RESEARCH ON ACCESS MECHANISMS IN A ROBOTIC PARKING LOT IN BUCHAREST

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Abstract: *The types of parking lots that can be implemented in Bucharest include simple parking areas, multi-storey facilities, electrically operated parking systems, and robotic parking structures designed for multiple vehicles, utilizing a high-efficiency mechatronic system. Based on the research conducted, a multi-storey robotic parking lot equipped with anti-seismic protection systems and photovoltaic panels is being considered.*
This paper explores the feasibility of constructing a parking facility above the Dâmbovița River, incorporating an access mechanism for vehicles. The study includes a structural, kinematic, and dynamic analysis of the chosen mechanism, as well as an evaluation of its mobility degree.

Keywords: the parking lot with robotic electric drive for many vehicles, mechanism, kinematic analysis.

1. INTRODUCTION

The proposed parking structure features multiple levels with dozens of organized parking spaces. To ensure efficient operation, it is essential to implement a mechanism that regulates vehicle entry and exit, functioning as a barrier system with a height limiter. Additionally, guidance systems similar to those used in Kandra will be integrated to facilitate quick identification of available parking spots. The incorporation of sensors for detecting permitted vehicle height and vacant spaces enhances parking efficiency, reducing time, costs, and fuel consumption. This initiative represents a step forward in social innovation and environmental protection. Several design alternatives for the barrier mechanism have been analyzed, and the adopted solution is detailed below (option 1) [1], [2], [3]

Fig. 1 The robotic parking lot(mockup, own contribution)

2. BARRIER MECHANISM FOR PARKING ACCESS

A robotic parking access mechanism includes several essential components to ensure the efficient and safe operation of the system.

A bar mechanism has been developed for vehicle access, as illustrated in Figure 2. The system consists of two identical parallel bars (AC and BD), hinged at their lower ends (A and B) to the ground, relative to the CDG element. A hinge (E) is positioned at the midpoint of bar AC, connecting it to bar EF, which is linked to element 5 (FGH) at hinge F. Element 5 (FGH) is coupled to element 2 (CDG) through joint G. The mechanism functions similarly to an industrial robot or crane.

To ensure proper operation, a limiter frame is attached at hinge H, balancing the structure at its symmetry point. By actuating rod AC via an electric motor, the system moves leftward, lifting the frame to the desired height, which is controlled by a photoelectric sensor that halts the system at the set position. A 1:50 scale model was created to test the mechanism.

Figures 3 and 4 illustrate the two extreme positions of the barrier system. The mechanism includes an electronic height restriction device with a photoelectric sensor to limit the maximum lifting height of the frame. In Figure 4, the system reaches its maximum height, indicated by a red signal when the locking mechanism engages, preventing further elevation [4], [5], [6].

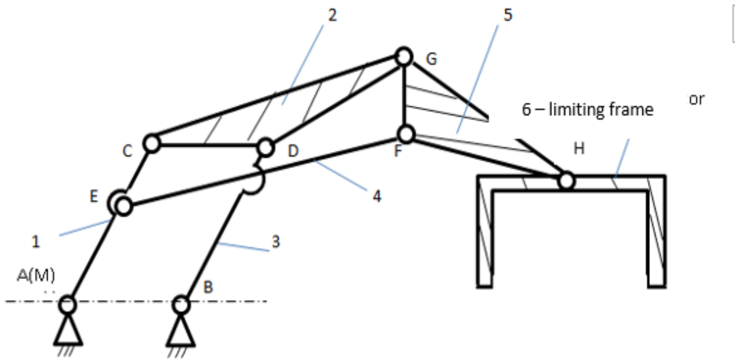

Fig. 2. The barrier mechanism for access to the parking lot and the limiting frame for access to the parking lot(mockup, own contribution)

Fig. 3 The barrier mechanism for access to the parking lot provided with the access frame in the lower position (mockup, own contribution)

The mechanism with the kinematic diagram in Fig. 4 is considered.

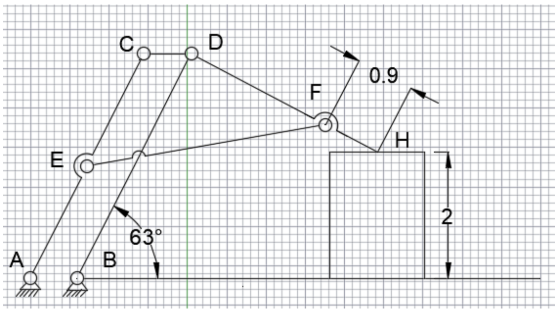

Fig.4

The mechanism in Fig. 4 is modeled in the ADAMS program for operation validation and kinematic analysis. For an adjustment of the F joint at a distance FH=0.9m, and a driving element angle of 63°, a minimum position of 2m from the base is obtained for point H.
The dimensions of the mechanism elements are presented in Table 1.

Elements in figure 1	**Actual length [m**
AC	4
CD	0,75
BD	4
EF	3,85
GH	3,35
FH	0,9

To create the model, the following steps were followed: defining points, defining kinematic elements, defining kinematic joints, and placing the motor. The mechanism is modeled in the ADAMS program for operation validation, the results being presented in fig.5.

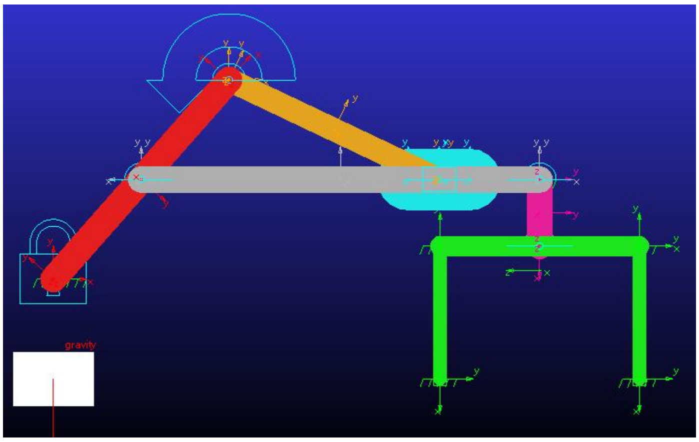

Fig. 5 The mechanism in the ADAMS program for validating the operation

The animation simulation was carried out for a duration of 10 seconds.
For H-point the trajectory tracing : Show for point H: displacement on Ox, displacement on Oy, velocity component on Ox, velocity component on Oy, velocity magnitude, acceleration component on Ox, acceleration component on Oy, and acceleration magnitude in the 10-second interval.

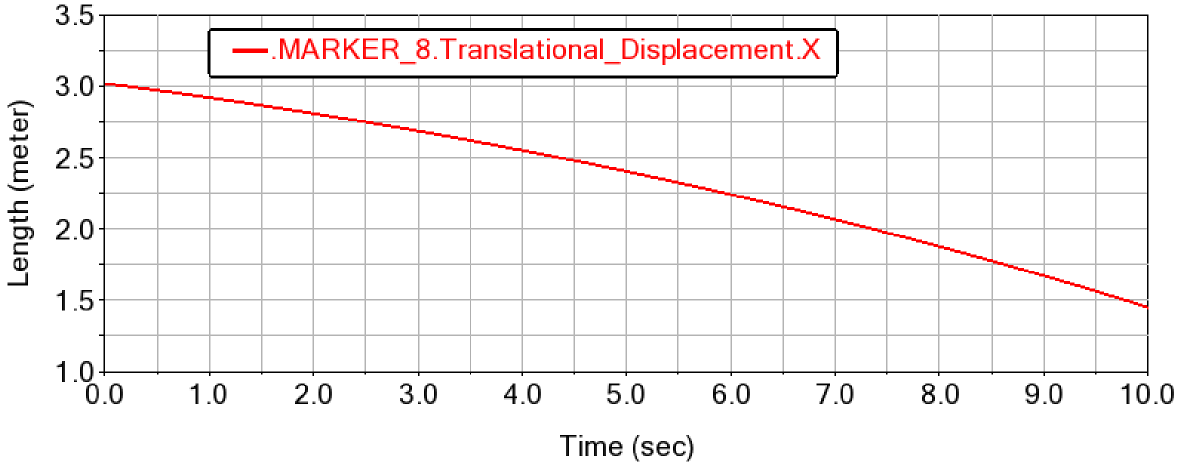

Fig. 6

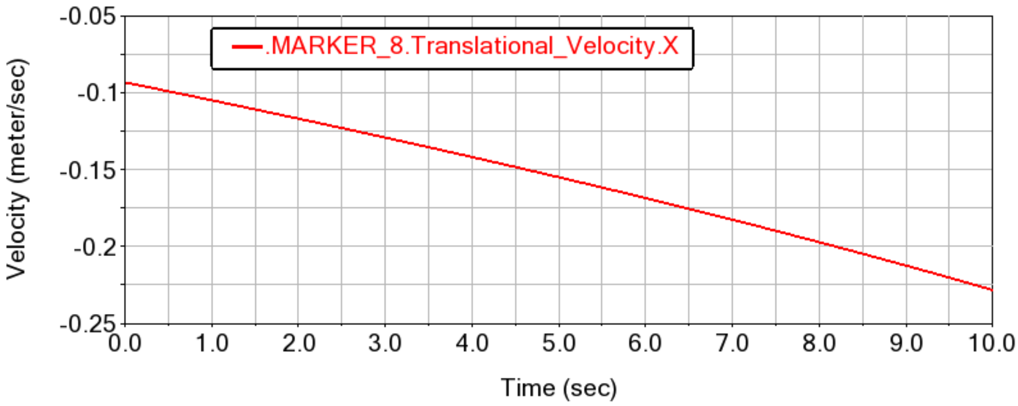

Fig.7

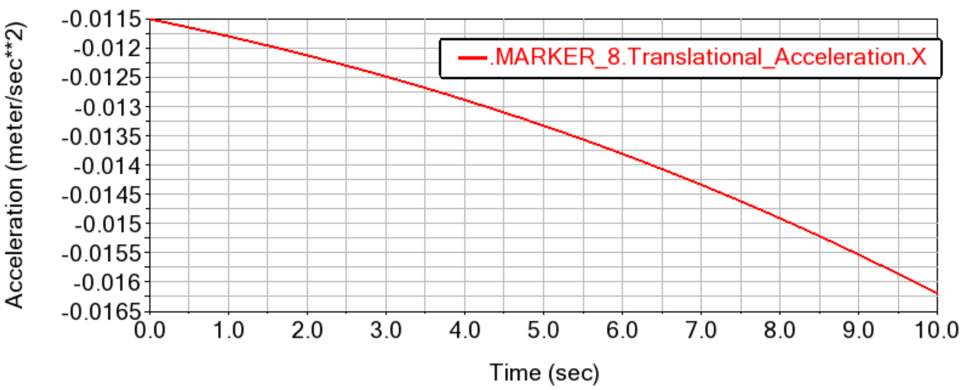

Fig. 8

3. THE KINEMATIC ANALYSIS

Calculation of the degree of mobility of the mechanism and the structurall diagram of the mechanism

The degree of mobility of the mechanism is calculated with the formula [7].

$$M= 3n- 2i-s= 3.5- 2.7- 0 = 15-14- 0=1,$$

where n = 5 mobile (kinematic) elements

i = 7 lower couples (V class kinematic couples)

s = 0 upper couples

It follows that the mechanism has an AC conducting element.

The structural scheme [8] of the mechanism in figure 2 is presented in figure 9.

The structural formula of the mechanism is:

$$Mec= E_c\ (0,1) +D1(2,3)+D1(4,5)$$

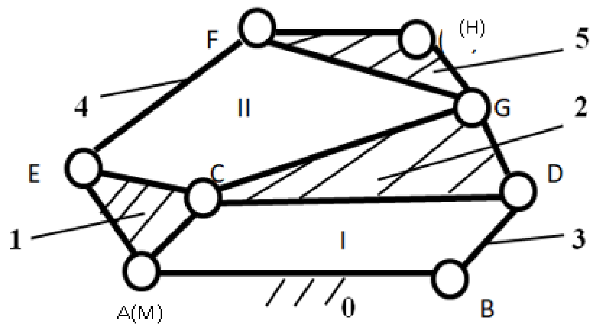

Fig. 9 Structural scheme of the mechanism

4. CONCLUSIONS

Advantages of the selected mechanism:

- Lower cost compared to other parking access solutions analyzed
- Advanced parking space counting system
- Reduced emissions
- Decreased driver stress
- Minimized time spent searching for parking
- Efficient and secure parking management

5. REFERENCES

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