DESIGN AND CONTROL OF A TWO-DEGREE-OF-FREEDOM ROBOTIC ARM

G. Ramakrishna[1], K.V.V.N.R. Chandra Mouli[2], K Anil[3]

Assistant Professor,Mechanical Engineering,
Raghu Engineering College(Autonomous), Vishakhapatnam [1,2,3]

ABSTRACT

It describes the design and control of a two-joint, two-link robotic arm. Our purpose has been to build an efficient arm in the sense that most of the energy provided by the. Motors are spent in doing the task (moving the tip mass) instead of moving the arm structure. In order to achieve that, we designed a robotic arm that has most of its mass concentrated on the tip. We wanted also to decouple radial tip motions from angular tip motions. The special mechanical configuration that fulfills all these specifications is described in Section 2. Section 3 descries the contemn scheme of this arm. A two-nested-loop multivariable controller has been used. The inner loop mantels the position of the motion while the outer loop controls the tip position. The resolved acceleration method is generalized to control this robotic arm. The compliance matrix was used to model the oscillations of the suture, and was included in the decoupling of this controller.

Keywords: Transformer, Dpdt Switches, Servo Motors, Grippers, Sata Cables etc.

I INTRODUCTION

The design and control of a small two-joint, two-link robotic arm that we have built in our laboratory. This arm operates in a plane on an air table. The arm is designed with exaggerated flexibility to facilitate studying the control of robotic structures; and is very light in weight compared to the mass placed at the tip (there. is no mass placed at the elbow joint). The prose of our research on robotic arms is to design more efficient and faster arms than the actual rigid arms. Our very lightweight arm is efficient in the sense the most of the energy provided by the motors is spent in doing the task (moving the tip mass), and little is wasted in moving the arm structure (unlike rigid arms). We wanted also to decouple radial motions of the tip from angular motions.

A special four-bar linkage is used to drive the elbow joint from a motor mounted near the base. Mechanics of this arm are described and a dynamical model is developed for this arm. That can be easily extended to any n-degrees of freedom lumped-mass robotic arm. Section 3 describes the control scheme of this arm. An important problem when controlling it was the large Coulomb friction of the motors. A two-nested-loop controller has been used. The inner loop controls the position of the motors while the outer loop controls the tip position. This method is the generalization to robots with more than one degree of freedom.

II MATERIALS USED:

1. TRANSFORMER.
2. DPDT SWITCHES.
3. CAPACITOR &BRIDGE RECTIFIER.
4. SERVO MOTORS.
5. NUT & BOLTS.
6. PLYWOOD.
7. GRIPPERS.
8. SATA CABLES.
9. SCREWS.

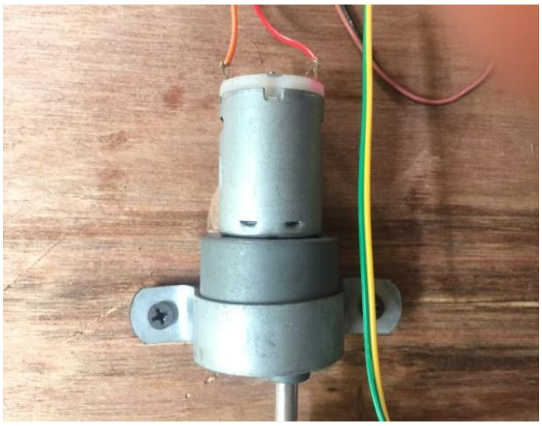

Fig-2.1

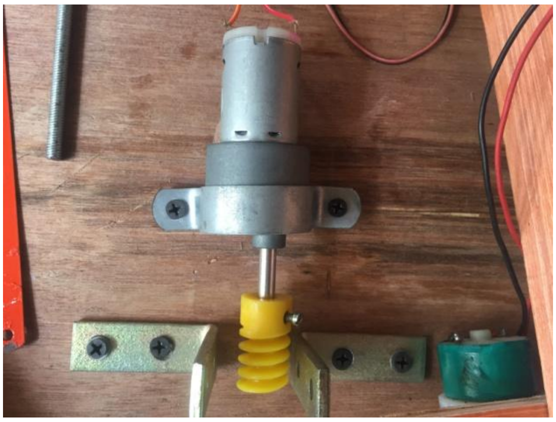

Fig-2.2

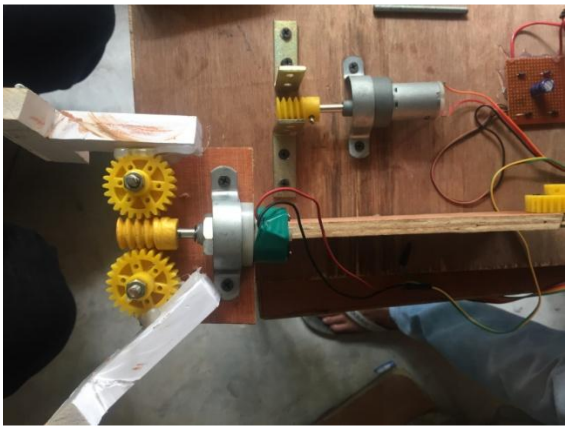

Fig-2.3

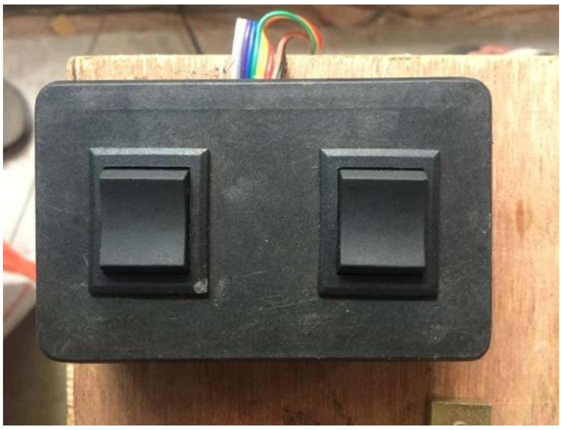

Fig-2.4

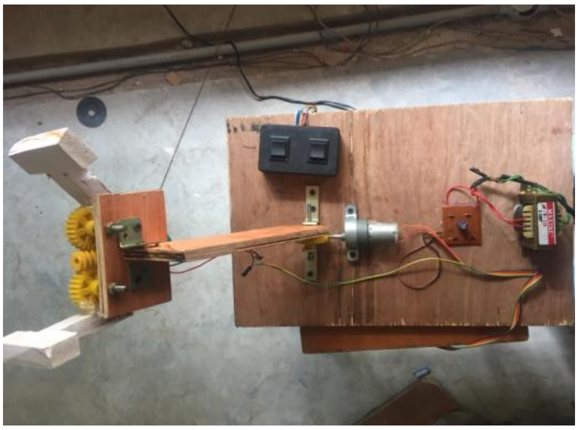

Fig-2.5

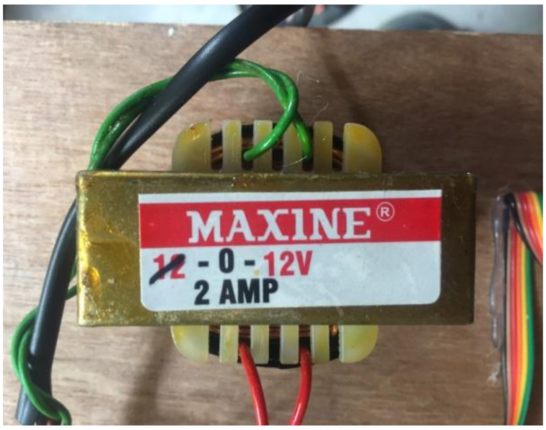

Fig-2.6

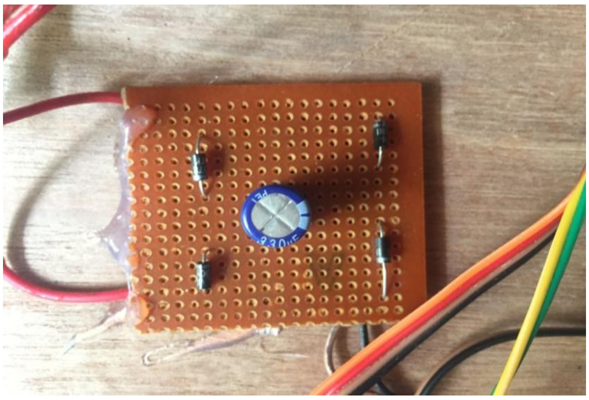

Fig-2.7

III MECHANICAL ISSUES:

This arm has been designed to fulfill two specifications, from the mechanical point of view:

1. The arm had to be very lightweight,
2. Radial motions of the tip had to be nearly decoupled from angular motions (if we neglect the vibrations because of flexibility).

In order to fulfill the first specification, the links were made of a very lightweight wire (having consequently a significant elasticity), and the motor that moves the elbow was placed close to the base of the arm. A four-bar linkage was used to transmit the motion of this motor to the elbow.

In order to fulfill the second specification, the length of the two links was made the same, and the dimensions of the four-bar linkage were especially designed.

IV EXPERIMENT PROCEDURE:

In this project, we use step down transformer of 230v AC to 12vAC.

Converts the 12vAC to 12vDC by using of bridge rectifier because of us use dc motor for student prototype projects for safety purpose.

On the bridge rectifier capacitor is placed for charge and discharge of current.

1. Two 12vDC motors are used:
2. Motor torque is 5kg and 100rpm for lift the robotic arm.
3. 3kg of motor is used and 100rpm for open and close the arm.

ADVANTAGES:

1. It is helpful to human source.
2. Decreased production costs.
3. Reduced waste.

DISADVANTAGES:

1. It is very delicate.
2. Handling should be very careful.

V OVER VIEW OF ROBOT ARM:

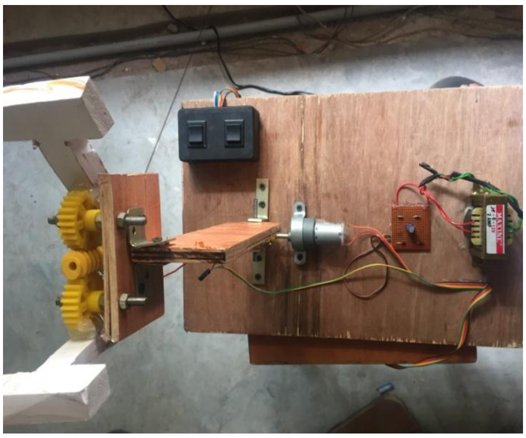

Fig-5.1

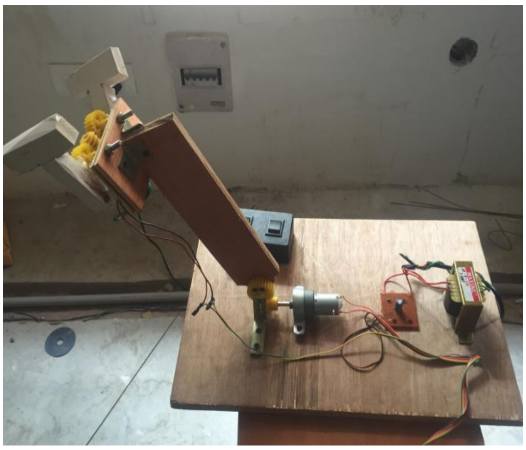

Fig-5.2

CONCLUSIONS:

Lightweight arms have the advantages of being easy. And being more efficient than heavier arms because very little energy is wasted in moving the arm structure. In Nm. these arms usually exhibit some flexibility phenomena that cause of oscillations to appear in the mechanical structure during the motion. A two-degree-of-freedom, planar, very lightweight flexible arm has been designed, built and controlled in our laboratory.

The motor of the second joint was mounted near the base of the arm. And a four-bar linkage transmitted the motion from the motor to this joint. This was specially designed to approximately decouple dial from angular tip motions. This arm exhibited two orthogonal vibration modes that changed in value and Orientation with the configuration. A simple dynamic model has been developed for this arm based on the use of two sub models: one to describe the motors, and the other to describe. The mechanical suction. The two coupled through the torques that the links on the motors. A control scheme has been deduced from this model which is robust to changes in the dynamic friction of the motor, and that removes the effects of the Coulomb friction. This convoy scheme is based on very simple concepts, and each mm of the condoler is designed according to very precise directions: terms that cancel Coulomb friction, terms that decouple the motors from the arm. Inner loop controller to make the motor response fast, candling terms for the mechanical structure dynamics, feed forward term for the tip response. Etc.

Experimental results have been presented, and they show that our control scheme performs well. Our control scheme is based on the assumption that motor dynamics are much faster than mechanical structure dynamics. This point must be confirmed before closing the tip position loop. The decoupling between radial and angular motions achieved by the four-bar linkage simplifies kinematic considerations.

REFERENCES:

[1] B. Möhl, “A Composite Drive with Separate Control of Force", in Proc. of the 11th International Conference on Advanced Robotics 2003 in Coimbra (ICAR 2003), pp. 1606-1610, 2003

[2] R. L. Lieber, “Skeletal Muscle is a Biological Example of a Linear Electro-Active Actuator”, in Proceedings of SPIE’s 6th Annual internationally symposium, PAPER NO. 3669-03, March 1999

[3] G. A. Knutson, E. F. Owens, “Active and passive characteristics of muscle tone and their relationship models of subluxation/joint dysfunction Part I”, in Journal of the Canadian Chiropractic Association, Volume. 47, No. 3, pp. 168-179, September 2003

[4] S. F. Giszter, F. A. Mussa-Ivaldi, E. Bizzi, “Convergent Force Fields Organized into the Frog's Spinal Cord”, in Journal of Neuroscience, Volume. 13, pp. 467-491, February 1993

[5] Y Nakamura, K. Yamane, I. Suzuki, Y Fujita, “Dynamics Computation of Musculo Skeletal Human Model Based on Efficient Algorithm for Closed Kinematic chain”, in Proc. of the 2nd Int. Symposium on Adaptive Motion of Animals and Machines, Kyoto, March 2003

[6] M. Stelzer, O. von Stryk, “Efficient forward dynamics simulation and optimization of locomotion: from legged robots to biomechanical systems”, in Proc. of the 3rd Int. Symposium on Adaptive Motion of Animals and Machines 2005

[7] A. Bilard, A. J. Ijspeert, “Biologically inspired neural controller for engine control in a quadruped robot”, IEEE-INNS-ENNS Internationally Joint Conference on Neural Networks (IJCNN’00), Volume 6, 2000

[8] A. Prochazka, V. Gritsenk, S. Yakovenko, “Sensory control of Locomotion: Reflex versus Higher level control”, In Sensorimotor Control, Exp. Med. Biol. 508: 357-367, 2002

[9] Y. Fukuoka, H. Kimura, A. H. Cohen, "Adaptive Dynamic Walking of a Quadruped Robot on Irregular terrain based on Biological Concepts", The Int. Journal of Robotics Research, Volume. 22, No. 3-4, pp. 187- 202, March April 2003

[10] M. M. Williamson, "Posturals primitive: Interactive Behavior for a Humanoid Robot", Fourth internationally Conference on simulation of adaptive Behavior, The WITH press, pp. 124-131, 1996

[11] B. Hannaford, K. Jaax G. Klute, "Bio-inspired Actuation and Sensing", in Autonomous Robots, Volume. 11, No. 3, pp. 267-272, Springer Science+Business Media B.V., November 2001

[12] H. Witte, M. S. Fischer, N. Schilling, W. Ilg, R. Dillmann, M. Eckert, J. Wittenburg, "Konstruktion vierbeiniger Laufmaschinen anhand biologischer Vorbilder", Konstruktion 9-2000, pp. 46-50, November 2000