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ANALYSIS OF THE STRUCTURES OF MOBILE PLATFORMS FOR PROMOTER ROBOTS

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Introductions

The modern development of robotics and automation is leading to the active introduction of robotic systems into various areas of human activity, including service, marketing, and promotion [1-3]. Robot promoters (RP) are becoming increasingly popular in shopping centers, exhibitions, presentations, and other public events, where they perform the functions of informing, advising, and attracting the attention of visitors.

A key component of any mobile robot is its mobile platform, which ensures movement in space, maneuverability, and stability of the system. For RP, the following characteristics of the mobile platform are particularly important: reliability of movement in crowded places, ability to position accurately, safety of interaction with people, and aesthetic appearance [4-6].

Designing a mobile platform for a promotional robot requires a comprehensive approach that takes into account specific requirements for operation in public places, the need to ensure autonomous operation, and integration with navigation systems, sensor equipment, and communication modules. Particular attention should be paid to safety, ergonomics, and adaptability to different operating conditions [7-9].

The analysis of existing designs of mobile platforms for promotional robots is relevant for determining optimal technical solutions that ensure effective functioning in public spaces, taking into account modern requirements for safety, maneuverability, and interaction with people.

Aim

Analyze existing designs of mobile platforms for promotional robots in order to identify their advantages and disadvantages and determine the optimal technical solutions for further design.

Materials and methods

The research methodology includes a systematic analysis of existing mobile platform designs, a comparative analysis of the technical characteristics of different types of drives and control systems, as well as mathematical modeling methods for calculating the motion and stability parameters of the platform. To select the optimal materials and components, a multi-criteria analysis method was used, taking into account factors such as weight, strength, cost, and performance characteristics.

The choice of drive type significantly affects the reliability, energy efficiency, and overall operating cost of a promotional robot, so it is advisable to systematize the main characteristics of the most common types of motors in a comparative table to determine the optimal solution (Table 1).

Table 1

Comparative table of drive types for RP mobile platforms

Parameter	DC motors	Brushless motors (BLDC)
Effectiveness	Up to 80 %	85-95 %
How it works	Use of commutation brushes	Brushless electronic commutation
Service life	Limited by brush wear	Greater due to the absence of brushes
Complexity of control	Simple (linear dependence of speed on voltage)	More complex (requires an electronic controller)
Cost	Low	Higher
Starting point	Good	Excellent
Speed range	Wide	Wide
Noise level	Average	Low
Maintenance	Requires replacement of brushes	Minimum

To determine the optimal drive parameters, it is necessary to establish technical requirements for the designed mobile platform. This work considers a robot promoter with a load capacity of approximately 30 kg, which includes the weight of electronic equipment, control systems, additional modules, and payload. Therefore, the recommended characteristics for a platform with a load capacity of 30 kg are determined (Table 2).

Therefore, BLDC motors are the optimal choice for a promotional robot with a load capacity of 30 kg due to their balance between reliability and efficiency, increased battery life, minimal maintenance requirements, etc.

Table 2

Recommended specifications for a platform with a load capacity of 30 kg

Parameter	DC motors	Brushless motors (BLDC)
Torque	0,5-2 Nm	1-3 Nm
Power	100-300 W	150-400 W
Rotation speed	1500–3000 rpm	1000-4000 rpm
Battery life	Smaller	Greater

The study included a comparative analysis of control systems used in the

design of mobile platforms for mobile robots, in particular promotional robots. The main focus was on the following types of control systems:

– proportional-integral-derivative (PID) control;

– microcontroller-based systems (e.g., Arduino, STM32);

– systems using FPGA or single-board computers (Raspberry Pi, Jetson Nano);

– intelligent control systems using artificial intelligence elements (neural networks, fuzzy logic).

The comparison was based on the following criteria: accuracy and stability of motion control; complexity of implementation; flexibility of adaptation to changes in the environment; energy consumption; cost and scalability.

The results of the analysis showed that for a promotional robot, the optimal solution is to use a microcontroller-based control system with PID regulation, which provides sufficient accuracy at a relatively low cost and ease of implementation. In cases where the platform must autonomously navigate a dynamic environment (e.g., in a shopping mall), it is advisable to use intelligent control systems with computer vision and decision-making algorithms.

To calculate the motion parameters and ensure platform stability, mathematical modeling methods based on classical mechanics and automatic control theory were used. The motion model is based on kinematic and dynamic modeling of the platform as a wheeled system.

Results and discussion

Based on the described methodology, a comprehensive analysis and calculation of the mobile platform parameters was performed, the results of which are presented below.

The calculations of the drive parameters showed that to ensure reliable operation of the mobile platform robot-promoter with a load capacity of 30 kg, the minimum motor power required is 24,57 W per wheel. The calculation was based on the following parameters:

– total weight of the system – 50 kg (30 kg load + 20 kg own weight);

– maximum speed: 1,2 m/s (safe for indoor use);

– calculated acceleration: 0,5 m/s^2 (comfortable movement);

– transmission efficiency – 0,85.

The traction force required to overcome resistance to movement is 34,81 N, which includes rolling resistance (9,81 N) and acceleration inertia (25 N). To ensure reliable operation in various operating conditions, it is recommended to increase the calculated power by 3-5 times, which gives an optimal power of 100-125 W per wheel.

The energy analysis of the system included energy consumption calculations:

– peak consumption: ~720 W (30 A at 24 V);

– average consumption in operating mode: ~200-300 W;

– autonomy with a LiFePO4 24V 20Ah battery: 1,5-2 hours;

– the selected type of LiFePO4 batteries provides over 2000 charge-discharge cycles, which significantly reduces operating costs compared to traditional lead-acid batteries.

The results obtained are of practical importance for the development of commercial promotional robots:

– the methodology for calculating parameters can be applied to platforms with different load capacities;

– the proposed architecture is scalable for different applications;

– the standardized Modbus interface simplifies integration with existing systems.

The research results show that the proposed mobile platform design provides an optimal balance between performance, reliability, and cost-effectiveness for use in promotional robots.

Conclusions

As a result of a comprehensive analysis of the designs of mobile platforms for promotional robots, the most effective technical solutions were identified. A comparative analysis of drive types confirmed the advantages of BLDC motors for platforms with a load capacity of 30 kg due to their high efficiency (85-95 %), long service life, and minimal maintenance requirements. Calculations showed the need for 24,57 W of power per wheel with a recommended reserve of 100-125 W to ensure reliable operation in various operating conditions.

Analysis of control systems revealed the optimality of a combined architecture using Raspberry Pi for high-level computing tasks and STM32 for real-time control. This structure provides the necessary performance for implementing SLAM algorithms while maintaining the reliability of critical safety functions. Mathematical modeling confirmed the effectiveness of the proposed motion parameters and energy characteristics of the system.

Energy analysis showed that the use of LiFePO4 batteries provides 1,5-2 hours of autonomous operation with an average consumption of 200-300 W and over 2000 charge-discharge cycles. The developed Modbus interface allows for standardized integration with other robot modules and provides reliable communication at distances of up to 1200 m.

The results obtained are of practical importance for the development of

commercial promotional robots and can be adapted for platforms with different load capacities. The proposed methodology for calculating parameters and selecting components provides an optimal balance between performance, reliability, and cost-effectiveness, which is critical for the successful implementation of robotic systems in the service and marketing sectors.

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