INTERNATIONAL JOURNAL FOR TRENDS IN ENGINEERING & TECHNOLOGY
VOLUME 8 ISSUE 1 – AUG 2015 - ISSN: 2349 - 9303

Design and Analysis of Voice Activated Robotic Arm

Ajay Aravind
S4 MTECH
Government College of Engineering, Kannur
ajayaravind05@gmail.com

Dr. T.D. John
PROFESSOR
Government Engineering College, Kannur

Abstract: This paper mainly focuses on the design considerations and force analysis of the robotic arm by voice commands. The dynamic analysis includes both flexible and rigid dynamics. Forward and Inverse kinematics is used to find the orientation and the joint angles of the robotic arm. Arduino microcontroller program is used to actuate the robotic arm and it is done using the embedded c program. Stress, strain and the total travel of the robotic arm is found by using flexible analysis .The total acceleration, velocity has been found by the rigid dynamic analysis. Design consideration is done for worm gear, DC motor and for the gripper links. Stress –strain graph has been plot to find the ultimate strength of the robotic arm. The total weight of the load to be picked is 5 kg and the joint angles taken are 450 and 600. Modeling of the robotic arm is done by CATIA .Flexible and Rigid dynamic analysis is done by using ANSYS WORKBENCH 14.0.

Keywords- Embedded C, Flexible and Rigid Analysis, CATIA, ANSYS

1. INTRODUCTION

A voice actuated robotic arm is a mechanical manipulator that work mainly by the voice recognition method. This robot arm has the following hardware components. They are Voice recognition Kit, Arduino Microcontroller with specification Atmega 328 P, Lithium battery, DC motors, Connecting wires, Driving circuits and LED. Time taken for the picking of the load is 1second. Table is obtained for the stress, strain, Total travel, Acceleration and Velocity. And their corresponding graphs are plotted. From the microphone of voice recognition kit. The voice commands are analog in nature. These analog signals are converted in to digital signal by means of IC in the speech recognition kit. The shift registers are the device, used to sample these digital codes and it is passed to the HMC Microprocessor. These binary codes will be the output of Speech recognition and at the same time input to the ARDUINO controller. The ARDUINO interpret these binary codes by the controller program that has been feeded. The wires used for the connections are single stranded, since it uses very small amount of current. In short, the command from the speech recognition is passed to the ARDUINO microcontroller. The controller controls the driver circuit and in turn the motion of the DC motor. Velocity, acceleration and total travel of the robotic arm is obtained by the flexible dynamic analysis and the graphs are plotted with Time.

2. DESIGN CONSIDERATIONS

It includes the specifications of the components used for the fabrication and its design calculation. It includes the design consideration of the gripper links, Worm gear, Dc motor and its output and input power calculations.

2.1 Design Consideration of gripper links

a) Object to be lifted - Wooden block
b) Weight of the object to be lifted - 10-100 gm.
c) Length of the Gripper Link 1 - 9 cm.
d) Length of the Gripper link 2 - 9 cm.

2.2 Design Consideration of worm Gear

In this section the parameter is found out by using Mechguru software. The input section includes the module, speed of the worm and gear. The analytical calculation is avoided to reduce the error.

2.2.1 Input section of the worm gear.

a) Module, m of the worm gear = Reference diameter of the gear/Number of teeth Reference diameter = 22 mm

Number of teeth = 11 Module, m = 22/11 = 2 mm.

b) Speed of the worm Gear = 4 RPM.

2.2.2Output section of the Worm gear

a) Axial pitch of the worm gear = 6.238 mm.
b) Number of teeth in worm gear, T1 = 11.
c) Number of teeth in gear, T2 = 29.
d) Pitch circle diameter of the worm, D1 = 16.071 mm.
e) Pitch circle diameter of the gear, D2 = T2∗pitch/3.14 =29∗6.238/3.14
= 57.612 mm
f) Centre to Centre distance ,C =D1+D2/2
=16.071+57.612/2
=36.841 mm
g) Value of L1 = (C^0.875)/2 = 11.828 mm
h) Value of L2 = (C^0.875)/1.07
= 22.1086 mm.

For the design to be safe, the value of D1 must lie in between L1 and L2. ie L1< = D1 <=L2. Hence in this case 11.828 < 16.071 < 22.1086. Therefore the design is safe.

2.3 Design consideration of DC motor

Mechanical power of the motor is simply the product of motor speed and torque load with correction factor. In this case the correction factor is avoided.

a) Voltage of the DC motor = 9 V
b) Current used = .001 mA.
c) Maximum speed of the motor, N = 100 RPM.
d) Input power = V* I
= 9 * .001
= .009 Watt.
e) Output power= Torque * Max Speed
=P∗60/ 2∗ π
=V∗I∗60/6.28
=.121 watt

2.4 Force calculation at joints

While picking the load, force will be exerted on the joints and the parameter used are the weight and length of linkages, and the object to be picked.

Length of first link, L1 = 20 cm
Length of second link, L2 = 15 cm
Length of third link, L3 = 9 cm
Weight of first link, W1 = 150 gm
Weight of second link, W2 = 40 gm
Weight of Load to be picked, W3 = 100 gm

Weight of the gripper, W4 = 60 gm

a) Torque about joint 1 M1 = (L1/2 *W1) + (L1 * W4) + (L1+ L2/2) * W2+ (L1 + L3) *W3
= (.2/2 * .150) + (.2 * .06) + (.2 + .15/2) * .04) + (.2+.09) *.1
=.067 N-m
b) Torque about joint 2 M2 = (L2/2 * W2) + (L3 * W3)
=. (25/2 * 40) + (.09 * .1) = .014 N-m

3. MODELING BY CATIA

CATIA modeling is carried in two stages part modeling and assembly modeling. In part modeling the components is modeled individually with correct dimensions and in assembly modeling all the component is joined in correct proportion with concentricity.

4. DYNAMIC ANALYSIS BY ANSYS

ANSYS workbench 14.0 is the software used in the analysis part. The 3D model of the robotic arm is made in CATIA and this part model is imported in the software to do the analysis. The stress, strain and the deformation of the link is found in the analysis part. The assembly model that we had drawn on the CATIA is imported on the ANSYS workbench and the analysis has been done and the results of the analysis is given below.

5.RESULT

In this project, a systematic approach to design and fabricate a Voice Activated Robotic Arm is described. The 2 DOF robot arm is fabricated using Arduino. Atmega microcontroller and speech recognition kit along with hardware components and the design analysis is done on ANSYS WORKBENCH. Modeling of the arm is done by using the CATIA software. The system was trained for 5 voice commands (Down, place, Pick, Rotate, Up,). According to these voice commands the movement of arm takes place. The joint angles taken for the first and the second joint are 45º and 60º. The microcontroller program is constructed by using Embedded C program.

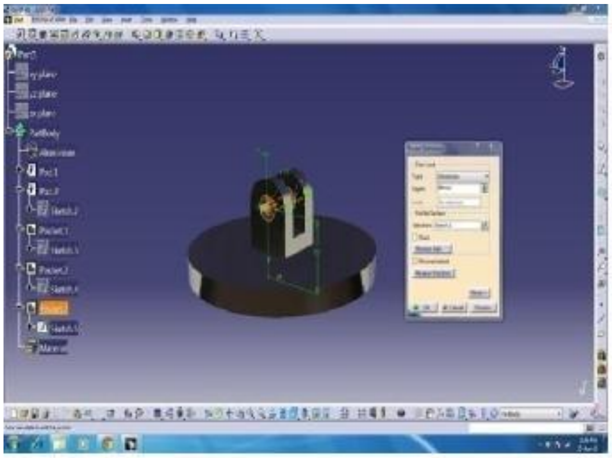

Fig 1 Part modeling of part 1

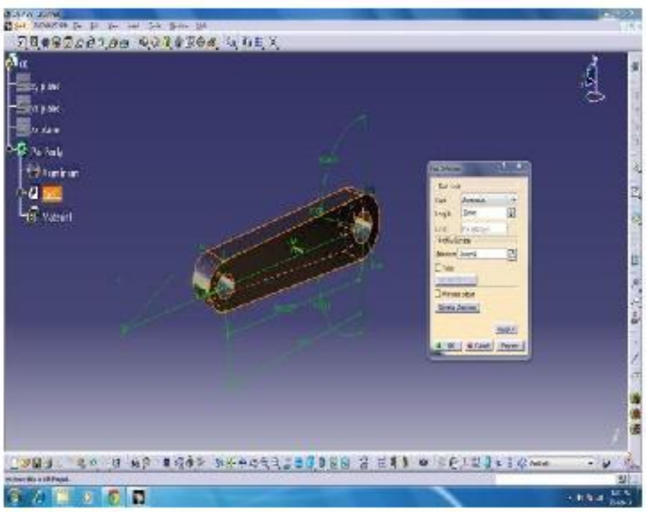

Fig 2 Part modeling of part 2

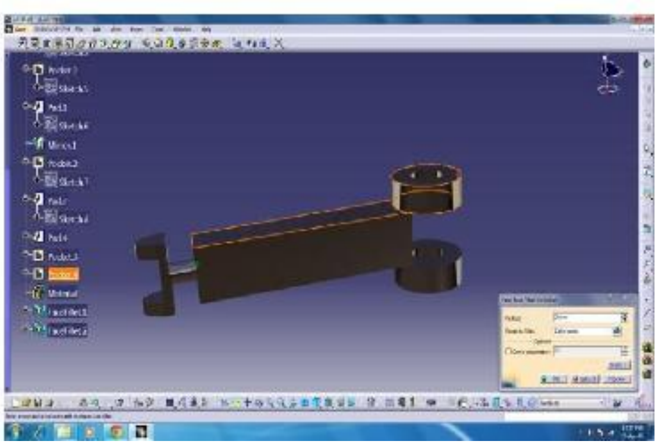

Fig 3 Part modeling of part 3

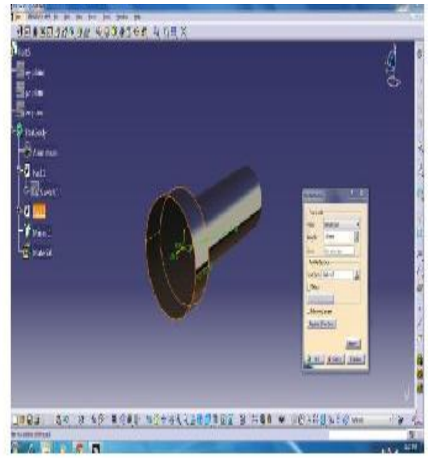

Fig 4 Part modeling of part 4

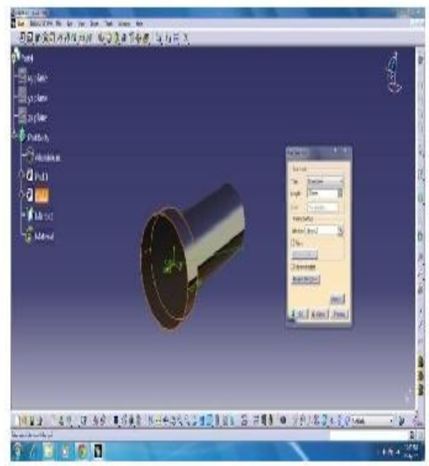

Fig 5 Part modeling of part 5

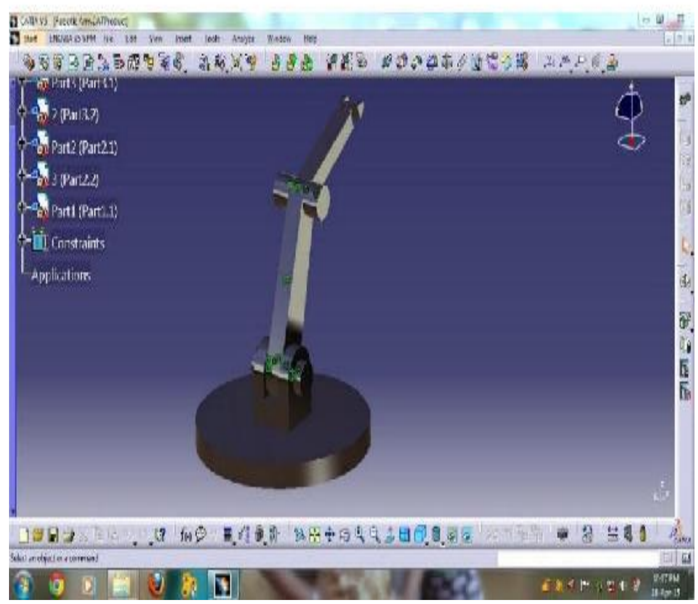

Fig 6 Assembly modeling of robotic arm

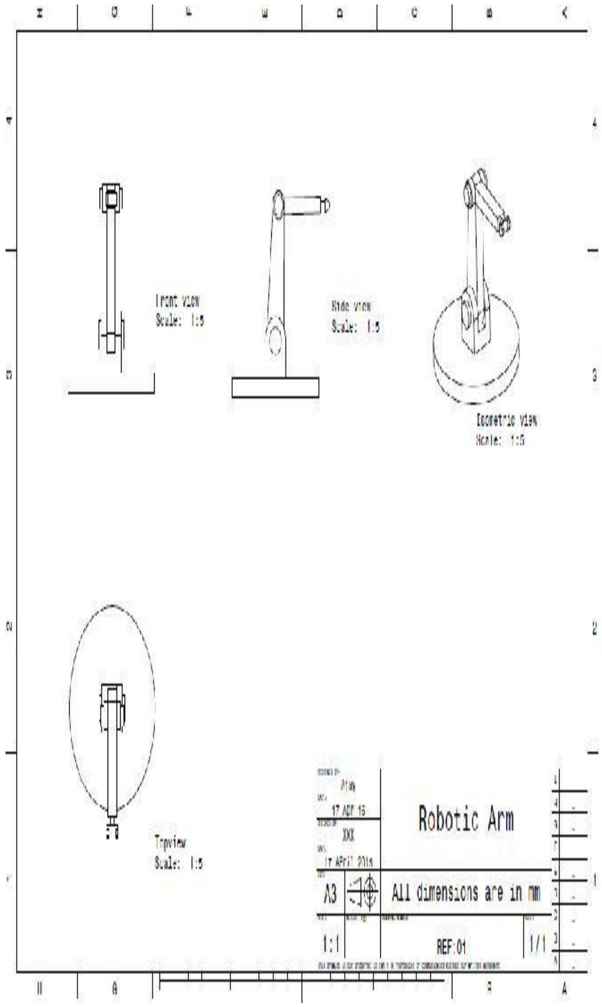

Fig 7 Different views of robotic arm in AutoCAD

Time [s]	Minimum [mm]	Maximum [mm]
0.		0.
1.e-002		3.6134
3.e-002		10.884
7.e-002		25.59
0.12		44.259
0.17		63.208
0.22		82.398
0.27		101.79
0.32		121.34
0.37		141.01
0.42		160.76
0.47	0	180.55
0.52		200.33
0.57		220.07
0.62		239.71
0.67		259.23
0.72		278.59
0.77		297.73
0.82		316.62
0.87		335.22
0.92		353.5
0.97		371.41
1.		381.96

Table 1 Total travel of the robotic arm for one second

Time [s]	Minimum [mm/s]	Maximum [mm/s]
0.	0	360.6
1.e-002		362.09
3.e-002		365.05
7.e-002		370.89
0.12		378.05
0.17		385.02
0.22		391.82
0.27		398.41
0.32		404.8
0.37		410.98
0.42		416.94
0.47		422.68
0.52		428.18
0.57		433.45
0.62		438.47
0.67		443.25
0.72		447.77
0.77		452.03
0.82		456.04
0.87		459.77
0.92		463.24
0.97		466.43
1.		468.21

Table 2 Total velocity of the robotic arm for one second

Time [s]	Minimum [mm/s²]	Maximum [mm/s²]
0.	0	606.86
1.e-002		608.13
3.e-002		610.68
7.e-002		615.73
0.12		621.96
0.17		628.09
0.22		634.1
0.27		639.99
0.32		645.74
0.37		651.33
0.42		656.76
0.47		662.02
0.52		667.09
0.57		671.97
0.62		676.64
0.67		681.11
0.72		685.35
0.77		689.37
0.82		693.15
0.87		696.69
0.92		699.99
0.97		703.03
1.		704.74

Table 3 .Total acceleration of the robotic arm for one second

TIME (S)	MINIMUM(MPa)	MAXIMUM(MPa)
0.2	1.6261e-010	2.4406
0.27	1.5736e-012	3.6041
.0.34	9.4529e-016	4.79
.445	7.1778e-012	6.577
.6025	2.3942e-012	9.007
076	1.8153e-013	10.943
.9175	5.3911e-013	11.794
1	7.7995e-012	11.624

Table 4 Stress acting on the robotic arm

TIME (S)	MINIMUM(mm/mm)	MAXIMUM (mm/mm)
0.2	1.2739e-015	1.4482e-005
0.27	7.8843e-018	2.1256e-005
.0.34	3.4191e-020	2.8133e-005
.445	3.589e-017	3.8434e-005
.6025	1.1976e-017	5.1988e-005
076	9.235e-019	6.2718e-005
.9175	2.7047e-018	6.8321e-005
1	3.8998e-017	6.7908e-005

Table 5 Strain acting on the robotic arm

Total travel of the robotic arm is 381.96 mm
Velocity of the robotic arm for one second is 468.21 mm/s
Acceleration of robotic arm for one second is 704.74 mm/s2
Torque about joint 1 is 0.067 N-m
Torque about joint 2 is 0.014 N-m.

The robotic arm has been fabricated successfully and 5 commands were tested and the working condition is satisfactory, but the system may misbehave when subjected to external noise.Thus the results of the flexible and rigid dynamics of the robotic arm has been found out. Maximum and minimum strain value acting in the robotic arm is determined.

6. CONCLUSION

Fabrication of the voice activated robotic arm was done successfully. The design considerations was done analytically. Gripper velocities, accelerations and the total travel of the robotic arm has been found by ANSYS WORKBENCH 14.0. Arm velocities decreases on increasing the weights and there by the stress and the corresponding strain. Many voice commands can be included by changing the embedded C (controller program). Rigid and Flexible body dynamic analysis can be done for various load masses. Travelling of the Robot manipulator changes for different joint parameters. The fabricated arm model will be very much beneficial for the physically handicapped people. Fabrication of the robotic arm is just a prototype.

7. REFERENCE

[1] Janice Gillispie Mazid , Muhammad Mazid Ali , Microcontroller-8051 and Embedded C Systems, Pearson Education.

[2], Industrial robotic technology, Mikell P Groover ,programming and applications, Page no:-110-180 ,Mc Graw Hill.

[3] P.K. Artemiadis, P.T. Katsiaris ,K.J. Kyriakopoulos, Modeling anthropomorphism in dynamic human arm movements, , pp. 3507–3512, 2010, IEEE/RSJ International Conference on Intelligent Robots and Systems

[4]"Wireless Mobile Robotic Arm", 41 (2012) 1072 – 1078,Reza Ezuan Saminb, Mohd Ashiq Kamaril Yusoffa, , Babul Salam Kader Ibrahimc ,.

[5]Mahesh Vashisth ,Anil Kumar, Puran Singh "Design of a Robotic Arm with Gripper & End Effector for Spot welding", Universal Journal of Mechanical Engineering 1(3): 92-97, 2013.

[6]Norberto Pires, Volume 32, Number 6, 2005.Robot by voice: Experiment on commanding an industrial robot using the human voice",

[7]www.embedded.com.