Poppy-Humanoid Left Leg

*Michel Magdy,43-5944,michel.yakoub@student.guc.edu.eg *Amr Abdrabo,43 15882,amro.abelaziz@student.guc.edu.eg *Paula Amir, 43-7652, paula.fahmy@student.guc.edu.eg, *Mina Saeed, 43-9123, mina.william@student.guc.edu.eg *Sherif Richard, 43-0827,sherif.habib@student.guc.edu.eg

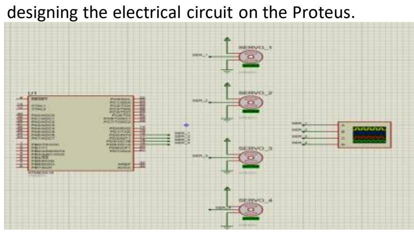
Abstract

The main goal of a robot is to design and implement a human similar controlled machine which fulfills tasks done by the people. The first step to make such a robot is to let him move in a specific path which is given by the user and this is actually the main goal of the course. To start implementing this process at the beginning we have to design the left leg of the Poppy Humanoid on solid works to calculate the exact values needed to buy the suitable motors and to 3D print the parts. It was very important to calculate the inverse and forward kinematics to make the desired trajectories given by the user on Matlab. After finalizing the design, the robot motion is tested using Simscape to make sure that all the values are suitable before any wiring. Last but not least we bought all the hardware components needed to build the left leg of the robot.

Methodology

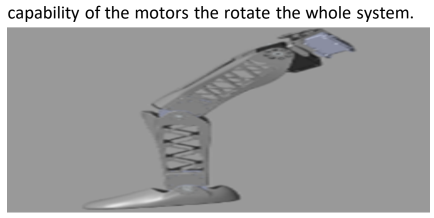
The goal of the project is to design and control a robotic leg which consists of 4 joints which corresponds of course to 4 servo motors to control the angle of rotation of each joint. Each team will work on a different part of the robot, either leg or arm, left or right and at the end the goal is to assemble the different parts together to come up with one complete robot as shown in the figures. Followed by a detailed description in the same section of the electrical circuit design, which is created using a program named Proteus. To test cooperation of the components with each other we simulated the whole process using matlab, solid works and Simscape.

1)After we figured out the components we started designing the electrical circuit on the Proteus.



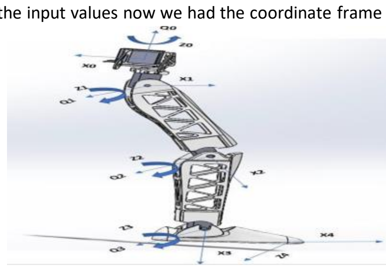
Proteus wiring

2)We combined the solid works design with Simscape so that we could put input torques on each joint to test capability of the motors the rotate the whole system.



Simscape

Regarding the forward kinematics, to move all joints we needed to give the program some inputs such as the amplitude, bias, frequency, etc… After assigning the input values now we had the coordinate frame :



Coordinate frame

Getting the forward kinematics by using DH convention:

Old to new frame	theta	d	a	alpha
0 to 1	Q0	-L1	0	90
1 to 2	Q1	L2	L3	0
2 to 3	Q2	0	L4	0
3 to 4	Q3	0	L5	0

Links	length
L1	4.5 cm
L2	2.3 cm
L3	19 cm
L4	18 cm
L5	10 cm

Number of joints	Number of links
4	5

DH convention table

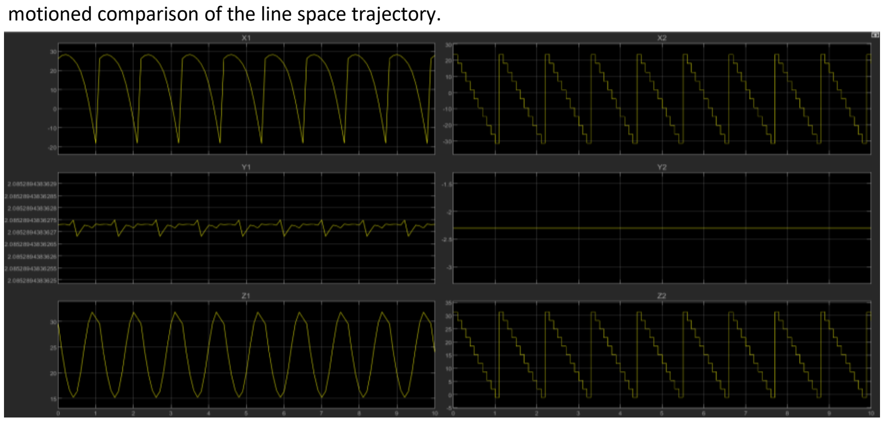
By applying the inverse kinematics, we tried 2 test cases. One with zero angles as inputs to the joints, and the other one with random angles. The results show that the x, y and z positions from Matlab function (dh-convention) are similar to those from Simscape with a small tolerance.

Zero position

Results:

Concerning the task space and joint space :

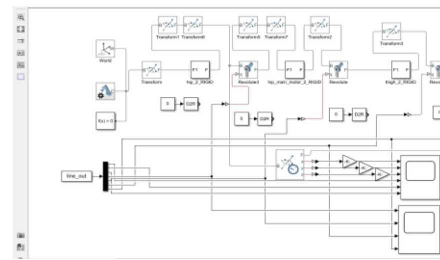
In order to calculate and analyze these results we first had to calculate the inverse and forward kinematics. So that we could compare the calculated results with simscape. Find below the motioned comparison of the line space trajectory.



X,Y,Z comparison

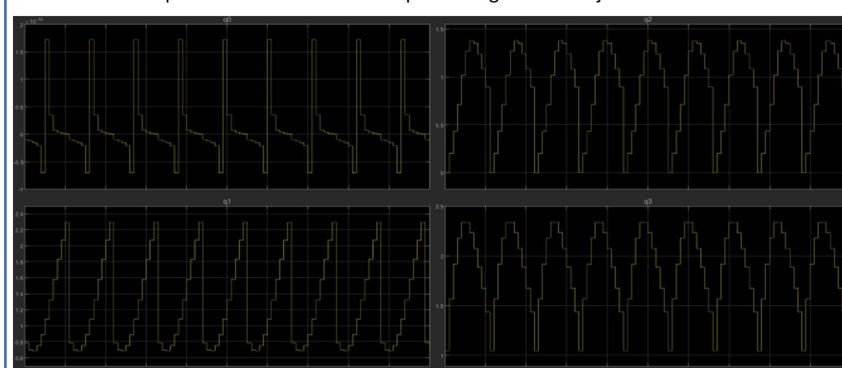
First we had to write a code on matlab to calculate all the values we need for simulating the whole process on Simulink as shown below. These results of the different qs calculated where used as an input for the simscape and for the controller(Arduino) to move the robotic leg using the desired values.

After finalizing the design and analyzing the results we had to simulate the whole process first before implementing it, to test weather everything will work as planned. To make this simulation we designed the process using Matlab and Simscape.



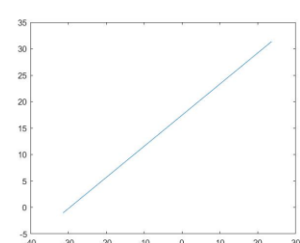
Simulink

Find below the qs calculated from the task space and given to the joints



Calculated qs from task space

Last but not least find below the graph describing the x vs the z axis in the line space trajectory



X vs Z

Scan it for more

Conclusion

To sum it all up, to start manufacturing the above mentioned robot our first step was to finalize the solid works design to move on to the next step which is designing the electrical circuit. After finishing those two steps we were able to figure out the exact dimensions and specs of the servo motors we need to rotate this robot by knowing the weight and other dimensions from the design. Before we purchased the materials we first had to test whether this combination of components will work or not, so we used Simscape to simulate the whole process which worked well. Last but not least we purchased the components and started the 3D printing of the robot. The main goal of Milestone two was fabricate and 3d print all parts of the left leg which we were assigned to. After finalizing the manufacturing of the parts we connected the 4 servo motors to test the rotation of each joint by giving it input from the Arduino. Throughout this milestone we also combined the final solid works design with Simscape through Matlab to test the position of the endefector when giving the system different angles. We also developed the DH- Convention of the limb and sensed the position of the end effector and was the same as that obtained by the kinematic equations with simple tolerance.

Initial Design on Solidworks

Final Design after Implementation