DESIGN AND IMPLEMENTATION OF EDUCATIONAL ROBOT

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ABSTRACT
The aim of this paper in to device and implement an educational robot with end effecter (Gripper), the arm include the electrical, wiring controller and devices to make the robot work correctly. The mechanical parts were manufactured by nontraditional cutting (Abrasive water jet), bending and drilling operation. The robot parts are assembled together the electrical element controllers in their right positions. An appropriate design selection for gripper is selected so it is can to with stand for light loads. To evaluate the static and dynamic behavior of the robot a selected test have been made for the robot to do some simple actions and the actions were acceptable from all mechanical actions were some motions are selected and whole system behavior was acceptable (motion – control –target.

Keywords:
Designing and Implementing, robotic, educational

INTRODUCTION

The response is simple Robotics is a science that combines a range of fields like Mechanical Engineering, Electrical Engineering, and Computer Science. Robotics is ideal for adolescent students because it exposes them to hands-on applications of math, science, and engineering concepts .In addition, robotics motivates potential scientists and engineers to understand how things work and encourages them to use their imagination to create new technologies and improve old technologies .The next part of this extended background should cover the main components of a robot including some basic concepts for third to fifth grade.[1] and [2].

Wissam K. Hamdan Sarraji [3]**.** Propose in this paper an inverse kinematics approach of 6Dof robot manipulator for machining of 3D surfaces rather than the use of CNC milling machine. From the experimental runs it could be concluded that very small time is needed for the calculations of the joints variable. The gathered results show the accuracy of the proposed method where the error between the required and verified CC-P(cuter contact point) .

Anurag V and Mehul Gor [4]. In this paper, the forward kinematics problem is concerned with the relationship between the individual joints of the robot manipulator and the position and orientation of the tool or end-effectors. Stated more formally, the forward kinematics problem is to determine the position and orientation of the end-effectors,

given the values for the joint variables of the robot. This work is an attempt to develop kinematic model of a 6 DOF robot which is used for arc welding operation. Developed model will determine position and orientation of the end-effectors with respect to various joint variables. Analysis is carried out in Matlab.

Anurag and Vivek A [5]. The forward kinematic analysis of 5- D.O.F SCORBOT-ER Vplus Robot is investigated. The mathematical model is prepared and solved for positioning and orienting the end effector by preparing a program in Matlab 8.0.

Himanshu Chaudhary et al [6]. In this paper, two approaches to generating such trajectories: straight lines in joint space and straight lines in Cartesian space have been discussed. This is one of the most common requirements in robotics for moving the end-effector smoothly from initial location to goal location. These are known respectively as joint space and Cartesian space tracking. Two user defined algorithms are developed for Joint space as well as Cartesian space trajectory tracking. The algorithm has been tested in simulation program.

Stress analysis of Part2.

Use this information in conjunction with experimental data and practical experience .Field testing is mandatory to validate your final design .COSMOS works helps you reduce your time-to-market by reducing but not eliminating field tests.

Study Properties

Study name	Study 1
Analysis type	Static
Mesh Type:	Solid Mesh
Solver type	FFEPlus
Inplane Effect :	Off
Soft Spring :	Off
Inertial Relief :	Off
Thermal Effect :	Input Temperature
Zero strain temperature	298.000000
Units	Kelvin
Include fluid pressure effects from COSMOSFloWorks	Off
Friction :	Off
Ignore clearance for surface contact	Off
Use Adaptive Method :	Off

Units

Unit system:	SI
Length/Displacement	m
Temperature	Kelvin
Angular velocity	rad/s
Stress/Pressure	N/m^2

Material Properties

No.	Body Name	Material	Mass	Volume
1	Part2	[SW]1060 Alloy	0.0609038 kg	2.2557e-005 m^3

Material name:	[SW]1060 Alloy
Description:	
Material Source:	Used Solid Works material
Material Library Name:	solid works materials
Material Model Type:	Linear Elastic Isotropic

Property Name	Value	Units	Value Type
Elastic modulus	6.9e+010	N/m^2	Constant
Poisson's ratio	0.33	NA	Constant
Shear modulus	2.7e+010	N/m^2	Constant
Mass density	2700	kg/m^3	Constant
Tensile strength	6.8936e+007	N/m^2	Constant
Yield strength	2.7574e+007	N/m^2	Constant
Thermal expansion coefficient	2.4e-005	/Kelvin	Constant
Thermal conductivity	200	W)/m.K(	Constant
Specific heat	900	J)/kg.K(	Constant

Reaction Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	8.52042e-008	-4.38558e-009	0.00210857	0.00210857

Free-Body Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	2.42153e-009	5.88045e-011	-3.06157e-009	3.90391e-009

Free-body Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant

Entire Body	N-m	0	0	0	1e-033

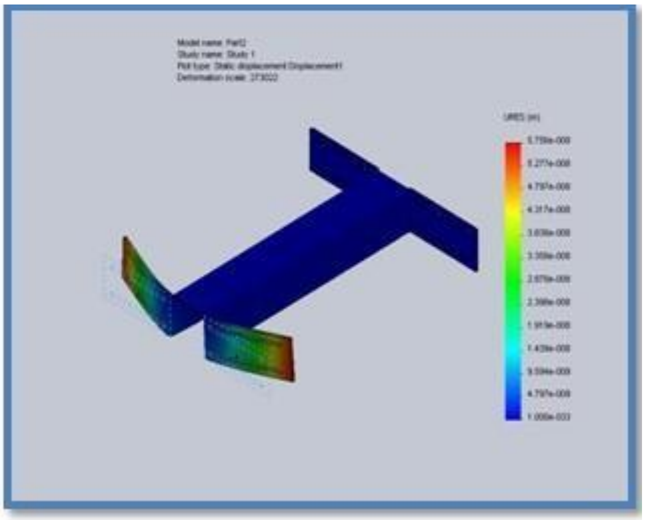


Fig.(1): Part2- Stress-Stress1

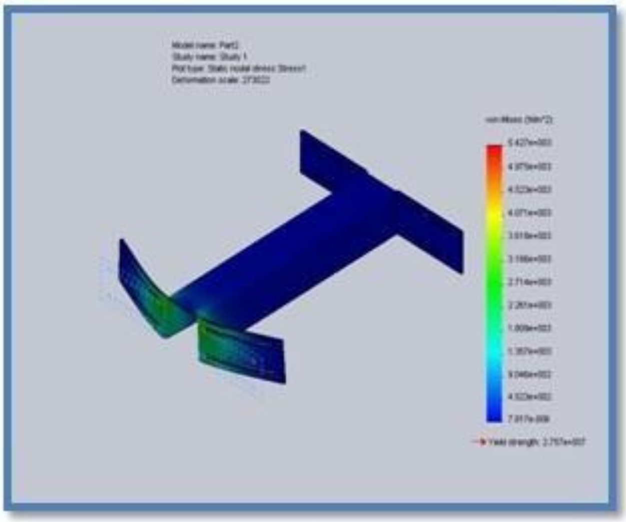


Fig.(2): Part2-Displacement-Displacement1

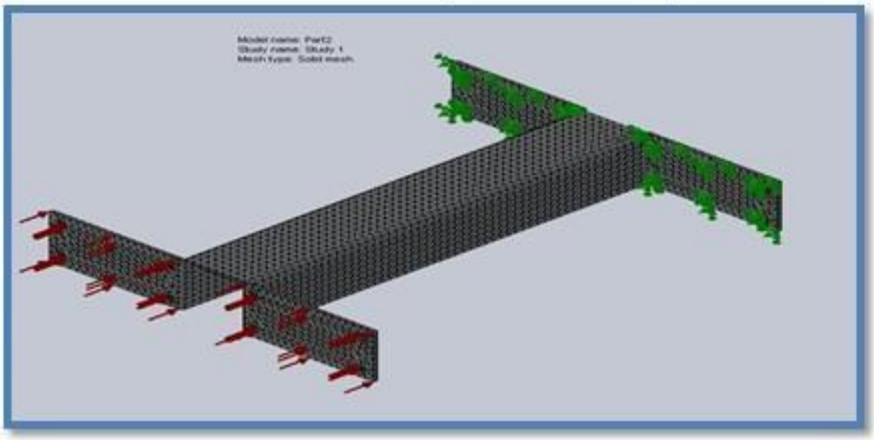


Fig.(3): Part2-Strain-Strain1

Stress analysis of Part5

Use this information in conjunction with experimental data and practical experience .Field testing is mandatory to validate your final design .COSMOS Works helps you reduce your time-to-market by reducing but not eliminating field tests.

Study Properties

Study name	Study 5
Analysis type	Static
Mesh Type:	Solid Mesh
Solver type	FFEPlus
Inplane Effect :	Off
Soft Spring :	Off
Inertial Relief :	Off
Thermal Effect :	Input Temperature
Zero strain temperature	298.000000
Units	Kelvin
Include fluid pressure effects from COSMOSFloWorks	Off
Friction :	Off
Ignore clearance for surface contact	Off
Use Adaptive Method :	Off

Units

Unit system:	SI
Length/Displacement	m
Temperature	Kelvin
Angular velocity	rad/s
Stress/Pressure	N/m^2

Material Properties

No.	Body Name	Material	Mass	Volume
1	Part5-	[SW]1060 Alloy	0.0340917 kg	1.26266e-005 m^3

Material name:	[SW]1060 Alloy
Description:	
Material Source:	Used SolidWorks material
Material Library Name:	solidworks materials
Material Model Type:	Linear Elastic Isotropic

Property Name	Value	Units	Value Type
Elastic modulus	6.9e+010	N/m^2	Constant

Poisson's ratio	0.33	NA	Constant
Shear modulus	2.7e+010	N/m^2	Constant
Mass density	2700	kg/m^3	Constant
Tensile strength	6.8936e+007	N/m^2	Constant
Yield strength	2.7574e+007	N/m^2	Constant
Thermal expansion coefficient	2.4e-005	/Kelvin	Constant
Thermal conductivity	200	W)/m.K(	Constant
Specific heat	900	J)/kg.K(	Constant

Mesh Information

Mesh Type:	Solid Mesh
Mesher Used :	Standard
Automatic Transition :	Off
Smooth Surface :	On
Jacobian Check :	4 Points
Element Size:	2.3295 mm
Tolerance:	0.11647 mm
Quality:	High
Number of elements:	14240
Number of nodes:	28448
Time to complete mesh)hh;mm;ss :(	00:00:07
Computer name :	ROBO-7BD3B4D51F

Reaction Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	-9.64876e-007	-5.1558	1.24244e-007	5.1558

Free-Body Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	2.09885e-008	-7.11719e-006	5.05166e-008	7.1174e-006

Free-body Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N-m	0	0	0	1e-033

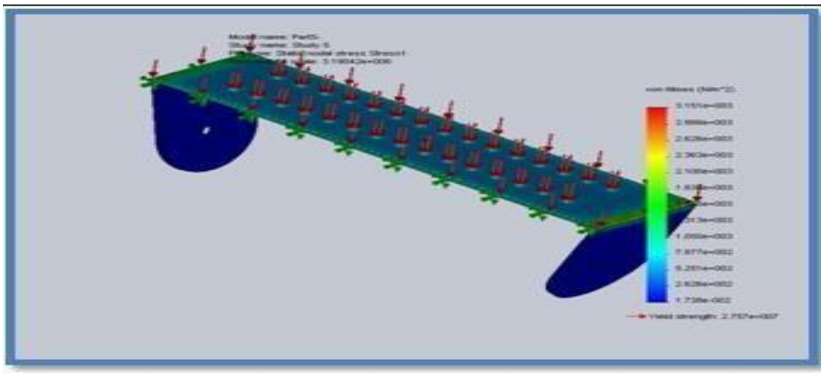


Fig.(4): Part5-Stress-Stress1

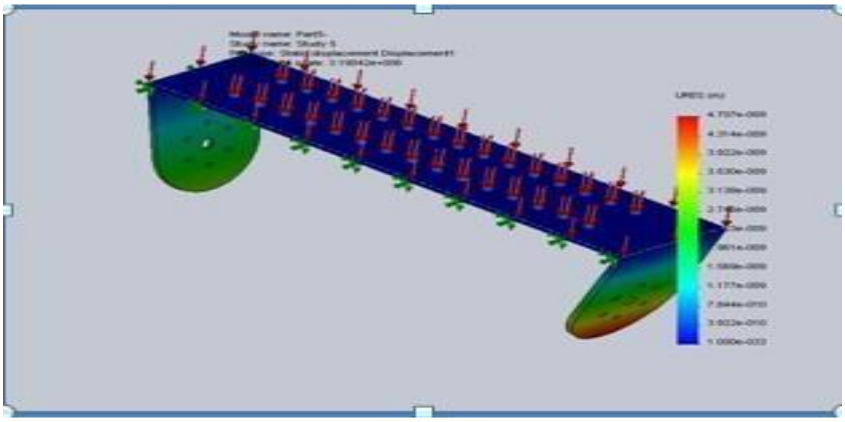


Fig.(5): Part5-Displacement-Displacement1

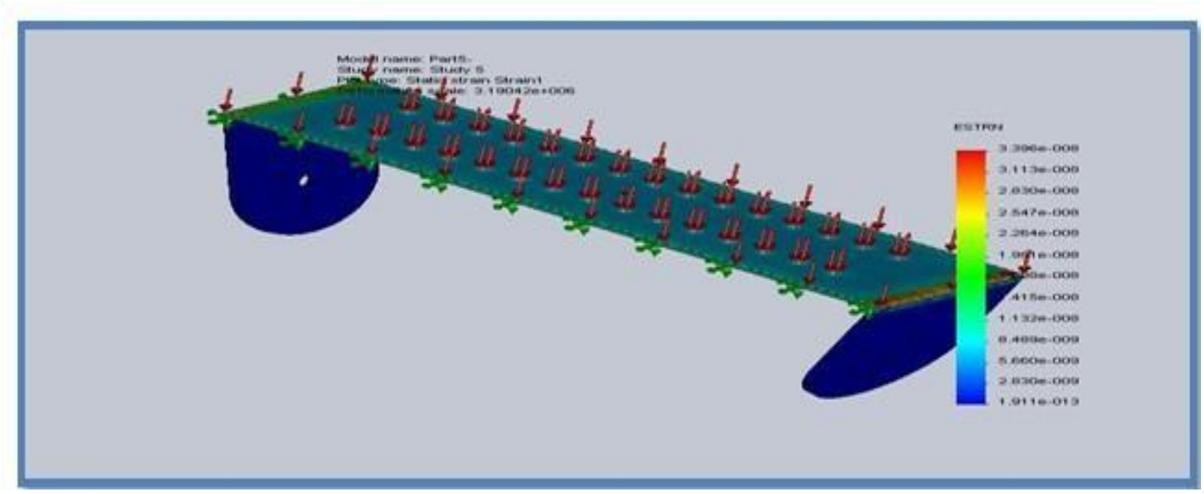


Fig. (6): Part5-Strain-Strain1

Control of Robot Manipulators

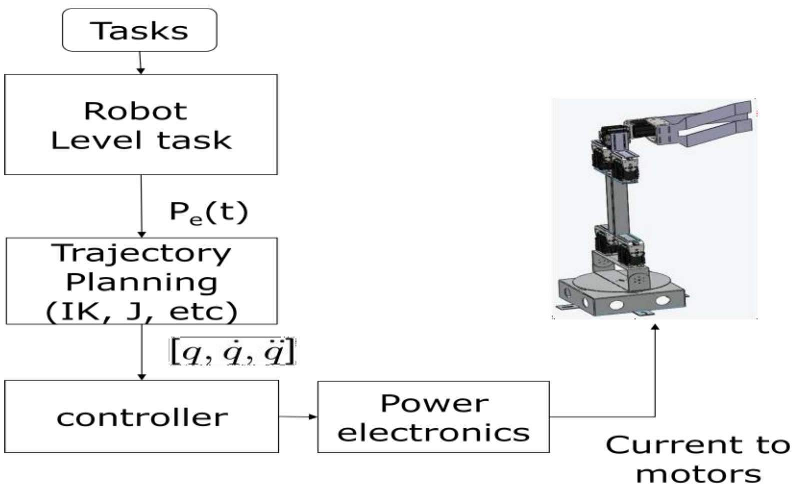


Fig. (7): Control of Robot Manipulators

Jointed system components:

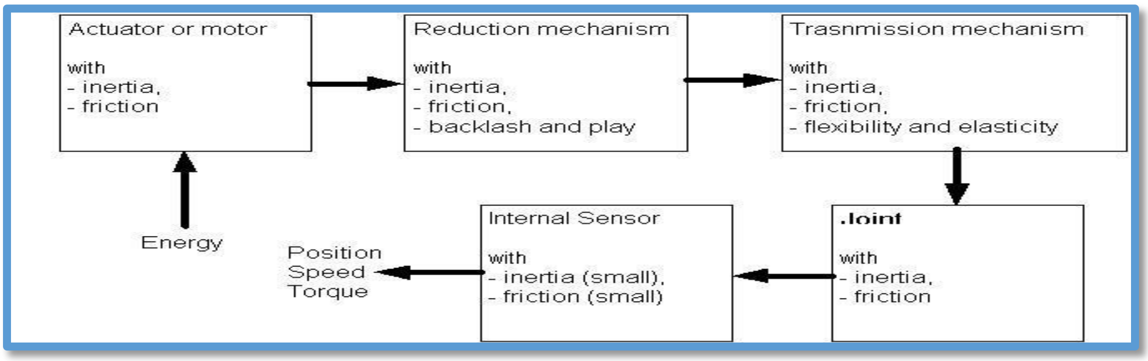


Fig. (8): Jointed system components

Independent Joint Control

[1] Use computed reference points (set points)for each joint
[2] Control each joint ―independently‖
[3] Simplifies control
[4] Block Diagram (next slide)
[5] Block Diagram of PE controller for a single joint

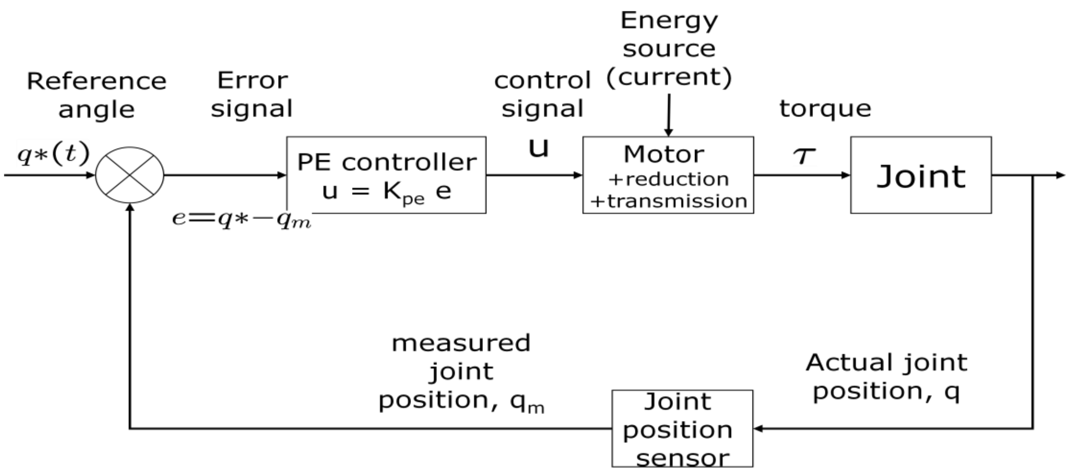


Fig. (9): Block Diagram of PE controller for a single joint

DC Motor:

Contents

[1] Overview of Direct Current Machines
[2] Construction
[3] Principle of Operation
[4] Types of DC Motor
[5] Power Flow Diagram
[6] Speed Control

DC motor principles:

DC motors consist of rotor-mounted windings armature and stationary windings field poles .In all DC motors, except permanent magnet motors, current must be conducted to the armature windings by passing current through carbon brushes that slide over a set of copper surfaces called a commentator, which is mounted on the rotor.

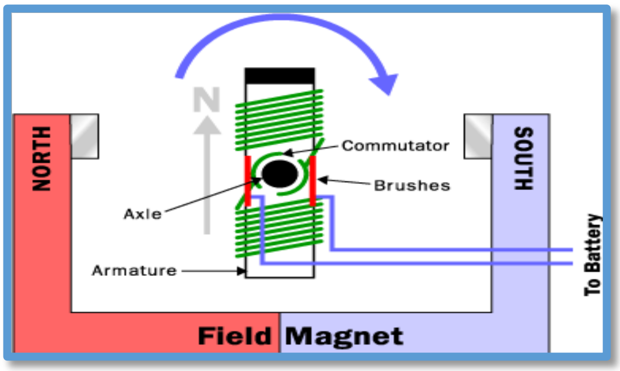
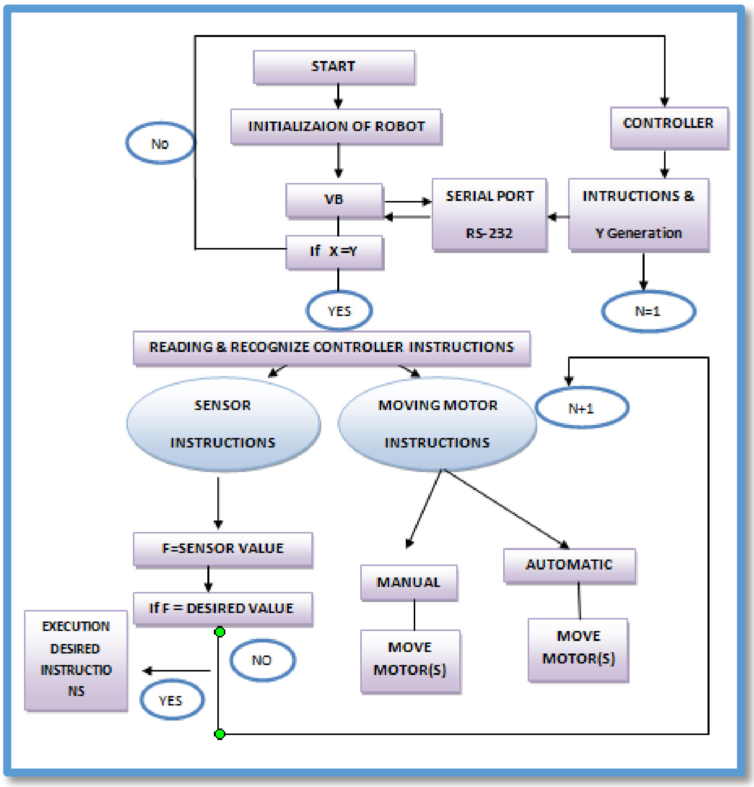


Fig. (10): DC Motor

RS Servo Motor:

3 wires :power, ground, control signal sets the position. High pulse every ~20 ms determines set angle; pulse width between ~0.5 ms and ~2 ms, indicating the two ends of angle range Internal gearing, potentiometer, and feedback control.

Fig. (11): RS Servo Motor



X =Check sum generated in VB, yY =Check sum generated in C & Basic, nN= Order of instructions in automatic moving motors, N default = 1

Fig.(12): Block diagram programming

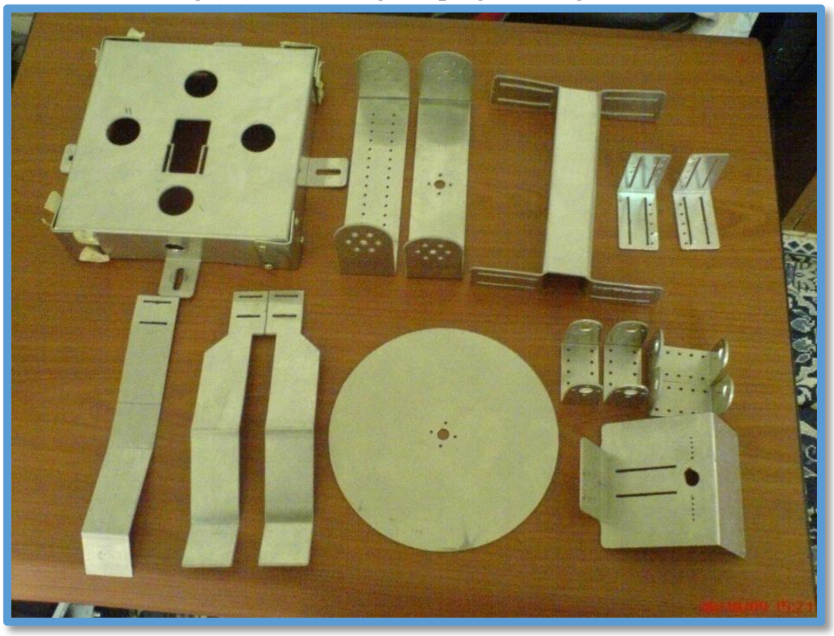


Fig. (13): Parts of the robot

Compute the Torque required for motor (1)

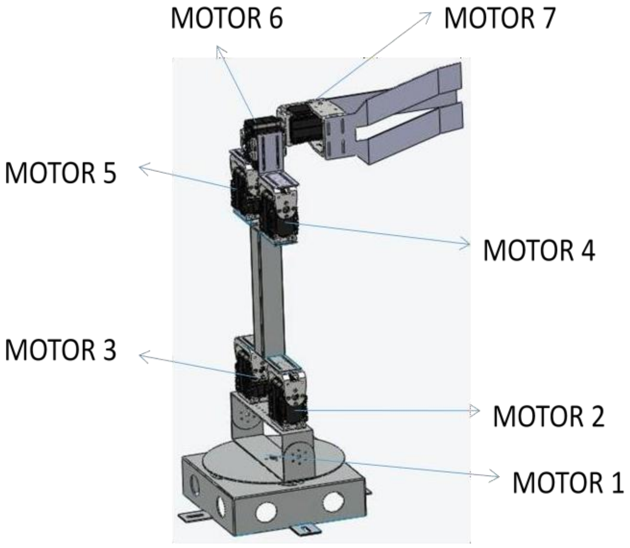


Fig. (14): The robot

The kinetic energy of m for part (4)

$$K = 0.5m\ (r^2 \dot{\theta}^2)$$

$$r = zero$$

$$K = zero$$

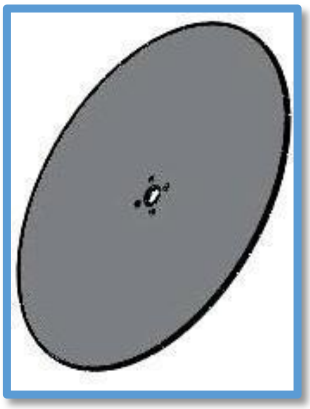


Fig. (14): part (4)

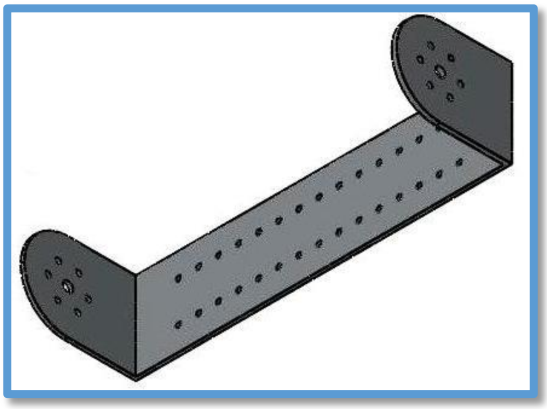
The potential energy of m for part (4)

$P = mgr\sin\theta$ $\quad r = zero$ $\quad \sin 90 = 1$ $\quad P = zero$

The kinetic energy of m for part (5)

$$K = 0.5m\,(r^2\dot{\theta}^2)$$

$$r = zero$$



$$K = zero$$

Fig. (15): part (5)

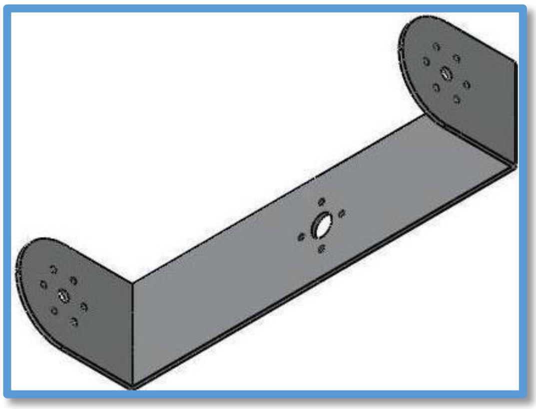
The potential energy of m for part (5)

$P = mgr\sin\theta$ $\quad r = zero \quad$ $P = zero$

The kinetic energy of m for part (6)

$$K = 0.5m\,(r^2\dot{\theta}^2)$$

$$r = zero$$



$$K = zero$$

Fig. (16): part (6)

The potential energy of m for part (6)

$P = mgr\sin\theta$ $\quad r = zero \quad$ $P = zero$

The kinetic energy of m for motor (2)

$$K = 0.5m\,(r^2\dot{\theta}^2)$$

The potential energy of m for motor (2)

$P = mgr\sin\theta$ $\quad r = zero \quad$ $P = zero$

The kinetic energy of m for motor (3)

$$K = 0.5m\,(r^2\dot{\theta}^2)$$

The potential energy of m for motor (3)

$P = mgr\sin\theta$ $\quad r = zero \quad$ $P = zero$

The Lagrange energy for this θ-r robot arm is

$$L = 0.5m(r^2\dot{\theta}^2) + 0.5m(r^2\dot{\theta}^2)$$

The Torque about the rotation:

$$L = mr^2\ddot{\theta} + mr^2\ddot{\theta} + T_2 + T_3$$

Compute the Torque required for motor (2) and (3).

The potential energy of m for m4 part (2)

The kinetic energy of m_m for motor (4) $K = 0.5m_m(r^2\dot{\theta}^2)$

The potential energy of m for m4 part (4) $P = m_m gr \sin\theta$

The kinetic energy of m_m for motor (5) $K = 0.5m_m(r^2\dot{\theta}^2)$

The potential energy of m for m4 part (5) $P = m_m gr \sin\theta$

The Lagrange energy for this [θ-r] robot arm is

–

$$P = m_2 gr_1 \sin\theta$$

$$L = K - P$$

$$L = 0.5m_m(r^2\dot{\theta}^2) + 0.5m_m(r^2\dot{\theta}^2) + 0.5m_m(r^2\dot{\theta}^2) - m_m gr \sin\theta - m_m gr \sin\theta - m_2 gr \sin\theta$$

The Torque about the rotation:

$$T = m_2 r^2\ddot{\theta} + m_m r^2\ddot{\theta} + m_m r^2\ddot{\theta} + m_2 gr_1 \cos\theta + m_m gr \cos\theta + m_m gr \cos\theta$$

$$= m_2 r_1^2\ddot{\theta} + 2m_m r^2\ddot{\theta} + g\cos\theta(m_2 r_1 + 2m_m r)$$

The torq

Min (0.9

$$T_2 = T + T_3$$

Max (1.5 N.M)

Motor (4)= 0.115 * 1.3 = 0.2 N.M

Motor (5)= 0.115 * 1.3 = 0.2 N.M

Motor (2)= 0.361 * 1.3 = 0.46 N.M

Motor (3)= 0.361 * 1.3 = 0.46 N.M

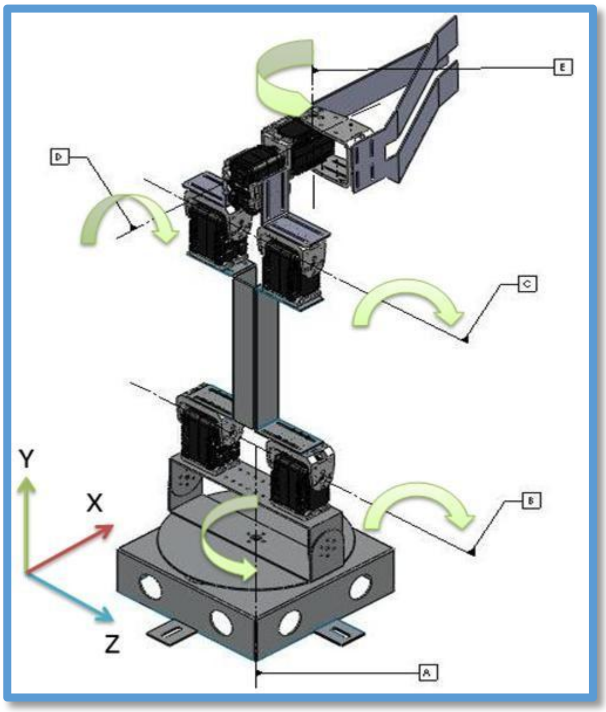


Fig.(17): Torque shown

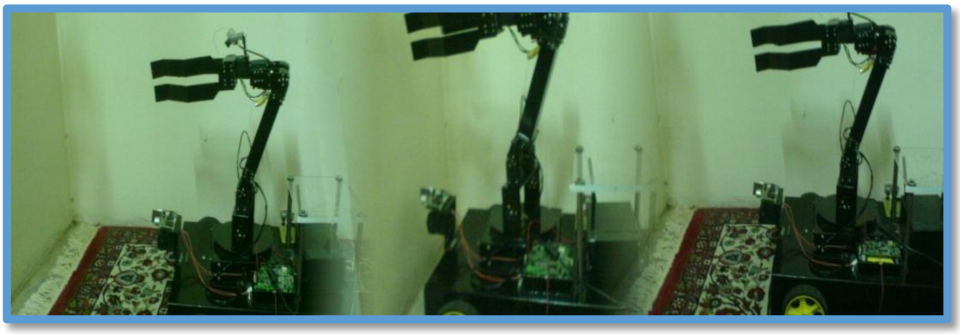


Fig. (18): Educational Robot

CONCLUSION

[1] The manufacturing mechanical frame of the robot provides the efficiency of the hand movements, and stiffness that accepted with some vibrations in the (links) as a result of the high-speed motors.

[2] The choosing (AL alloy) helped many to reduce weight with the ability selection of motors with a simple capabilities Torque (12kgf.cm) to address all the movements of the robot.

[3] Dynamic capabilities are added to the robot through the wheels to expand the work of the robot in all directions, which facilitated the ability of the robot to accomplish tasks or workers with a wide.

[4] Our designing and inventing of the robot is suitable for our goals that we planned to do them.

[5] the manufacturing of mechanical parts done by using modern methods such as (Abrasive water jet), which enable the access to the exact dimensions of the various constituent parts of the robot and this contributed to the achievement of precision in manufacture.

[6] The robot was provided with two types of motors (Servo motors & DC Gearbox) and they was a good choice where the Servo drives the work of moving the arm and detent successfully completed, while the DC Gearbox engines move the vehicle in all directions.

[7] The adoption of programming (VBA) was a convenient and proven it is success in the leadership and moves the robot.

[8] 8 – The robot is supply with the remote control system (wireless) increase it’s capability of moving to all directions and it is tested and confirm it’s success.

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