

Nov 5, 2018 Shetty
Interactive Physics.

DESIGN OF A 5 DOF JOINTED ROBOTIC MANIPULATOR FOR WELDING PURPOSE USING WORKING MODEL SOFTWARE.

1. About Working Model Software :

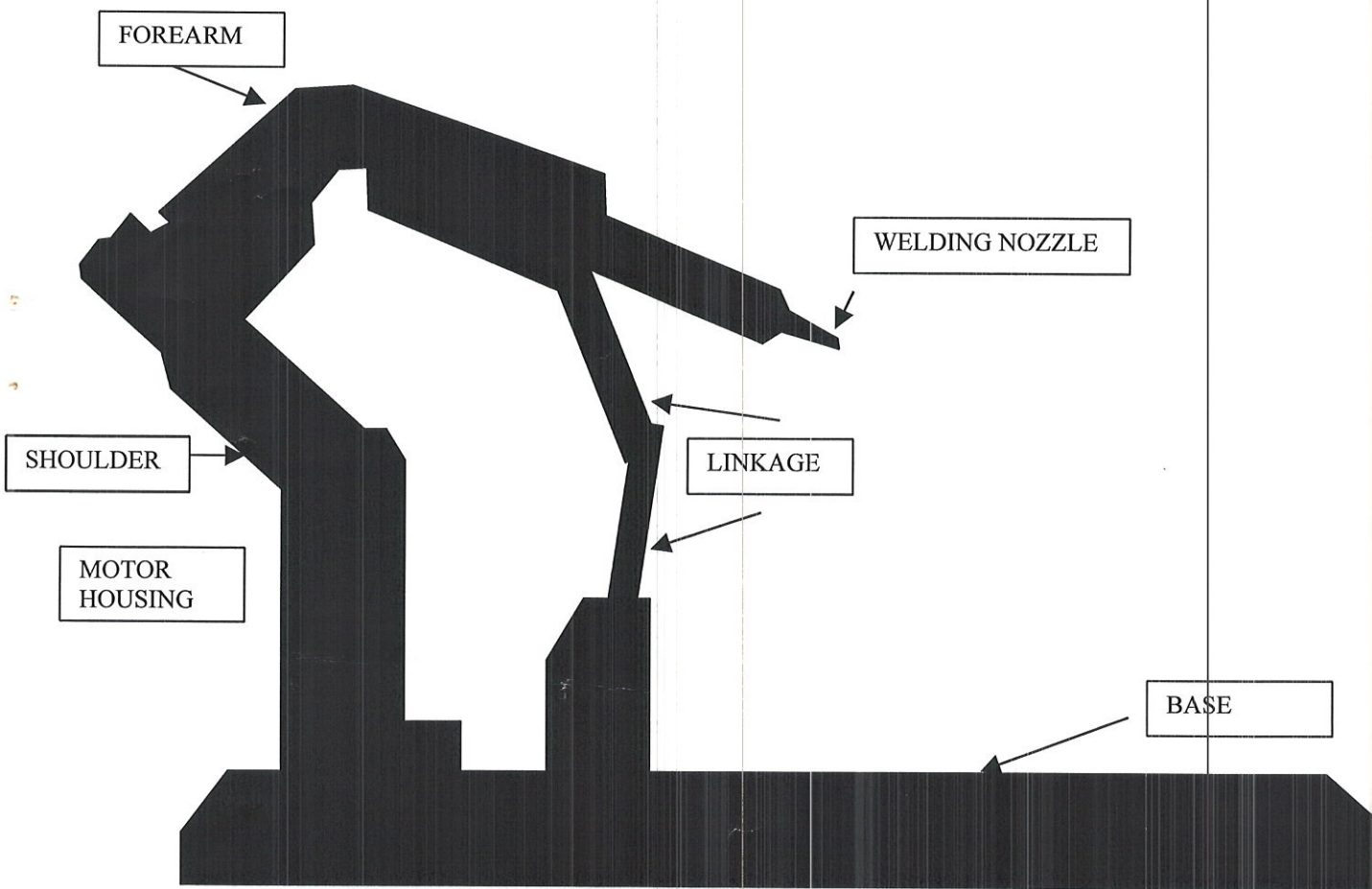
The Working Model is a software which allows for simulation of mechanical elements, in a gravity based environment, where the elements can be connected by the means of pin joints or any other type of coupling. The Working Model provides the user with a one dimensional space, and gravity, and air resistance, along with several other parameters like friction, force field, electrostatics, magnetics etc. The software has a World menu where by parameters such as friction , force field etc can be changed to meet the design environment. Besides that it also has Define menu which allows vector algebra, and new application interface. The Measure window allows to record or display graphically on the screen the time, displacement, velocity, acceleration, force, and other kinematic and dynamic variables. The software has a whole range of tools on the side to create the solid elements with mass in one dimension and couple them with gear trains, pulleys or pins. There are anchors available to anchor and fix a particular entity, besides that, double clicking on each mass reveals its properties which can be edited.

A control can also be implemented using working model, and can be appropriately simulated.

2. Principle parts of my Robot:

- i) The Base- which is a flat bed on which the entire robot is mounted. The base has to be fairly heavy so as to absorb vibrations and also to provide a firm mounting.
- ii) The Motor Housing- which are essentially vertical boxes which house motors and drives and also the circuit boards. A cooling system is also located in this casing to dissipate the excess heat generated. A cable routing has also been provided.
- iii) The Shoulder – it's the arm, which is connected to the motor housing, and directly driven by the motor. The fixed sequence of pulses to the motor causes the motor to change polarity within given time interval, which causes the robot shoulder to oscillate.
- iv) Forearm-This is a vital component of the robot arm and carries the welding tool, the nozzle and the sensors. It also carries a small on

ROBOT SCHEMATICS AND PART LIST



Force 18 Magnitude

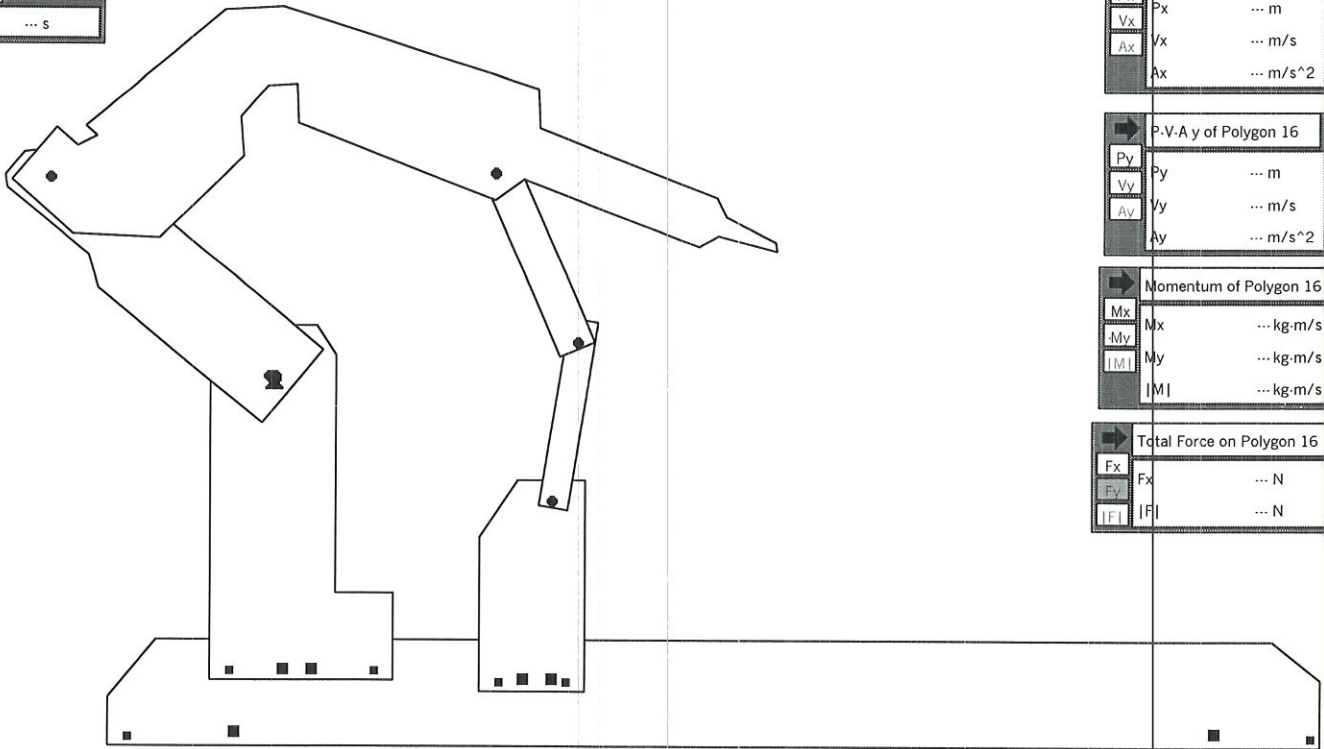
Force 18 Direction



3.46

1.70

Time
t ... s



Torque on Polygon 16
Torque ... N-m

P-V-A of Polygon 16
Px ... m
Vx ... m/s
Ax ... m/s^2

P-V-A y of Polygon 16
Py ... m
Vy ... m/s
Ay ... m/s^2

Momentum of Polygon 16
Mx ... kg-m/s
My ... kg-m/s
|M| ... kg-m/s

Total Force on Polygon 16
Fx ... N
Fy ... N
|F| ... N

Force 18 Magnitude

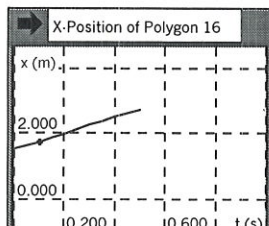
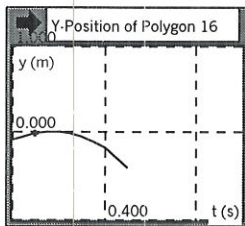
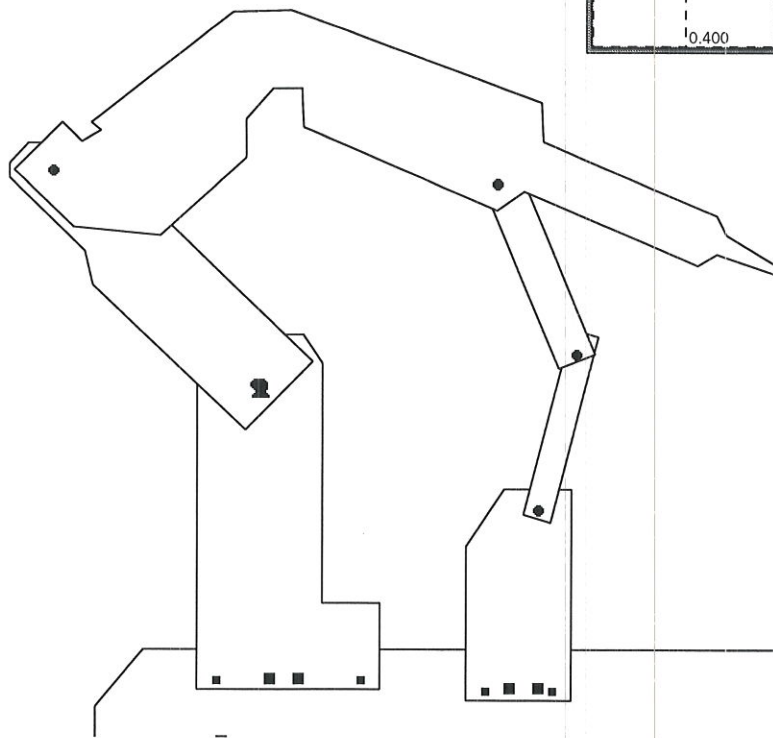
Force 18 Direction



3.46

1.70

Time
t 0.100 s



Torque on Polygon 16
Torque -43.783 N-m

Velocity of Polygon 16

Vx	2.438 m/s
Vy	0.503 m/s
V	2.490 m/s
Vθ	-31.718 °/s

Acceleration of Polygon 16

Ax	1.829 m/s ²
Ay	-6.648 m/s ²
A	6.895 m/s ²
Aθ	-83.410 °/s ²

Momentum of Polygon 16

Mx	18.703 kg-m/s
My	3.857 kg-m/s
M	19.096 kg-m/s

Angular Momentum of Polygon 16
L -953.945 kg-m²/s

board CCD camera, which identifies the tool position with respect to the work piece.

- v) The Linkage- A two bar chain is used as a support linkage to prevent collapse of the structure, and for positioning of the robot arm.

3. Procedure :

- i) First the base was created and anchored.
- ii) The next step was to create the motor housing, using polygon command.
- iii) Now the motor housing was anchored with the base, using fixed pins or anchor points.
- iv) Next the shoulder was hinged into the motor housing and the forearm was also connected in a similar way to the shoulder and the two bar linkage.
- v) Finally a motor was applied between the shoulder and the forearm.
- vi) Pause control logic was used to control the motor so that the motor would reverse when the time becomes greater than 1 second. An advanced control can be implemented by using an equation, which would describe the motion suitably, and incrementing or decrementing the time value, or changing the velocity and acceleration also.
- vii) Plots of the position, velocity and acceleration of the forearm are obtained and attached with this report.

4. Conclusions:

It can be very well seen, from the simulation that the robot works fine. The linkage as some physical constrains which might be due to overlapping of the bodies somewhere which can be avoided in actual conditions using a controlled tolerance during manufacturing.

