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Manufacturing and controlling 5-axis ball screw driven industrial robot moving through G codes

G kodu ile hareket eden beş eksenli bilyalı mil tahrikli endüstriyel robot imalatı ve kontrolü

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Abstract

These days, in industrial robot applications, servo motors with reducer have been used to move robot manipulators. Due to the weight of the robot parts, it causes undesirable conditions such as backward movement, downward movement and vibration caused by the moments of inertia at the time of movement. In this study, step motor ball screw driven actuators, which use push-pull force instead of servo motor with reducers, were utilized to provide rotational movement in robot arms. The ball screw system reduces the effect of moments of inertia caused by the movements of the robot joints, and restricts the free movements of the robot joints. It also provides an advantage by reducing costs since it uses smaller motors. In articulated robots, the complexity of kinematic equations and the use of high-order polynomials for trajectory planning cause difficulties in controlling. In this study, the information of the points, where the robot went during the manual movement, was obtained by using the macros prepared in program interface without using kinematic and trajectory planning equations. The position lines taken at these points were printed in a text file by adding the code G01 and f feed-rate. The robot was made to move by running this file in the program interface used for control. This method allows the operator to use the robot without advanced kinematics knowledge.

Keywords: Actuators, Ball screw, Control with G code, Industrial robot

Öz

Günümüz endüstriyel robot uygulamalarında robot manipülatörlerini hareket ettirmek için redüktörlü servo motorlar kullanılmaktadır. Robot parçalarının ağırlıklarından dolayı, hareket anında atalet momentlerinden kaynaklanan geriye doğru hareket, aşağı doğru hareket ve titreşim gibi istenmeyen durumlara neden olmaktadır. Bu çalışmada, robot kollarında dönme hareketini sağlamak için redüktörlü servo motor yerine itme-çekme kuvveti kullanan adım motorlu bilyalı mil tahrikli aktüatörler kullanılmıştır. Bilyalı mil sistemi, robot mafsallarının hareketlerinden kaynaklanan atalet momentlerinin etkisini azaltmakta ve robot mafsallarının serbest hareketlerini kısıtlamaktadır. Ayrıca daha küçük motorların kullanılmasıyla maliyetleri azaltarak avantaj sağlamaktadır. Mafsallı robotlarda, kinematik denklemlerin karmaşık olması ve yörünge planlaması için yüksek dereceli polinomların kullanılması kontrolde zorluklara neden olmaktadır. Bu çalışmada, kinematik denklemler ve yörünge planlaması denklemleri kullanılmadan program arayüzünde hazırlanan makrolar kullanılarak robotun manuel hareketi esnasında gittiği noktaların eksen bilgisi alınmaktadır. Bu noktalarda alınan konum satırlarına, G01kodu ve f ilerleme hızı eklenerek bir metin dosyasına yazdırılmaktadır. Bu dosya kontrol için kullanılan program arayüzünde çalıştırılarak robot hareket ettirilmektedir. Bu yöntem, operatörün ileri derecede kinematik bilgisi olmadan da robotu kullanma imkanı sunmaktadır.

Anahtar kelimeler: *Aktüatörler, Bilyalı mil, G kodu ile kontrol, Endüstriyel robot*

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1. Instruction

1. Giriş

Many countries are in a high competition to renew their production chains in order to produce environmentally friendly and energy-efficient products. (Pham & Ahn, 2018). The demand for flexible automation systems in manufacturing and assembling materials used to produce parts for different applications has increased (Sugavaneswaran et al., 2020). At present, industrial robots are widely used in manufacturing industry in order to reduce labor costs. (Raza et al., 2018). Industrial robots are increasingly being used in assembly, automotive, and aerospace industries to produce light and large parts such as frames made of aluminum, fiber-reinforced or composite materials (Denkena et al., 2017). With the increase in positioning accuracy of robots in working conditions, most of the motor energy is used for the weight parts. With the change of materials and geometric shapes, a 10% reduction in loads has been achieved (Buğday & Karali, 2019). Cost expenses decreased by using industrial robot and together with PLC in industrial automation systems in a factory where ball valve with side union was produced. By means of this system, a flexible production has been achieved (Enes et al., 2021). Industrial robot manipulators are widely used in many different fields and different applications in the industry. It is preferred to ensure the safety of life in applications that may endanger time, effort, and human life (Sahu et al., 2017). Electric actuators are used in the driven robot manipulators because of their high precision. The biggest advantage of electric actuators is that they lift more weight with low power (Gaspar-Badillo et al., 2017). A robust end-effector design for a robot is crucial for the performance of the robot work cell. The use of robots in automation systems, together with the design of the fingers and jaws of industrial grippers, have attracted great attention (Honarpardaz et al., 2017). Although an industrial robot consists of kinematic structure and mechanical parts such as a reducer and many important components such as servo motor, drive, sensors, and controller; the use of precision gearboxes makes up about 25% of the material cost (Pham & Ahn, 2018).

The robotic system includes a specially designed end effector, RGB-D camera and high-quality computer with a graphic processing unit, programmable logic controllers, other electronic equipment and a six-degree freedom industrial arm (Arad et al., 2020). An industrial robot with six-degree freedom industrial arm was designed and assembled. All joints of the robot are made of rotary joints; and a servo-controlled AC motor is placed on each axis (Eren & Kaftanoğlu, 2001). In the control system of six axes industrial robot, real-time and fast communication solutions are required to increase the kinematic accuracy of the end effector (Bu-Hai et al., 2017). Some tests were developed with a Texas DSP Delfino C2000 that focused on designing a pneumatic robot with a total of 4-degree freedom with a hardware interface to control pneumatic actuators (Gaspar-Badillo et al., 2017). It presents the design of a Double Arm System consisting of a humanoid robot arm, which is used as two high-performance KITs. Utilizing human arm kinematics, each arm can have 8 degrees of freedom together with one joint of the inner shoulder. Compared to robots with 7 degrees of freedom, it provides a greater working area and dexterity when used with the inner shoulder joint (Rader et al., 2016). While robotic harvesting often remains a problem in an unstructured and complex environment, a new barrier separation algorithm is developed to enable a harvesting system to pick strawberries from clusters. The algorithm pushes the strawberry leaves, strawberries and other obstacles surrounding its gripper arms aside. Thus, a theoretical method is proposed to create thrust paths based on the obstacles in the environment (Xiong et al., 2020). There are applications in both industry and healthcare, which requires higher accuracy combined with high compatibility. A self-adapting 6-degree freedom parallel robot is proposed as it is difficult to achieve conflicting accuracy and harmony at the same time (Jamwal et al., 2020). A double-arm robot manipulator, consisting of two industrial arms with 6-degree freedom and a body with 2-degree freedom, is designed. This double-arm robot manipulator is designed as a 6-axis industrial arm to use in the assembly of automotive parts. It can be also used as a stand-alone 6-axis industrial robot manipulator and as part of a double-arm manipulator (Park & Park, 2018). While the eco-design of robots was rarely searched in the past, bio-sourced materials such as wood could be used instead of metal or carbon composite parts to reduce the environmental impact of the robot significantly during the design stage. Wood has interesting mechanical properties, but its performance changes according to dimensions, atmospheric conditions, external factors and conditions in which the trees grow (Kaci et al., 2019). With the developing technology in the field of industrial robots, progress has been made in the field of robot-human cooperation. By using the control system with sensors and drives, robots act in active and passive cooperation with humans (Dilibal & Şahin, 2018).

As shown in Figure 1, at O point on the 3rd axis, the actuator performs rotation by pushing or pulling the arm. This arm continues to work by performing a rotational movement in two different ways. The motor, connected to O point, performs movement by rotating the direct arm or by push-pull force of the actuator connected to the end of the arm. In both cases, a comparison was made based on the torques falling on the motors; and their advantages were tried to be determined. In order to calculate the torque on the motor directly connected to O point, the weight of the bar is to be 2.5 kg, and the weight of the load and gripper connected to the end of the arm is accepted as 25 kg. To find the torque of the motor, the moment at point O is taken as;
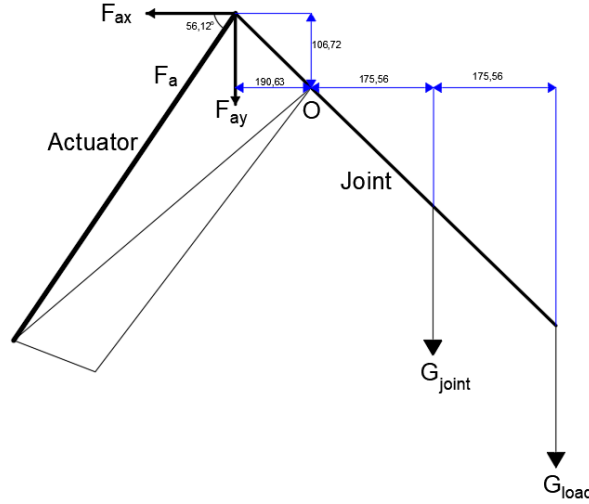

Figure 1. Torque calculation on the robot axis
Şekil 1. Robot ekseninde tork hesabı

$$T_{motor}=2.5*9.81*0.17556+25*9.81*0.35111=90.415 \text{ Nm} \tag{1}$$

In the same way, to calculate the force drawn by the actuator and how much torque this force creates on the motor over the ball screw, a moment is taken at O point as (see Equation 2-5):

$$F_{ax}*0.10672+F_{ay}*0.10963=2.5*0.17556*9.81+25*0.35111*9.81 \tag{2}$$

$$F_a*(\cos 56.12)*0.10672+F_a*(\sin 56.12)*0.10963=90.415 \tag{3}$$

$$F_a*0.1505=90.415 \tag{4}$$

$$F_a=600.74 \text{ N} \tag{5}$$

After calculating the force drawn by the actuator in this way when the pitch of the shaft used in the actuator is 5 mm and the diameter is 16 mm, the torque falling to the motor is (Equation 6-7):

$$F_t=0.005*600.74/(pi*0.016)=59.71 \text{ N} \tag{6}$$

$$M_{motor}=59.71*0.016/2=0.477 \text{ Nm} \tag{7}$$

According to these two calculations, the use of smaller powerful motors in the actuator provides a great advantage in terms of both weight and cost.

The aim of this study is to reduce the cost and the weight of the robot by using smaller powerful stepper motors. In addition, complex equations are employed in the kinematic calculations and the trajectory planning of the industrial robots used in rotary joints. These equations make the control of the robot difficult. The robot is moved manually without using these equations. With the help of macros written in Mach3 interface, G codes of the points along the trajectory are written and recorded. These codes are uploaded to the robot system, and the system is required to repeat the same work. Thus, the operator, who does not have advanced robot kinematics knowledge, will be able to use the

robot by eliminating the difficulties brought by complex equations.

2. Material and method
2. Materyal ve metot

Precision planetary gear systems, which are generally composed of gears with sensitive involute profiles and provide a speed reduction of around 1/20, are used in articulated robot arms. Since the assembly and manufacturing of precision gears used in the planetary gear systems require using high technology, large amounts of money are spent to procure these systems from abroad (Li et al., 2020; Guanjin & Wenyi, 2018). Therefore, instead of the planetary gear systems, stepper motor driven ball screw actuators are used in the industrial robots. The design of this robot resembles an articulated industrial robot that works like an excavator type construction equipment. Thus, step motors with smaller torque capacities

are employed instead of large-torque servo motors used in the planetary gear systems.

The general view of the robot with five-axis and step motor driven designed and manufactured in this study is shown in Figure 2. The body and arm joints of the robot rotating in the vertical axis are rotated in a horizontal axis parallel to each other. The gripper unit at the tip of the robot arm is rotated in two vertical axes for any position in the working space. The rotational movements of the robot joints are similar to that of hydraulic actuator used in an excavator. As a result of the choice of the ball screws actuator system, an alternative solution is brought to the problems of the difficulty of controlling the step and servo motors used in robots at low speed and high torque and the expensive supply of precision gearboxes. As the ball screws are rotated by step or servo motors in a position-controlled manner, the robot is operated by the actuators moved forward-backward linearly.
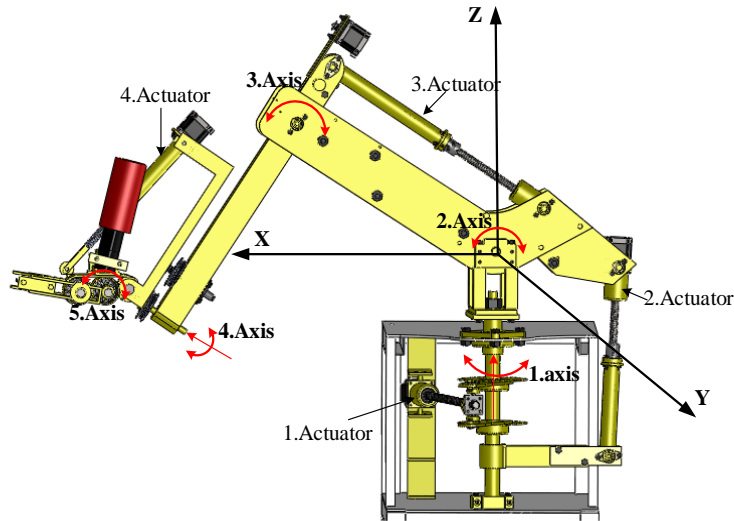

Figure 2. View of five-axis robot.
Şekil 2. 5-axis robot görünümü

2.1. Design of actuators
2.1. Aktüatör tasarımı

Ball screw actuators are mainly used in many applications such as precise engineering and aerospace applications (Okwudire, 2011). Ball screw actuators, which are compact, stiff and precise, are used in applications of miniature robotics (Garinei & Marsili, 2012). On one end of the actuators, there is a ball screw rotated by the stepper or servo motor and a ball screw nut at the

other end. When the motor is rotated clockwise, the length of the actuator increases; and when it is rotated in the opposite direction, it decreases.

The sectional view of a designed and manufactured step motor-driven ball screws actuator is shown in Figure 3. Pairs of angular bearings are mounted back-to-back on the ball screws in the motor flange. The motor movement is transferred to the ball screws by a coupling mounted between the motor shaft and the ball screws.
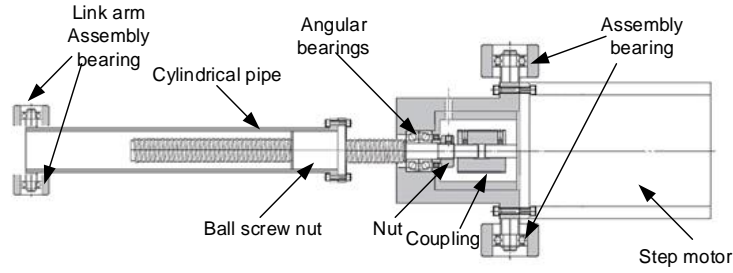
Figure 3. Actuator design and internal section view
***Şekil 3.** Aktüatör tasarımı ve iç kesit görünümü*

On the other side of the actuator, there is a pipe piece with connecting pins at one end and a ball screw nut on the other end. The actuator is mounted with two pins at the end of the pipe and the flange motor as shown in Figure 4. When the motor is rotated in the clockwise direction, the length of the actuator increases and when it is rotated counterclockwise direction, the length of the actuator shortens. As the actuators used in robots are long and the ball screws diameter is small (16 mm), they are operated under tensile load due to the risk of buckling. It is aimed to reduce the starting torque of the motor by selecting small pitch ball screws in actuators (5 mm).
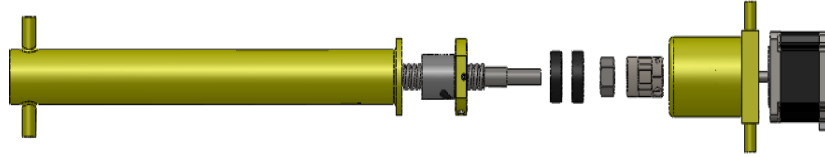

Figure 4. Disassembled view of ball screw shaft actuator
***Şekil 4.** Bilyali mil aktüatörün demonte görünümü*

In the gear systems used in robots, it is difficult to control the servo motor as it requires large torque at controlled rotation speeds for the motor during load lifting. In this study, ball screws systems are preferred in the driven robot because of the economic difficulties in procuring 1/50 precision gearbox and the difficulty of controlling servomotors at low speed and high torque. As a result of rotating the ball screws by a servo or step motor operated by a computer, the ball screw nut is moved forward-backward linearly, allowing the robot to operate.

2.2. Robot design and manufacture
2.2. Robot tasarım ve imalatı

To rotate the robot body in the vertical (1st axis) axis, as shown in Figure 5, a shaft with a flange at its upper end is mounted with two bearings on the table. When the robot is rotated in the vertical axis, a step motor driven ball screw actuator is used to enable the robot to turn 140 degrees on its 1st axis. The robot body (2nd axis) is made of two sheet plates by placing pieces of pipe between them and being fastened with bolts. A shaft located at the bottom of the robot body and the upper flange of the vertical axis shaft is mounted with bearings, and thus rotation of the robot body is realized. An actuator is placed between the lower end of the body and the connecting arm fixed to the vertical shaft; as a result, the robot body is rotated 100 degrees in the horizontal plane.

The robot arm (3rd axis) consists of a sheet metal profile placed between the robot body and the gripper. The bottom end of the robot arm is mounted on the upper end of the robot body with a shaft and two bearings. A ball screw actuator is mounted between the upper end of the robot arm and the robot body; as a result, the robot arm is provided to rotate 120 degrees.

Figure 5. Assembly of robot body
Şekil 5. Robot gövde montajı

2.3. Robot gripper design and manufacture
2.3. Robot tutucu tasarım ve imalatı

A human hand, one of the most complex organs of the human body, is the inspiration for robotic grippers. The human hand performing functions such as loosening and feeling in addition to its excellent gripping and tightening function is a very good example in the design of robot manipulators (Karaçizmeli et al., 2014; Bray et al., 2005). As shown in Figure 6, to hold cylindrical, spherical and rectangular prism-shaped pieces, two holding arms with V channels that open and close symmetrically are placed on the gripper. The gripper arms are opened and closed symmetrically with two right trapezoidal screws and their nuts on one side and two left trapezoidal screws and their nuts on the other side. The screws, embedded in the gripper body from the middle part, approach each other when they are turned clockwise and are moved away when they are turned counterclockwise. The screws used to open and close the gripper arms are rotated with a chain and gear system.

A right-angle electric motor with a reducer is used to open and close the gripper arms. The motor is mounted vertically on the gripper's body. The screws are driven by a chain gear attached to the motor shaft. By this way, cylindrical or spherical parts are held symmetrically between the gripper arms. It is mounted at the end of the robot arm using pins and bearings to rotate the gripper unit. A timing belt pulley system driven by a stepper motor placed at the upper end of the robot arm is used to rotate the gripper. The shafts carrying the timing pulleys with 10 and 40 gears are mounted on the

robot arm using bearings to increase the step motor torque (Koç & Doğan, 2020).

Figure 6. Mounting gripper on robot body
Şekil 6. Robot gövdesi üzerinde tutucu montajı

2.4. Five-axis robot's motion system
2.4. 5-eksen robot hareket sistemi

Mach3 is a very flexible program designed to control machines such as milling machines, plasma cutters and routers. Most connections between machine and the PC running Mach3 are made through the parallel port and usb in the computer (Wai & Aung, 2019). Mach3 motion control card is used in this study. There are 6 motor output ports, input ports for controlling sensors and output ports for controlling relays on this card.

6 axes are controlled with X, Y, Z, A, B, and C axis in Mach3 control card program. As shown in

Figure 7, the 1st axis Y, the 2nd axis Z, 3rd axis X, the horizontal movement of the gripper (5th axis) A and vertical movement of the gripper (4th axis) is driven by B. The Mach3 control card is programmed by entering codes and pin numbers in the card menu. In Mach3 program, the motor output ports, the motor direction and pin numbers

(Step and Dir) of the step motor are determined for each axis according to the motion of the robot. The PINs of the switches that are used to limit the movement of the axes are selected and the pins used clockwise (++) and counterclockwise (--) for each axis are activated. Motor output pins on the control card are activated to run the motors.

Figure 7. Introducing the axes
Şekil 7. Eksenlerin tanıtılması

For the advancement of the actuator control, each axis should be equal to the axis progress in the program. When the number of steps of the motors used in this study is 200, the micro-step value is 1/8 and the pitch of the shaft is 5 mm, and the number of steps in a revolution (steps per setting) is calculated as 320. Similarly, for the speed and tour settings of the timing belt used in B axis, the rotation angle of the gripper is taken as 360 degrees, the number of steps of the motor as 200, the micro-stage setting as 1/8 and the pulley ratio as 1/16. The number of steps per revolution is also calculated as 142.22. The number of steps, acceleration and speed value of the motor for one revolution is determined in each axis for tuning settings. For the actuator used in the robot, according to the feature of the Mach3 control card, the highest speed values are selected as 0 - 3000 for feed rate and 200 for acceleration.

3. Results
3. Bulgular

Motion trajectory of five-axis articulated type robot is recorded in a program file in the online programming system, widely used in robots; and the same operations are automatically performed by the robot (Biggs & MacDonald, 2003; Khort et al., 2013; Rossano et al., 2013). In this study, the

online programming system is used for controlling the robot. The method used to control the robot predetermines the points that the robot arm is gone. The G codes of each point are created and written in the program file. G codes are written in a text file opened in Mach3 program, and this file is run by pressing the start command. In order that a new G code can be written in the file, the old G codes in the file must be deleted. New G codes are written after the G codes in the file are deleted. These operations can also be performed without using the keyboard and computer screen. For this, the axes of robot are moved using joystick by the operator and G codes of points in the movement trajectory are written in the text file using macros of Mach3. G codes in the file are loaded into the load G-Code of the Mach3 program by the macros and the robot is moved in the recorded trajectory. Thanks to this feature, programming of the motion trajectory for the operation of the robot is performed online by the operator in a short time. The same process is performed for a long time by an experienced operator, according to the characteristics of the program and the motion trajectory by entering the normal data. This online programming system is added to the competitive power of the robot as it can easily be implemented by classical operators.

3.1. Macros used in robot control

3.1. Robot kontrolünde kullanılan makrolar

Macros in Mach3 program folder are created using VB Script Editor window under the operator menu. The commands of the operations to be carried out are written in the window that is opened and whose macro names are created with numbers starting with m. These macros are run by clicking on run in the program interface, pressing F5 key or by typing the macro name on the command line, and the lines in the program written in the macro are sequentially executed.

The m225 macro shown in Figure 8 prints the axis values onto the text file. In Mach3 program, 0 is used for X-axis, 1 for Y-axis, 2 for Z-axis, 3 for A-axis, 4 for B-axis, and 5 for C-axis. GetDRO command is used to get the last active axis values and define them to the variable. These axis values are printed in the text file in order. To be able to use in Mach3 program, G1 linear motion code is used at the beginning of the line and the feed rate is printed as f. If additional G-coded lines are to be printed in the same text file, m5 macro is used.
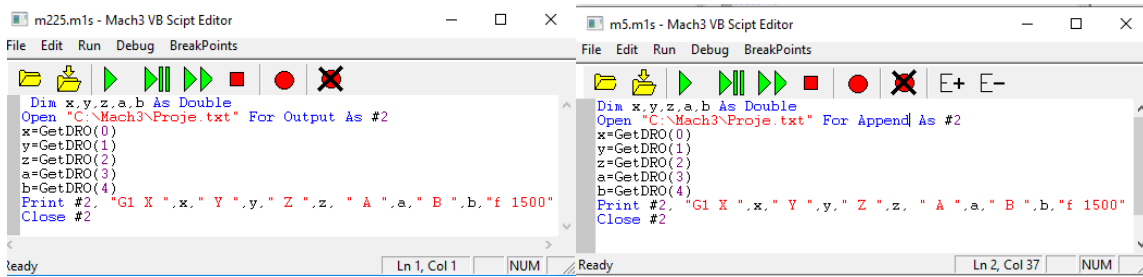

Figure 8. m225 and m5 macros
Şekil 8. *m225 ve m5 makroları*

When the robot is in the position of holding the piece, m222 macro shown in Figure 9 is used to close the gripper arms. With the closing of the gripper arms, the switch behind the pressure spring cuts the energy of the motor. Since energy is supplied to the motor both during the closing and opening of the gripper arms, the energy in the opening direction is cut off. When the contactor that is used in the closing direction of the gripper arms is energized, the motor is rotated to close the

gripper arms. The time required for the gripper arms to grip the piece is calculated as 3 seconds. The motor is de-energized after three seconds. The m555 macro is used for the gripper arms to release the part. The relay is de-energized and the gripper arms are opened. At the end of three seconds, the motor is de-energized and the robot continues to operate. Thus, the robot leaves the piece and continues its movement in the determined trajectory.
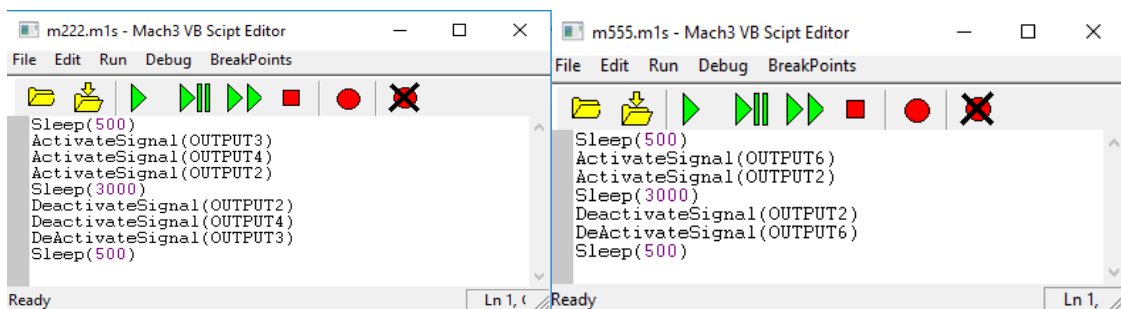

Figure 9. m222 and m555 macros
Şekil 9. *m222 ve m555 makroları*

The m22 macro shown in Figure 10 is used to close the gripper arms and to write m222 macro onto the text file. After determining the point of the piece and the gripper arms are closed. The m55 macro is

used to write the m555 code in the text file and to open the gripper arms by the motor when the robot comes to the point where it releases the piece.
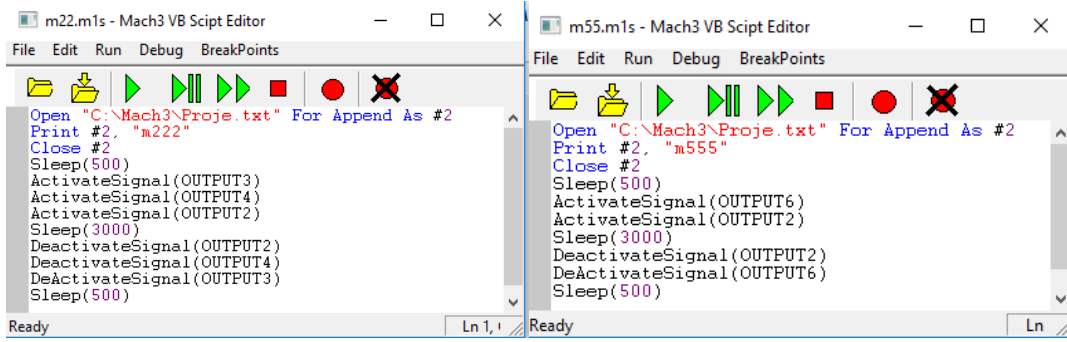
Figure 10. m22 and m55 macros
Şekil 10. m22 ve m55 makroları

Loading the text file into the program can be done by clicking the load G-Code tab in Mach3 Program window. In addition, as shown in Figure 11, it can be done by using m25 macro. The m52 macro is used to run the file in Mach3 program.
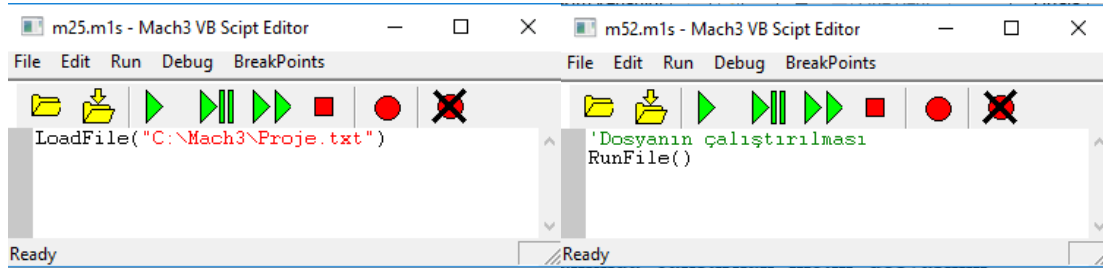

Figure 11. m25 and m52 macros
Şekil 11. m25 ve m52 makroları

When you want to run the same process again, m252 macro shown in Figure 12 is used. The m525 macro removes the file from the program so that it can be rewritten into the text file run in Mach3 program.
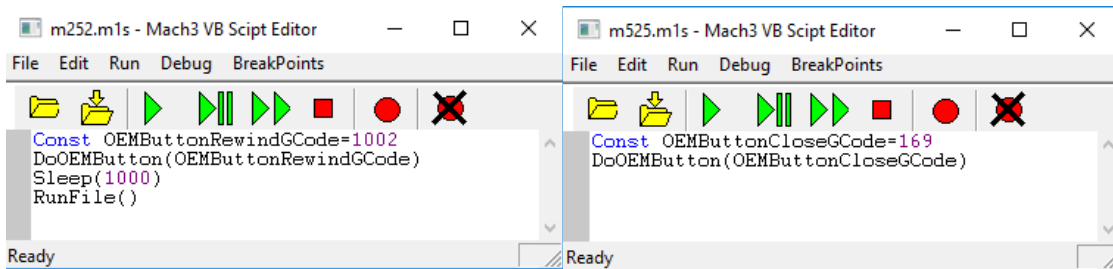

Figure 12. m252 and m525 macros
Şekil 12. m252 ve m525 makroları

3.2. Writing macros with PLC without keyboard
3.2. klavyesiz PLC ile makroların yazılması

As shown in Figure 13, PLC and four 24 V DC relays are used to write macro names on the command line on Mach3 screen without using a keyboard. Enter, m, 2, and 5 keys used on the keyboard are employed in writing the name of the macro on the command line and running it. 4 relays used in the system are connected to the joystick as enter, m, 2, and 5 keys.

To run the macro by printing on the screen, respectively, enter, m, numbers used in the macro name, enter and enter keys are short-circuited. On PLC device, Y0 is used for the enter key, Y1 for m key, Y2 for 2 key, and Y3 for 5 key. The time relay used in PLC programming is set to 200 ms for a single click in the keyboard integration. For short circuit, the relay that Y output that is connected is

activated with the set command; and after 200 ms Y output is deactivated with the reset command. The keys used as inputs of PLC and the macro names used as the output of PLC are defined as shown in Table 1.
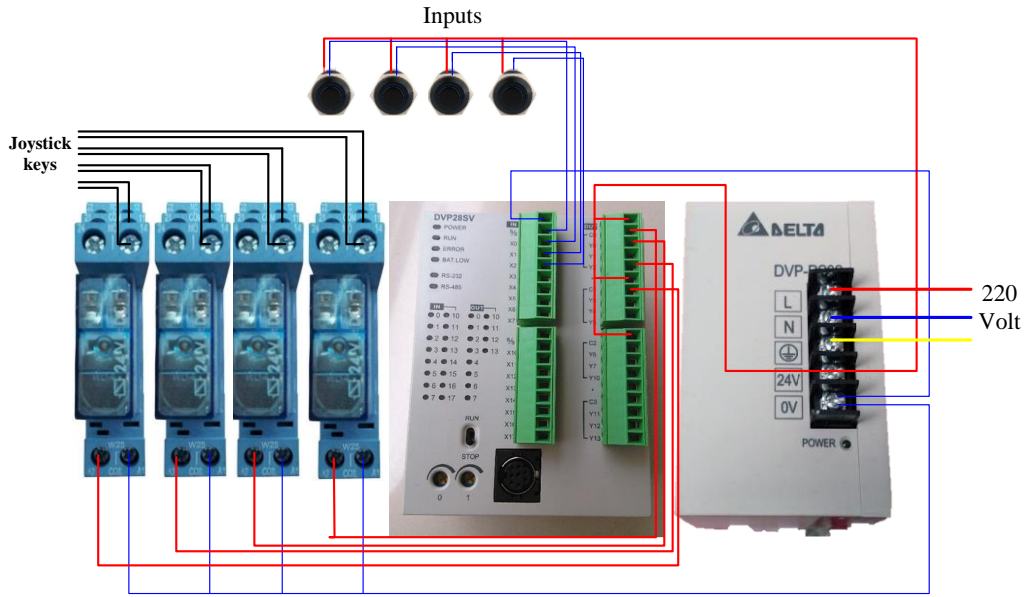

Figure 13. Writing macros on the screen with PLC and relay.
Şekil 13. *PLC ve role ile makroların ekrana yazdırılması*

Table 1. Usage of macros and keys in PLC
Tablo 1. *PLC'de makro ve anahtarların kullanımı*

Inputs and Outputs	Assigned Keys and Macros
Y0	Enter
Y1	m
Y2	2
Y3	5
X0	m225
X1	m5
X2	m22
X3	m55
X4	m25
X5	m52
X6	m252
X7	m522

4. Discussion and conclusions
4. Tartışma ve sonuçlar

When robot designs are examined, it is seen that servomotors and reducers are used in robot driven systems, which provide the movement for the arms. In this study, instead of geared servomotors, an actuator working with a ball shaft, which provides movement with push-pull force, is used. Considering the designs working with linear motion system, it is revealed that one of the most important advantages of ball screws is that they use less power while converting rotational force to linear force under less frictional medium. When the torque is applied to the rotation point to ensure the movement of the joint forming the 3rd axis, the torque falling on the motor is 90.415 Nm. When the actuator is placed at the same turning point in such a way that it creates torque with the effect of force, the torque falling on the motor that rotates the actuator is calculated as 0.455 Nm. When these values are compared, it is found out that the use of the actuator moving with a ball screw provides a great advantage. The motor used in each axis also carries the weight of the motors used in the next axis. Therefore, by reducing the weight of the motors used in the arms, it reduces the load of the motor used in the next axis. Thus, with the motor carrying more load, the effects caused by the weight of the arms are reduced and the cost of the robot arm is also reduced by using a stepper motor instead of a servomotor. In addition, since the actuator is mounted at the end of the joint, the free movements of the joints are restricted. However, when the robot movement is performed with a ball shaft, it is insufficient to provide movement at the desired speed; and the working speed decreases compared to other robots. Articulated robots have difficulties such as the complexity of the kinematic equations and the creation and supply of software required for controlling the robot. The extraction of these equations, the trajectory planning needed for motion and the determination of robot positions

using kinematic calculations also require advanced engineering knowledge. In this study, without using equations for kinematic calculations and polynomials for trajectory planning, the axis values of these points are saved to the file by moving the working robot manually to all the points it needs to go. G1 linear progress code and f feed rate are added to the axis values of these points and written onto the file. After the axis values of all points are printed, the file is loaded into the interface of Mach3 program and repeated the work done when it is run. Thus, the robot can be operated by operators who do not have advanced kinematics knowledge.

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Author contribution
Yazar katkısı

All authors contributed to the manuscript equally.

Declaration of ethical code
Etik beyanı

The authors of this article declare that the materials and methods used in this study do not require ethical committee approval and/or legal-specific permission.

Conflicts of interest
Çıkar çatışması beyanı

The authors declare that there is no conflict of interest.

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