ISSN: 3029-0724

Research Article

Journal of Environmental Science and Agricultural Research

Compilation of A Dynamic Model of a Remotely Controlled Mobile Robot Chassis And Dynamic Parameter Study of its 18v Dc Electric Motor

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Received: May 26, 2026; **Accepted:** June 17, 2026; **Published:** June 24, 2026

ABSTRACT
This study focuses on the development of a dynamic mathematical model for a remotely controlled mobile robot chassis prototype, built at Kaunas College, and presents an experimental analysis of its 18V DC motor dynamic parameters. The methodology combines the mathematical modelling of chassis motion with experimental testing of motor behavior under both no-load and full-load conditions. The experimental results reveal a significant difference in motor requirements between operating states. Specifically, overcoming static friction under load requires a start-up voltage of 5.51 V and a current of 6 A, corresponding to 33.06 W of power. The developed dynamic model, validated by the obtained experimental data, allows for a more accurate prediction of the robot's motion trajectory and provides crucial insights into the motor power requirements necessary for stable initiation of movement under loaded conditions.

Keywords: Engine, Chassis, Model, Dynamics, Robot, Research

Introduction

The era of mobile robots began in the United States. It is one of the first states to look for sages due to a reduction in the workforce. At the end of the nineteenth century, almost half of all U.S. workers were occupied on farms. By 2000, the rate had fallen to 2% [1]. After the increase in unemployment, the US states began to produce robots that could move boxes, work in agriculture, deliver food to homes, etc. this country solved all the non-labor and engineering problems until other countries of the world began to engage in the production of robots and their industry. Japan, Brazil, China and EU countries like Germany were most involved in the production and industry of robots. According to the listed non-EU countries, one or several countries can be distinguished that examine the operation and control of autonomous, mobile robot chassis, the dynamic trajectories of their movement, i.e. China, Japan. Chinese scientists like Gao and et al. examine the operation and control, speed, speed of wheeled robots, its dynamic characteristics in the environment, and ensuring human safety in dangerous places [2].

These Chinese scientists use sensors to recognize obstacles and overcome them. The sensors used to recognize obstacles according to the wishes of scientists have not fully proven themselves. Instead of sensors, they proposed to later use the VFH vector field histogram method, which can direct the robot in the appropriate direction to the obstacle that has arisen. The vector field histogram method of the VFH allows you to form a logical algorithm according to which the robot can successfully reach the end point. However, these scientists claim that this method of application is complex and takes a lot of time to program. Without the approval of this method of VFH, they returned to the previously used sensors. It is noticed that Chinese scientists do not study the power of e-motors, DC electric motors and their other characteristics.

A Japanese scientist like examines the operation of autonomous robots in domestic and office environments [3]. From an experimental point of view, this topic under consideration of his is based on a strategy that allows to increase the stability, operation of autonomous mobile robots in domestic and office environments [3]. The scientist focuses on solving the movement of the robot, the installation of navigational systems, etc. However, it is noticeable that the scientist, like other scientists, does not pay much attention or pays not much attention to the study of engine systems and its components.

Citation: Saulys P. Compilation of A Dynamic Model of a Remotely Controlled Mobile Robot Chassis And Dynamic Parameter Study of its 18v Dc Electric Motor. J Envi Sci Agri Res. 2026. 4(3): 1-6. DOI: doi.org/10.61440/JESAR.2026.v4.186

From a scientific point of view, looking at other scientists from countries, it can be said that the study of DC electric motors is a rampage. Mainly, scientists study batteries, battery life, etc. The direct current motors used in robots. DC motors are widely used to provide ac speed drive systems in industrial fields, similar to automation, military devices, electric thrust, fixed disk drives, as they work without noise, very powerful, compact, reliable and low maintenance and cost-effective, according to scientists Vijayalakshmi and Archana [4]. These scientists look at it positively, since electric traction is important for vehicles such as autonomous robots, platforms, etc. Taking this into account, the group assembled by the scientists of Kaunas College decided to examine the operation, control, dynamic characteristics and dynamic parameters of the 18V DC electric motor, which are important for further research, of the prototype-type remotely controlled mobile robot chassis.

Materials and Methods

For the compilation of the dynamic model, a model of the created prototype remotely controlled mobile robot chassis is used. The developed model of a prototype remotely controlled mobile robot chassis is made up of the following components: the chassis body; engine; wheel; stars; bearing; axis; an adapter for connecting a wheel to an axle; chain; battery; control unit; wiring. The created model is shown in (Figure 1).

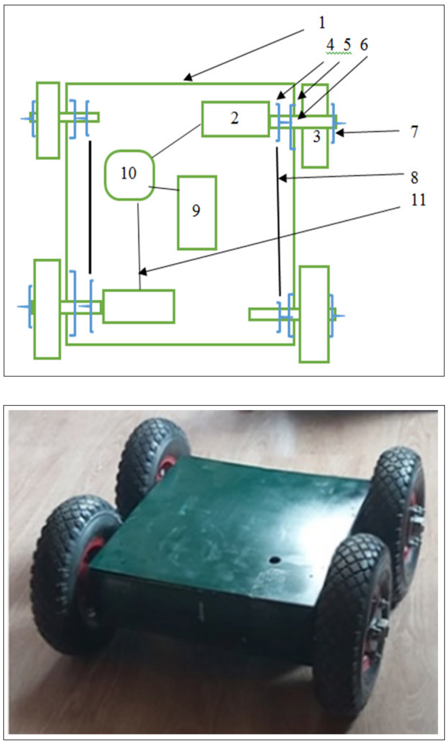


Figure 1: Prototype designed and manufactured remotely controlled mobile robot chassis: 1. Chassis body; 2. Engine; 3. Wheel; 4. Asterisk; 5. Bearing; 6. Axis; 7. The adapter is designed to connect the wheel with the axis; 8. Chain; 9. Battery; 10. Control unit; 11. Cord

In (Figure 1), the greatest role in the chassis is played by two 18 V DC motors, a battery and a control unit. 18 V DC motors drive the left and right sides of the wheels, the battery feeds alternating current to the motors and the control unit, the control unit allows you to control the chassis in the direction of x, y.

This prototype robot weighs 30 kg, dimensions: 400x400 mm, has a GPS satellite system. Šaulys and at. ask the system installed by the GPS satellite broadcasts the exact time of the transmitted signal The principle of operation of this mobile robot construct is as follows: The control unit (10) through the wires (11) directs the electricity contained in the battery (9) to the engines (2) [6]. Under the influence of electricity, they begin to rotate and transmit torque through the axis (6) which is fixed in the bearing (5), and the adapter (7) to the wheel located near the engine. Another wheel on the same side receives torque when the first axle rotates the asterisk on it (4), and it transmits torque through the circuit (8) to the next star, which rotates the second axis. The second axle, which is connected by the adapter to the second wheel of the same side, thus transmitting torque to the second wheel of the same side. In this way, all four wheels of the robot are driven, thereby increasing the possability of the robot's chassis. Vabolys and at. [5]. Now that we have a prototype model, we can find a methodology that would allow us to determine the dynamic parameters of the 18 V electric motors used. To determine this, a mathematical-dynamic model is created.

The mathematical-dynamic model is formed gradually. First, the object (model) under consideration is selected, after which the algorithm is recorded, assessing the road surface and the results are obtained. To create a mathematical-dynamic model, we will accept that the robot's chassis moves on a straight-line paved road with a coefficient f=0.013. To compile such a selected model algorithm, the equation of movement is recorded by estimating the mass of the chassis m, the elements of chassis stiffness and damping. Figure 2 shows the compiled mathematical-dynamic model [6].

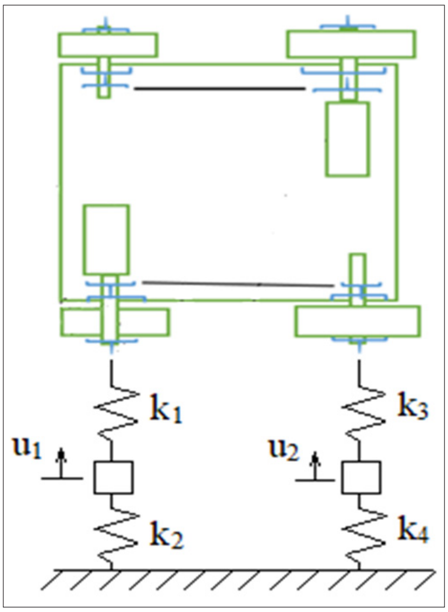


Figure 2: Mathematical-dynamic model: k1, k2, k3, k4 – elements of rigidity; m1, m2, m3 – mass elements; u1, u2, u3 – elements of inhibition; φ – turning angle, M – wheel torque, I – inertia torque

According to the system shown in (Figure 2), one of the links is a solid body, the movement of which is defined by the linear displacement of its center of gravity and the turn around the center of gravity. In this system, linear displacements move only in one direction, i.e. x. Having applied Ii Newton's law to the center of gravity, mass of the flat moving chain, and the theorem of the kinetic moment about the center of gravity, we will write down three equations of dynamics for each element. Write Eq.1

$$\begin{cases} m_1\ddot{u}_1 = -(u_1 - u_2 - \varphi x)k + F \\ m_2\ddot{u}_2 = -(u_1 - u_2 - \varphi x)k + F \\ I\ddot{\varphi} = -(u_1 - u_2 - \varphi x)kx + M \end{cases} \quad (1)$$

Having written down the three equations of dynamics, we will express them in a matrix:

$$\begin{bmatrix} m_1 & 0 & 0 & 0 \\ 0 & m_2 & 0 & 0 \\ 0 & 0 & m_3 & 0 \\ 0 & 0 & 0 & m_4 \end{bmatrix} \begin{Bmatrix} \ddot{u}_1 \\ \ddot{u}_2 \\ \ddot{u}_3 \\ \ddot{\varphi} \end{Bmatrix} + \begin{bmatrix} k_1+k_2 & 0 & -k_1 & k_1l_1 \\ 0 & k_2+k_4 & k_3 & -k_1l_2 \\ -k_1 & -k_3 & k_1+k_3 & -k_1l_1+k_2l_2 \\ k_1l_1 & -k_3l_2 & -k_1l_1+k_3l_2 & k_1l_1^2+k_3l_2^2 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ \varphi \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix} \quad (2)$$

From the matrix we can write down the general dynamic Eq.2 of movement:

$$m_1\ddot{u}_1 + (k_1+k_2)u_1 - k_1u_3 + k_1 1_1\varphi = 0 \quad (3)$$

where: $m_1\ \ddot{u}_1$ – inertial force, N; $(k_1 + k_2)u_1$ - stiffness force acting directly on the node; k_1u_3 - force of connection between the first and third mass points; $k_1l_1\varphi$ - force resulting from the angle of rotation present in the system.

The compiled matrix shows that the resulting equation is the dynamic equation of the system. To use continue the, Matlab" program for programming, a functional equation of uniform movement is compiled and the maximum speed of movement of the robot's chassis is calculated by assessing the road surface. We accept that this is a straight-line smooth movement, the road surface is asphalt with a coefficient *k=0.013.* By entering the equation of movement into, Matlab", we get a graph of the dependence of speed on time, which is shown in (Figure 3) [7].

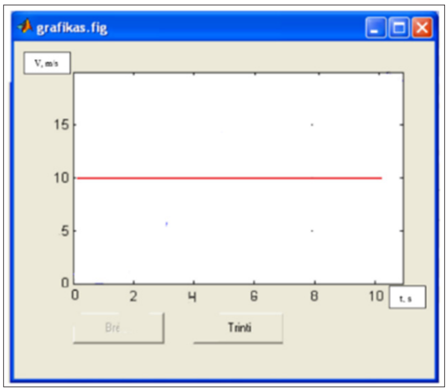
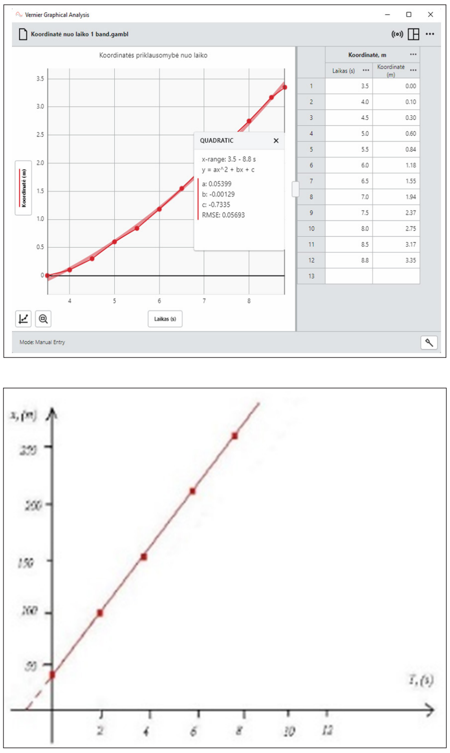


Figure 3: The schedule of the dependence of speed on time is compiled by the, Matlab" program

From the presented graph it can be seen that the maximum speed of the chassis in the selected paved even road surface is 10 m /s, the speed is constant. Also, this calculated maximum chassis speed coincides with previous experimental studies.

Next, it will be decided what are the coordinates of the movement of the body in space. As the body moves in space, it usually takes a new position in it. As the body moves in space, the time, speed and distance of its movement change. To get a schedule of body movements, you need to know the coordinates and time of the body. According to the previous kinematic studies conducted, below we present the recorded results obtained at that time in (Figure 4).

A



B

Figure 4: Coordinate dependence on time (a) – exploratory, (b) – physical

After conducting a number of measurements earlier during the study, it was noted that the obtained research curve is almost the same and differs very little from the physical graph. It is also noted that the recorded coordinate of the chassis varies according to the law of the parable as is described in the equation of kinematics. The equation of kinematics is written Eq.3:

$$x = x_0 + v_0 t + \frac{at^2}{2} \quad (3)$$

This kinematic study was conducted using the Go DirectR Motion Detector sensor. Go DirectR Motion Detector – a motion detector that measures the position or coordinate, speed and acceleration of moving objects with ultrasound. It connects via Bluetooth® wireless technology or via USB to a computer or mobile phone. The Go DirectR Motion Detector motion detector accurately tracks objects located at a distance of 15 cm to 3.5 m. This detector is compact, has wireless capabilities, can work with or without a cable. The Go DirectR Motion Detector motion sensor can be used not only to measure speed and acceleration, but also to conduct other experiments (Go Direct®, 2022). For example: to study the position, speed and acceleration of carts when installed on the rails; to match position or speed graphs created in the Vernier Graphical Analysis™ program for graphical analysis.

After creating a mathematic-dynamic model and performing calculations, the following is the progress of the research. To conduct the selected study, we will first select the appropriate research methodology and equipment. The methodology of the study is given in (Fig. 5).

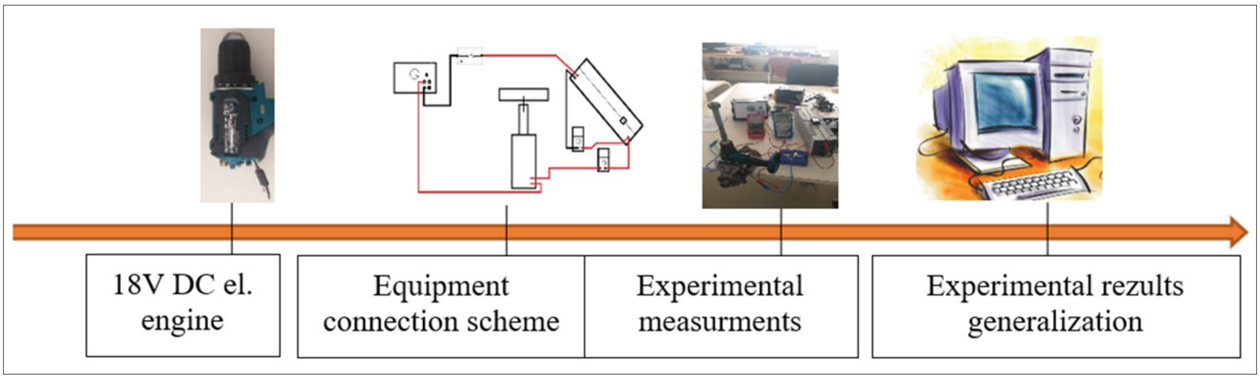


Figure 5: Experimental research

The following equipment is needed to study the electrical dynamic parameters of an electric motor of 18 V DC: 18 V DC electric motor (technical parameters: speed without load 0 - 400 / 0 - 1300 min⁻¹, max. torque 42/72 Nm, two speed) and an additional clamp is mounted at the table for storing the motor, 2 multimeters (for recording current strength and voltage), a personal computer, a rheostat, a switch, a power supply. To carry out this study, a principled exploratory scheme drawn up, which is shown in (Figure 6).

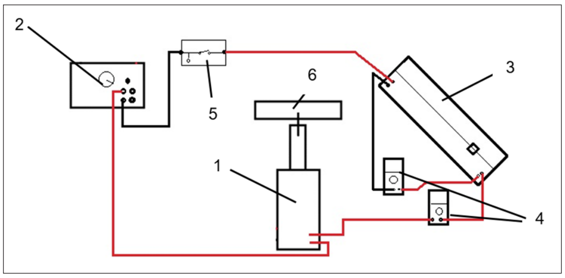


Figure 6: Principled exploratory scheme for DC current measurement of an electric motor of 18 V DC: 1 – electrical motor, 2 – power supply, 3 – reostat, 4 – multimeter, 5 – switch, 6 – wheel

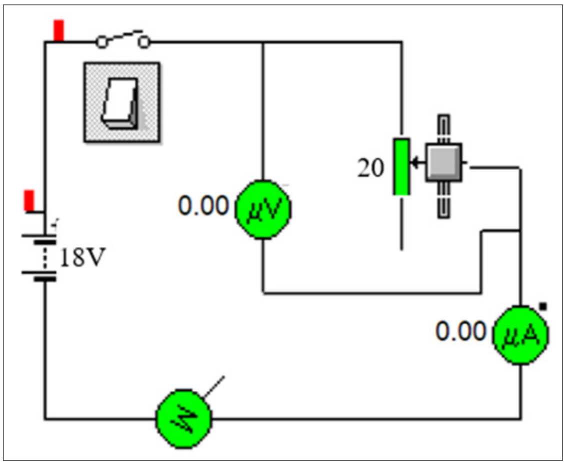
The chassis of the robot under consideration uses not only 12 V, but also electric motors of the 18 V DC type. The purpose of these listed DC motors used in the robot chassis is to drive the left and right sides of the wheels. In this study, only 18V DC type electric motors were selected for examination, since the previously studied 12V DC electric motors showed that they can only move at a maximum speed of 10 m/s, the engine requires a voltage of 6.5 V, a current of 5.1 A.

Results and Discussions

The study is carried out in a standardized electronics laboratory. First of all, the DC electrical circuit from the power supply, rheostat, switch, multimeter (ammeter) and motor is connected in series. A serially turned on multimeter measures the voltage falling on the rheostat. A voltage of 18 V supplied from the power supply is distributed over the motor and rheostat. By manually reducing the resistance of the rheostat, the falling voltage on the motor gradually increases, so that the sum of these voltages remains constant and equal to the voltage of 18 V supplied from the source. To manually generate data into tables and to draw graphs from the obtained data and calculate the falling voltage on the engine, the program of the training, Phywe" company's computerized stands, measure is used. Fig.7. shows a diagram of the measurements of the 18V DC type electric motor without load, with a load, and an electrical circuit.

A

B



C

Figure 7: Diagram of 18V DC type electric motor without load (a), load (b) measurements and electrical circuit (c)

By combining the 18V DC motor without load circuit, the results of the study were recorded. After that, the recorded results of the study are entered into the data table of the program Exel manually and the dependence of the current on the voltage graph is obtained. The resulting graph is shown in Fig.8.

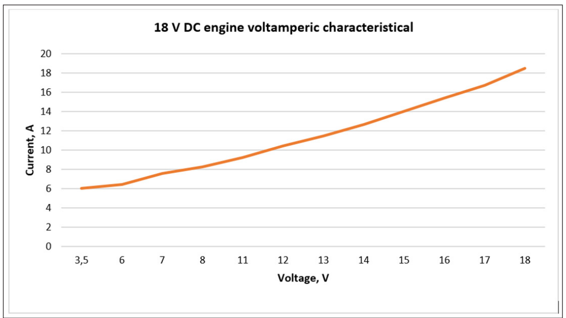


Figure 8: 18 V DC unladen electric motor current strength dependence on voltage voltamperic characteristic

The linear voltamperic characteristic of the motor is most often a straight line in which the current is directly proportional to the voltage. That is, a higher voltage causes a higher current and vice versa. However, the voltamper characteristic of brush motors may be somewhat more complicated, due to their specific transmission mechanism.

Brushed el. motors usually have a voltampere characteristic, which is linear to a certain limit point known as a "critical point". After reaching a critical point, the characteristic changes depending on the electromagnetic torque. From the voltampere characteristic we see that by increasing the voltage falling on the motor, the motor starts to rotate after reaching a current of 6 A at a voltage of 3.5 V, i.e., it is necessary to calculate the power according to the Eq.4:

$$P=I\cdot U; \quad (4)$$

where: [I]=1A - current strength, [U]=1V - voltage.

With the further increase in the falling voltage of the electric motor under study from 3.5 V to 18 V, the current flows more and more, the rotation of the electric motor increases until it reaches the maximum limit. An even increase in current shows what energy of rotational movement is taken by the engine at the beginning when a voltage of 18 V falls. The engine stops when the speed control button is automatically released.

When the engine is loaded with a load of 2 kg, we get the same proportionally linear voltamperic characteristic as with an unloaded motor. Differs from each other only in that the voltage supplied with a loaded motor is higher than that of the uncharged one, and the current does not change. From the resulting graph in Fig.9. it can be seen that the engine is loaded by 2 kg. does not require greater capacity, as it is not burdened. It takes a voltage of 5.51 V to start the engine, current 6 A. Power according to the 2nd formula is equal to 33.06 W.

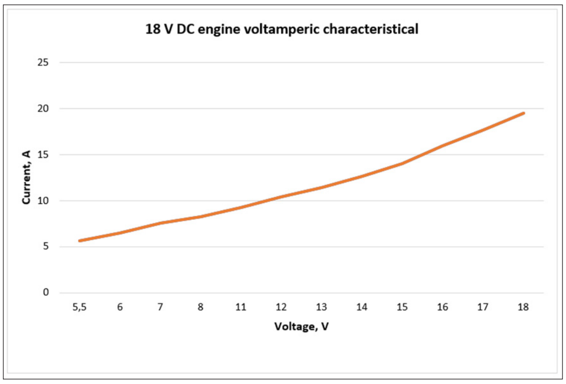


Figure 9: 18 V DC loaded electric motor current strength dependence on voltage voltamperic characteristic

From the resulting graph it can be seen that the engine is loaded by 2 kg. does not require greater capacity, as it is not burdened. The rotational speed of the chassis 18 V DC e-engine is calculated by the following Eq.5:

$$v = l * n; \quad (5)$$

where: v - speed of the chassis el. engine, *m/s; l* - length of the wheel, *m; n* - maximum engine speed at load, s^{-1}.

v = l * n = 0,2*1300 = 4.3 m/s

We can also find out the rolling force of resistance. The rolling force of resistance can be found by the Eq. 6 below:

$$F_F = m * g * \left(\frac{2}{D} * \left(\mu_L * \frac{d}{2} + f \right) + c \right) \quad (6)$$

where: F_F – rolling resistance force, *N*; m is the mass of the chassis, in kg; *g* = free fall acceleration equal to $g = 9.8\ m/s^2$; *d*- diameter of the axis, mm; *μL*- coefficient, *μL*= 0.005; *D* - diameter of the wheel, mm; *f* - coefficient f=0.5; *c* - coefficient, c = 0.003.

$$F_F = 30 * 9.81 * \left(\frac{2}{200} * \left(0.005 * \frac{1960}{2} + 0.5 \right) + 0.003 \right) \quad (7)$$

F_F=0.164 kN

This calculated rolling resistance force is directly proportional to the force of the vertical load and inversely proportional to the pressure in the tire.

Conclusions

- After analyzing the sources provided by foreign scientists, it is noted that the problems of the movement of robots, the installation of navigational systems in them, the design and its operation are most touched upon, but other problems such as the parameters of el. engines are not touched upon.
- After constructing the prototype's mathematical-dynamic model and conducting dynamic calculations, the „Matlab” program we chose, we obtained that in an even movement the maximum speed is 10 m/s in the same way as in previous recorded experimental studies using 12V el. engines. The graph of the dependence of speed on time shows that the speed is constant.
- The study of the dynamic parameters of electric DC motors of the 18V DC type shows at what power, voltage and current the unloaded and loaded 18V DC electric dc motor can start at. The unladen electric DC motor can start at a current of 6A and a voltage of 3.5 V, and a load of 2 kg from 5.51V and 6A currents. In order for the engine, overcoming the friction of seriousness, to start spinning, it is necessary for an unloaded engine with a power of 21 W, and a loaded 33.06W.

References

1. Ford M. Rise of the Robots: Technology and the Threat of a Jobless Future".Basic books. A Member of the Perseus Books Group. 250 West 57th Street, New York, NY 10107. 2015.
2. Gao X, Zhang Q, Li M, Lan B, Fu X, et al. Mobile Robot Combination Autonomous Behavior Strategy to Inspect Hazardous Gases in Relatively Narrow Man–Machine Environment. Chinese Journal of mechanical engineering. 2022. 34: 135.
3. Yuta S. Autonomous Mobile Robotics Research for Daily-Life Environment. University of Tsukuba Tsukuba 305-8573. 2001. 34: 31-38.
4. Vijayalakshmi. S, Archana. M. 2019. Robotic car arduino with bluetooth controller. 2019. 1.
5. Vabolys M, Šaulys P, Niauronis S, Stonys G. Modelling and Experimental Assessment of Dynamic Parameters of Mobile Robot Chassis. Proceedings of 24th International Scientific Conference. Transport Means Kaunas, Lithuanian. 2020. 1022-1027.
6. Šaulys P, Niauronis S, Dargužis A. Exploring the possibilities of using a developed remotely controlled mobile robot. Professional studies: Theory and Practice 2023. 12: 106-111.
7. Leandro C, Jefferson RF, Patrick YS, Denis FW. 2012. Intelligent Robotic Car for Autonomous Navigation: Platform and System Architecture. Conference: II Brazilian Conference on Critical Embedded Systems. 2012.