ELEVATOR-TYPE PARKING LOTS

Student – Ph.D. Candidate: Eng. **Carmen Elisabeta RADU,** e-mail: carmenradu23@gmail.com , University POLITEHNICA of Bucharest, Romania
Student – Ph.D. Candidate: **Edward RĂŞCHITOR** e mail: edwardraschi@gmail.com **,** University POLITEHNICA of Bucharest, Romania
Ph.D. Eng. Professor Emeritus **Iosif TEMPEA** e-mail: iosiftempea@yahoo.com
University POLITEHNICA of Bucharest, 313, Spl. Independentei, Bucharest, Romania

Abstract: *The paper deals with the types of automated parking facilities in operation, taking into account the advantages and problems induced by them. There are presented underground parking, one-and two-platform elevators and their mechanisms, as well as robotic parking along with the existing mechatronic system.*

Keywords: Parking, elevator, platform, mechanism

1. Introduction

In the modern world, transport is an essential element for the smooth running of economic and social activities. Urban road transport requires a better fluidization of road traffic in view of the increasing number of existing vehicles in cities and the lack of sufficient number of car parks. The existence of an increasing number of motor vehicles implies the clutter of runways and also negatively influences public transport and pedestrian traffic. It is necessary to carry out a study on the possibility of constructing different types of parking spaces, depending on space, capacity, existing technology and financial possibilities. The necessary parking spaces in Bucharest are highlighted in the paper "Necessity of Parking System Development in Bucharest" [1].

2. Parking lot provided with underground vertical lifting

This type of parking involves building an underground concrete space on a variable surface depending on the number of cars that can be parked (see figure 1). The assembly includes an electric motor and a chain drive to drive the platforms.

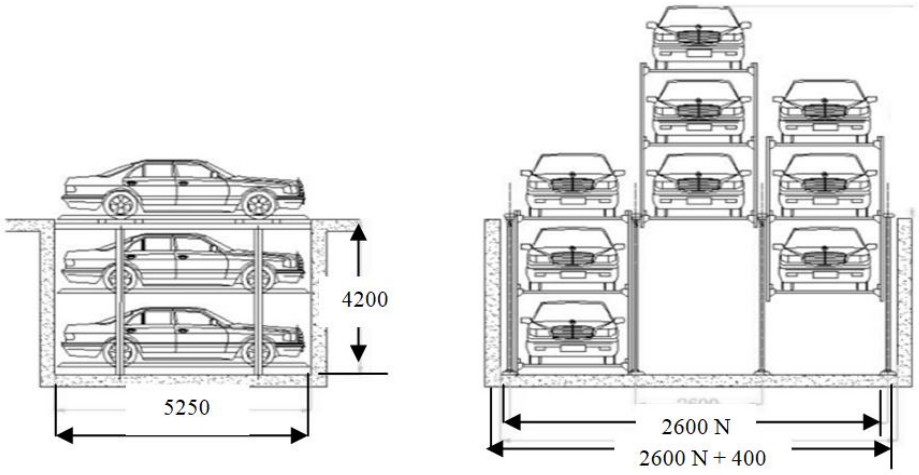


Fig. 1 Vertical underground parking lot

The advantages and shortcomings of an underground parking lot [1]

- One may use a small land area and a larger underground area (fig.1). Elevations: depth 4200 mm, length 5250 mm, maxes underground width (2600*N + 400) mm, where N= number of vehicles that can be parked
- One may provide one or more units for more parking units
- The system is simple and reliable, because it only implies a lower area made of concrete, a 3 KW electrical drive engine, and a chain gearing for driving the platforms
- The vehicles to be found at the lower levels are well insulated against rain and snow during the cold season and against excessive heat during the hot season by adopting a proper ventilation system
- The vehicles to be found at the lower levels are provided with a very good anti-theft protection
- One may use power supply installations for the electrical cars in the parking lot
- They must be built in a very stable area at the ground level, so that no declivity issues would occur in time
- The price is higher than a simple ground-level parking lot
- It is imperative that a fire-fighting verification be constantly performed in order to prevent fires
- The following items are absolutely necessary: a high-quality electrical installation, a ventilation installation, very good lighting and a sewerage installation for discharging the water that may accumulate
- It cannot be used in narrow areas, between buildings or in the proximity of green areas
- The pollution issue may occur if the assembly is placed in a closed location
- In order to be able to remove the underground vehicles, one must move the ground-level vehicles
- The vehicles to be found at the lower levels can be evacuated with relative difficulty in cases of strict emergency

3. One-platfprm elevator

This elevator model with a platform is similar to those used in car services. The system is actuated by an electrical engine that actuates, in its turn, a hydraulic pump, and includes a chain gearing. [3]

The area where the parking lot would be installed must have the following features:

- Sufficient lighting
- The area should be weatherproof;
- The area should properly be ventilated;
- Unpolluted environment;
- Noise level below the one provided by the legal norms ≤70 dB
- There should not be dangerous movements generated by other cars of operating equipment in the area;
- No inflammable, explosive, corrosive or toxic materials should be stored in the installation area of the parking lot;
- The distance from the pillars to the walls or other fixed equipment should be minimum 70 cm;

Advantages, disadvantages and issues entailed by this type of elevator:

- Economical system with low noise level during operation
- Simple structure, easy installation, minimal troubleshooting requirements
- One requires a small area for installing such an assembly
- Restricted use, only for two vehicles (cars).
- The need to remove the ground-level vehicle to be found at in case another vehicle is parked on the platform
- The presence of a person that would operate the platform lifting and lowering switch

4. Two-platform elevator

The elevator is made up of two platforms (lower I and upper S) on which vehicles stay.

In the first phase, the engine M in figure 2 acts on the translation element that moves to the right.

The I+S assembly moves to the right, and at this point, the first vehicle is loaded onto the upper platform.

In the second phase, the movement is to the left, and the vehicle is loaded onto the lower platform.

The advantage of this system consists in the independence of the two parking spaces, while it is no longer necessary to move the vehicle from the lower platform for loading or unloading the one on the upper platform.

As a disadvantage, one may mention a more complicated construction of the infrastructure, depending on the elevations of the device.

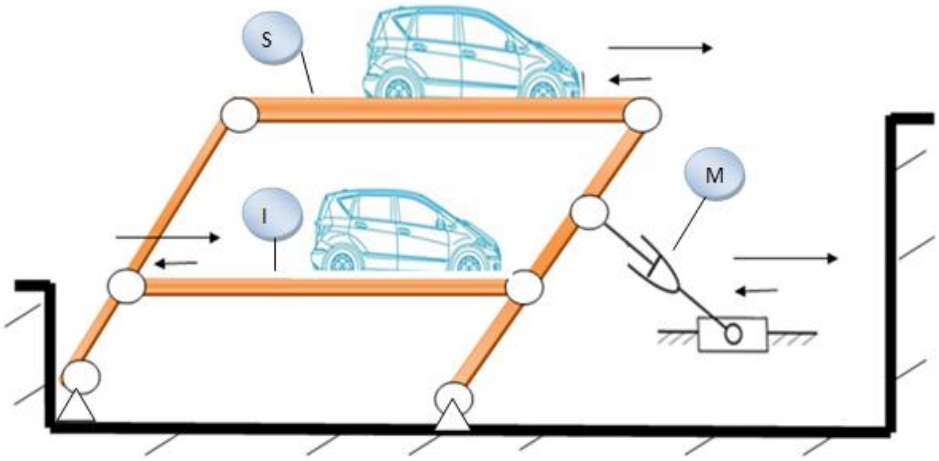
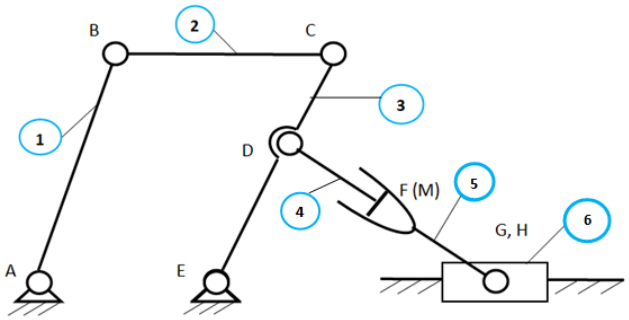


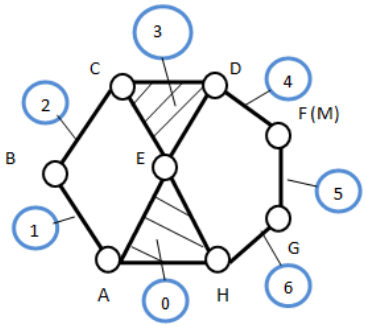
Fig. 2 Elevator with two platforms

THE KINEMATIC SCHEMES FOR TWO VARIANTS OF AN ELEVATING MECHANISM

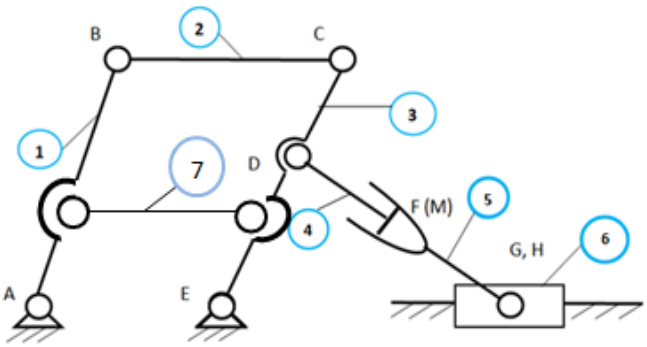
The kinematic schemes and the structural scheme

The kinematic chain and the mobility degree of the mechanism





n = the total no. of elements , $n = m + 1$, $m = 6$ mobile elements, $i = 8$ lower kinematic couplers (R or T),
Mobility degree $M = 3m - 2i - s = 18 - 16 - 0 = 2$



Variant including a passive element (7), parallel with the element (2).
The structural scheme for the two-platform mechanism for two parking spaces.

$M = 7$ mobile elements
$i = 10$ lower kinematic couplers (R or T)
$s = 0$ upper kinematic couplers

In the first variant, the mechanism includes 6 mobile elements, among which a balancer (3), the base element and 8 lower kinematic couplers (rotation and shifting). The mechanism is a desmodrome cinematic chain with a fixed element whose degree of mobility is equal to the number of its leading elements. [4]

The mobility degree is

$$M = 3m - 2i - s = 18 - 16 - 0 = 2 \quad (1)$$

In the second variant, the mechanism includes 7 mobile elements and 10 lower kinematic couplers (including a passive element and related couplers). The motor element is F(M).

The passive element consolidates the mechanism, facilitates its transition through the extreme positions, and avoids its temporary blockage. The passive elements and the related couplers are excluded from the calculation when establishing the mobility of the mechanism. So, also in the second variant, the mechanism also has the mobility degree $M = 2$. [3]

5. Robotic operation parking

The previously presented parking lots imply that certain conditions must necessarily be met - and they are not always easy to blend. Thus, the following are imperative:

The availability of large areas required for laying out these parking lots in order for them to be used for several vehicles, which leads to the decrease of the green areas, circulated urban areas and the possibility of using these areas for other purposes;

The possibility of using restricted areas only for a small number of vehicles and with a total decreased mass of less than 2000 kg.

The previously mentioned elements can be solved by using robotic parking lots, controlled by certain applications. [6]

In this situation, one uses a cyber-mechatronic system for industrial environments, which can be applied in situations where the multilevel parking lots are required.

The mechatronic system includes in this case (fig.3):

- The Remote Monitoring and Control Center - it includes a computer provided with a remote control and monitoring robot software and router which is internet-connected;
- Mechatronic Subsystem - Cyber Space - Control Panel and Robot Software, Smart Telecontrol Equipment, Modem and Antenna. It is linked to the Internet of that facility;
- The industrial robot - a robot including the handlers of the vehicles, the control unit, electrical connections and the interface with the computer system.

As soon as a vehicle with a subscription enters the parking lot, the subscription is read, validated and thus the PC performs a connection between the owner's parking space, which is paid for, and the need to move the vehicle to that space. The robot loads the vehicle into the lift, the command is given for moving the lift where the vehicle is loaded into, and according to the data available in the data base, the vehicle shall be lifted up to height h, length L to the garage level and floor j. At that point, the robot removes the vehicle from the lift and parks it at the set place. For more vehicles, one must provide more lifts, while the heavy and special vehicles must be parked on the ground floor or on the lower floors.

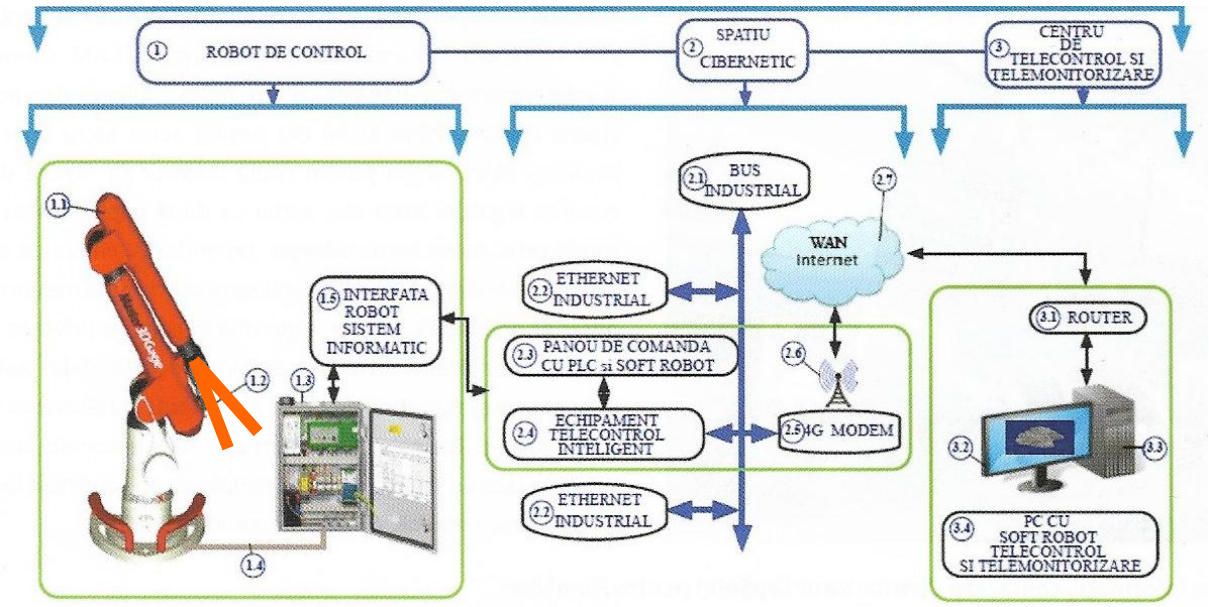


Fig. 3 Mechatronic system used for robotic parking

6. Conclusion

In view of the above, the following conclusions can be drawn:

- Parking with the highest efficiency and most useful in a big city is the robotic parking;
- For the financial possibilities and the reduced spaces compared to the robotic system, more and more underground parking lots will be adopted;
- One or two platform elevators are only solutions for situations where robotic parking or underground parking cannot be used.

References

[1] **Radu, C. E., Răşchitor, E, Tempea, I,** *Necesitatea Dezvoltării Sistemului de Parcare din Municipiul Bucureşti*, „DURABILITY AND RELIABILITY OF MECHANICAL SISTEMS" - SYMECH 2018-Tirgu Jiu

[2] **Two-floor-Mechanical-parking-garage-system**_1872899813.html

[3] **www.creeaza.com**/familie/diverse/Manual-de-Utilizare-Elevator-C918.php

[4] **Tempea,I, Dugăeşescu, I, Neacşa**, **M**, *Mecanisme*- Ed. Printech, 2006

[5] **Creţu, S.M,** *Mecanisme- Analiză structurală*- Editura Sitech, Craiova, 2010, pag. 64

[6] **Gheorghe, Gh.,** *Contribuţii originale şi ştiinţifice la dezvoltarea sistemelor cyber-mecatronice pentru medii industriale, economice şi societale* - Revista TechnoMarket - februarie - martie - aprilie - mai 2017