweight in a lift. This buffer is simple and inexpensive, which needs nearly no routine service and provides consistent performance over wide temperature ranges. In accordance with the invention, a mechanical brake is used to absorb the kinetic energy, and its braking force is progressively increased with buffer stroke to provide smooth deceleration below a peak level [5].

Sugahara et al. (1992) invented a lift apparatus provided with a guiding device for guiding a passenger car without vibration with respect to the guide rails. Sensors are provided so that a pressure applied to the guiding device from the guide rails is maintained constant, and an actuator is driven by the output of the sensor. The sensor may be a pressure sensor and, as the output of the sensor increases, the distance between the guide rail and the passenger cage is controlled in a manner to be decreased [6].

John H. Klote, (1995) invented a lift rope guide assembly which prevents or lessens vibration of the ropes connected to the cab by means of the auxiliary guide roller pairs disposed on either side of the cab sheave. Additionally, the cab sheave has rope engaging grooves, which are substantially deeper than the diameter of the rope and include outwardly divergent sides [7].

Richter et al. (1998), developed a mechanism drive frame for a self-propelled lift car traveling on guide rail running surfaces which drive frame includes a pair of generally vertically extending side beams, a yoke beam connected between upper ends of the side beams by a pair of gusset plates, a pair of frame brackets each attached to a lower end of an associated one of the side beams, each of the frame brackets having a support surface formed thereon for supporting an lift car body, and a frame crossbeam connected at opposite ends thereof to the frame brackets and having lateral passages formed in the opposite ends thereof. A pair of rocker arms each is pivotally mounted at one end to an associated one of the frame brackets at a rocker bearing. A pair of axle tubes each has an inner end connected to one end of a drive unit and an outer end attached to an opposite end of an associated one of the rocker arms [8].

2.2 Multi level car parking system

Business, Transportation and Housing Agency California Department Of Transportation presented a report "Parking and TOD: Challenges and Opportunities" (February 2002) ,which is intended to provide information to local jurisdictions, transit agencies, developers, financial institutions, and others as they develop and implement parking standards and programs for transit-oriented developments (TODs) in California. It provides an overview of available information regarding the extent to which parking for various types of land uses may be reduced in the vicinity of major transit stations. TOD offers significant opportunities to reduce the number of parking spaces below conventional parking requirements for retail, office and residential land uses. TOD provides these opportunities by increasing transit accessibility and combining a mixture of land uses. At the same time, increased densities in TODs, coupled with the goal of improving accessibility for pedestrians to transit stations, often means building structured parking garages.

This special report is organized in five main sections. The first section presents general findings regarding the extent to which parking can be reduced in TODs, which derive from interviews/surveys of transit agencies and developers in California and around the country, and a review of the literature. Sources that were reviewed include academic studies, trade journal articles, consultant reports, agency studies, and planning documents available in hard copy or on the Internet. These findings show that parking can successfully be reduced in TODs. The next two sections of the report present summaries of site-specific and regional strategies that various jurisdictions and developers are using to reduce parking or to use parking more efficiently in TODs. The fourth section of the special report suggests a generalized process for developing a local parking program. The primary purpose of this section is to point out general issues that need to be addressed. Finally, the report provides several appendices that supplement other information presented and provide some illustrative examples [9].

The First American application of a large scale mechanical parking will be in Hoboken, NJ, where Robotic Parking Inc. is installing a 334- car garage on a 10,000 square foot lot in residential section of the city. While hundreds of multi-story mechanical garages have been built in Europe and Asia, interest in the U.S. has been relatively slow to develop. As land values continue to escalate rapidly in many urban markets, however, other U.S. cities are also considering implementing this technology.

Robotic Parking Inc.'s modular automated parking system (MAPS) integrates auto transport technology used in auto assembly plants with state-of-the art warehousing technology to double the number of cars that can be parked in a typical

garage. Drivers park their car on an at-grade, leak proof pallet and then take a ticket, punch in a code, or swipe a card to activate the system. Then three autonomous robots move the pallet and car to an open stall. Drivers use their ticket or card to retrieve their car, which is returned within a few minutes to the ground level bay [10].

In the last 20 years, MHE-Damage has been representing KLAUS Multi parking from Germany in South East Asia for supplying mechanized car parking systems. KLAUS Multi parking GmbH, is one of the most important suppliers of innovative multi parking systems worldwide with over 500,000 parking spaces installed. KLAUS multi parking has 100 years of company history and has 40 years of know-how in the planning and production of parking systems.MHE-Demag's car parking systems, either mechanized or fully automated car parking systems, are renowned for their reliability and efficiency. After handing over the parking systems to the client or end users, our after sales support is committed to ensuring that the system runs smoothly and uninterrupted [11].

Hitendra G. Wasnik (2011) in their paper "Optimal Automatic Car Parking System for Indian Environment", presented that due to the proliferation in the number of vehicles on the road, traffic problems are bound to exist. This is due to the fact that the current transportation infrastructure and car park facility developed are unable to cope with the influx of vehicles on the road. In India, the situation are made worse by the fact that the roads are significantly narrower compared to the West. Therefore, problems such as traffic congestion and insufficient parking space inevitably crops up. Various measures have been taken in the attempt to overcome the traffic problems. To alleviate the aforementioned problems, the smart car parking system has been developed [12].

KSIIDC-IL&FS Project Development Company (KIPDC) 2009 presented the prefeasibility report "Development of multi-level car parking facilities", to conduct project prefeasibility study for development of the proposed project on PPP at the identified locations and include the project concept, need for the project at the location, preliminary market / demand assessment, broad financial feasibility/viability, implementation framework, recommendation of nodal agency for the project at individual locations, role of nodal agency & IDD and way-ahead.

The pre-feasibility essentially focuses on the viability of the project on PPP with / without State / Central Govt. support, segregation of projects / locations requiring VGF support and project development approach for projects proposed to be taken up for project development by KIPDC. The Prefeasibility study has been carried out with location analysis and assessment of viability for development at multiple locations across the State. KIPDC proposes to provide advisory services for the implementation of MLCPs in the cities identified as an innovative urban infrastructure development program of the Government of Karnataka [13].

Infrastructure Development Corporation (Karnataka) Limited presented a Pre-Feasibility report "Multi-Level Parking Facility at Brindavan Gardens", to reduce the impact of the growing number of tourists and vehicles to Brindavan Gardens, it was thought that an organized parking area should be provided without the need to expand horizontally on the ground. A pre-feasibility study was carried a multi-level parking facility for cars and buses and also providing for passenger amenities. Components of the project are parking facility for cars, parking facility for mini-buses, parking facility for buses, facilities for passengers [14].

2.3 Kinematic analysis, dynamic analysis and synthesis of mechanism

Vasile Zamfir et al. (2010) in their paper "Synthesis of four-bar linkage using displacement equations", presented a synthesis of four-bar mechanism using Freudenstein equation. In this paper, algebraic methods for the synthesis of four-bar linkages as well as other planar mechanisms will be considered. Such methods of synthesis are based on displacement equations, i.e., equations relating the input and output variables of a mechanism in terms of its fixed parameters [15].

Prof. N. G. Alvi et al. (2012) wrote a paper "Computer aided analysis of four bar chain mechanism", in which a graphical approach are proposed for the analysis of velocity and acceleration to study motion of a four bar mechanism. But values of velocity and acceleration changes with respect to time for different positions of the crank. So Analytical approach is alternate method and preferable than graphical to save time and cost. For that, a computer program is prepared to solve this problem and to get the values of velocity and analysis at different positions of the crank [16].

Ajay A. Dhore1, et al. (2012) in their paper "Synthesis of four-bar linkage using Freudenstein equations", Presented a method to enumerate and codify the solutions of type synthesis of linkage mechanisms with rotoidal and prismatic joints. The essence of mechanism synthesis is to find the mechanism for a given motion. Type Synthesis is the first stage of conceptual design of mechanisms, where the number, type and connectivity of links and joints are determined. It is followed by the Dimensional Synthesis stage, where the link lengths and pivot positions are computed to fulfill a given kinematic task. The latter and the subsequent stages of detailing design are very costly [17].

Chin Pei Tang (2006) wrote a paper "Lagrangian dynamic formulation of a four-bar mechanism with minimal coordinates", which describes the detailed steps in formulating the dynamic equation of a four-bar mechanism in the minimal coordinate form using Lagrangian formulation. In this article, he shows the systematic process of using the extra number of generalized coordinates to parameterize the configuration of the closed system, and reducing the required coordinates to only one when formulating the dynamic equations in this case. He performed the position and velocity analysis for a simple four-bar mechanism problem. Since the system has only 1 D.O.F., he shows that the dynamic of the system can be completely parameterized by only one coordinates (in this case, the input angle µ.) Finally, a simple forward dynamic simulation was performed in the real-time setting for completeness [18].

Hakan ÜLKER (2010) wrote "Dynamic analysis of flexible mechanisms by finite element method", where vibration characteristics of flexible four-bar mechanisms are investigated by using the procedure developed in ANSYS. Kinematics and kinetics of the four-bar mechanism having rigid and flexible links are presented for finite element modeling of the flexible mechanism. Equations of motion for rigid and flexible four-bar mechanisms are derived by using Lagrangian dynamics to show the theoretical approach. In order to find the natural frequencies of the flexible four-bar mechanism for different configurations, Eigen analysis of the mechanism is carried out by considering the discrete crank positions. Dynamic natural frequencies based on the motion induced axial loads are found by using the discrete inertia forces acting on the nodes of the finite element model. The mode shapes of the flexible four-bar mechanism are also found and plotted with undeformed configurations [19].

Manish Mehta et al. (2012) in their paper "Elastodynamic analysis of four bar mechanism using MATLAB and ANSYS WB", presented FEM for dynamic analysis of high speed mechanism. Based on this method program was developed in MATLAB for determined deformation in coupler link of mechanism. An example problem has been solved. Same example has been taken in ANSYS WB for elastodynamic analysis. Results from MATLAB and ANYSYS WB are compared and presented in form of graphs [20].

Tian Hongyu et al. (2011) in their paper "Design and simulation based on Pro/E for a hydraulic lift platform in scissors type", presented design of a scissors lift platform based on Pro/E can be done such as the main components 3D modeling, visual assemble, interference checking etc., which help the designer find the problems in the 2D design . The model set up from the three dimension software expression the designer's idea sufficiently about the work [21].

Jian-Yi Wang et al. (2011) in their paper "Innovative design of the lifting mechanisms for forklift trucks", presented the innovative design of a new lifting mechanism for forklift truck. Firstly, a spatial multi-link lift-guidance mechanism is proposed. And then, under the constraints of this mechanism, the mobility of the fork and fork frame is investigated in theory. Lastly, a new lifting mechanism based on it is presented and computer simulation is used to demonstrate the feasibility of motion. This multi-link lifting mechanism takes advantage of flexible cable drive and rigid body guidance, which not only provides the operator with a wider field of vision but also reduces the equilibrate weight of a vehicle and therefore improves the fuel economy [23].

Xin-Jun Liu Wang et al. (2011) in their paper "A new family of spatial 3-DOF fully-parallel manipulator with high rotational capability", presented a new family of spatial 3-DOF fully-parallel manipulator with high rotational capability to overcome their low rotational capability. Parallelogram allows the output link to remain at a fixed orientation with respect to an input link, for which it has many unique roles, especially when creating a desirable DOF output in the design of parallel manipulators. The role of a parallelogram here in described, is used completely for the design of a new parallel manipulator family. In this family, the moving platform of a parallel manipulator is connected to the base by three non-identical

legs. The fact that all joints involved in the rotational DOF are with single DOF guarantees the high rotational capability performance of the manipulators. The parallel manipulators proposed here have wide applications in industrial robots, simulators, micro-motion manipulators, parallel kinematics machines, and any other manipulation devices that a high rotational capability is needed. The research provides a new design methodology of novel parallel manipulators [24].

2.4 FEA analysis

Vaibhav K. Bhagat et al. (2012) in their paper "Development and structural analysis of translation carriage for reach truck", presented F.E.M. technique and CAD modeling to analyze and develop translation carriage for reach truck. This analysis has been carried out in terms of strength and stiffness and by means of F.E.M. technique. There have been simulated different load cases and boundary conditions that the structure of carriage should bear. This load cases can be obtained from normal and extreme operation of the carriage and the results are validated [25].

Atish Gawale et al. (2012) in their paper "Nonlinear static finite element analysis and optimization of connecting rod", presented nonlinear static analysis and optimization of forged steel connecting rod. Optimization is important as less time required to produce the connecting rod which is stronger, lighter with minimum cost. The design and weight of the connecting rod influence the engine performance. Hence optimization is to be carried out. Specifications of connecting rod have been evaluated to calculate the loads acting on it. Nonlinear static analysis is carried out on piston end and crank end of connecting rod then further study was conducted to explore weight reduction opportunities for a production of connecting rod. The component is to be optimized for weight subject to constraint of allowable stress and factor of safety. A proper CAD model is developed using software CATIA V5 then FEA of connecting rod is carried out to determine the maximum vonmisses stresses for the given loading conditions using software ANSYS WORKBENCH. The percentage weight reduction obtained was 7.35% by optimization [26].

2.5 Summary

In this literature review is discussed in four parts. Historical reviews of the lifts are discussed in first part. Multi-level car parking systems are discussed in second part of literature review. Kinematic, dynamic and synthesis of mechanism are discussed in third part of literature review. FEA analysis are discussed in forth part of literature review. Second important section of the manuscript **author's information** this section provides full names of all authors or used initials or first and last name. Affiliation details should include the name of the department(s) and institution(s), university, organizations, city, state, country, and where the work attributed should be specified for all authors. Contact detail of all authors in manuscript email is mandatory. At least one of the author's name should be designated as the corresponding author with a hash mark (#) used to indicate corresponding author name. It is the corresponding author responsibility to ensure that the author's list and the summary of the author's contributions to the study are accurate and complete.

3. CONCLUSION

As we know that parking is a very common problem in everywhere with the phenomenal increase in personalized motor vehicles, one of the major problems confronted by the motorists is the acute shortage of parking space. The provision of multilevel parking and their effective use emerges as the most viable initiative in the cities. Proper parking manages reduce the congestion on the road. The improvement of parking conditions has a direct impact not only on the improvement of traffic conditions and road safety in the area considered, but also on the local economy.

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