IJIRMET ISSN (Online): 2456-0448
International Journal Of Innovative Research In Management, Engineering And Technology
Vol. 3, Issue 2, February 2018

Labview Based Motion Controlled Bionic Arm

[1]S.Siddharth, [2]S.Somasundaram, [3]P.Vimal, [4]V.Prasanna and [5]S.M Girirajkumar
[1],[2],[3],[4]UG Student, Department of ICE, Saranathan College of Engineering, Panjapur, Trichy, Tamilnadu, India,
[5]Professor & Head, Department of ICE, Saranathan College of Engineering, Panjapur, Trichy, Tamilnadu, India
[1]Email: siddu1605@gmail.com

Abstract: ***Engineers across the world are searching for the next big thing after automation. Though artificial intelligence (AI) has answered the call, some concerned by the other face of it has called for more conservative approach. The key to achieving that would be to equip the robots with thinking ability but with limited autonomy. One way of doing that would be to combine human skill set and robotic precision. To demonstrate this, we have come up with a motion controlled bionic arm.***

Keywords— myRIO; Bionic arm; Lab VIEW; 3D-printing; Flex sensor

I. INTRODUCTION

Industrialisation introduced heavy machineries and large scale production was made possible. Slowly automation took over and before realising the full potential of this technology, engineers and scientists are probing the possibility of artificial intelligence (AI) to take the manufacturing industry to next level. An Artificially intelligent system brings a lot of advantage but also possess a severe threat. If not monitored or controlled properly, these systems can go out of control. This is a risk that is not worth taking considering the fact that we only want to give machines the thinking ability and not complete autonomy. We can put machines and humans together to achieve this. This is not a simple human operated machine. It will be a machine that integrates the qualities of human beings and machines. To integrate human skill, knowledge and robotic precision we need an effective communication tool. A study shows that gestures are the best and intuitive way to communicate with robots [1]. A complex surgery performed by a surgeon who is half way across the world using augmented reality (AR) and human robot collaboration is the best example to support this claim [2][3]. The use of such robots can only improve the productivity [4] of the plant. To realize this, we have discussed here the design and implementation of a robotic system based on Lab VIEW that mimics the motion of the hand and performs tasks that any human hand would do by tracking the motion of a human hand.

In the following section, we have discussed the mechanical design of the bionic arm encompassing the issues with different designs and concepts that can be used. In section III we have laid out the working principle of the proposed system. Included in it are the basic principles of some of the components used.

II. MECHANICAL DESIGN

Overview

The sensors that are used to acquire the motion of the arm are placed on a glove, which an operator wears to work. The palm and the fingers of the bionic arm were designed using Solid Works and were 3D printed using PLA (Poly Lactic Acid). It is a cheap, biodegradable thermoplastic. The finger actuation is done by the mini servo motors that are housed within the palm section of the arm with one servo controlling one finger. The fingers and the servos are linked by two strings, one on each side of the plus shaped gear. The support structure or the elbow section is laid out by appropriate mechanical structure coupled with two stepper motors to actuate the bionic arm along y and z axis.

B. Palm design

It is a hollow structure that is designed based on the scaled-up dimensions of the human hand. It has five sleeves to fit as many fingers into it. The wrist portion of the bionic arm attaches with a tapering pair of rods that has plates bolted to it at both ends. The rear of the palm has opening for accommodating mini servos.
Refer figure 1.

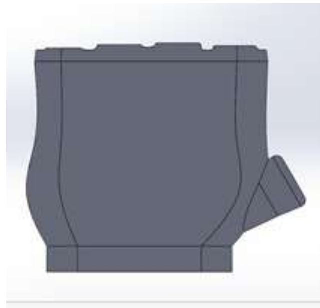


Figure 1: palm design

Finger design

We studied the design of continuum robots [5] for the fingers because they are more natural. But to achieve the required bending, the length to shape ratio [6] was very low, that it would be disproportionate with respect to the size of the palm

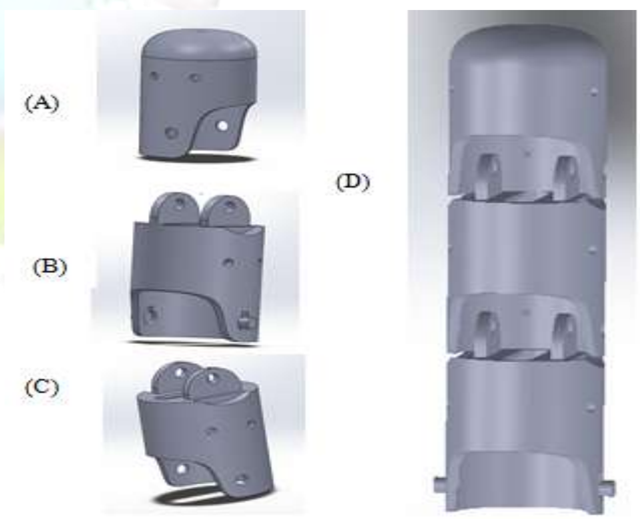


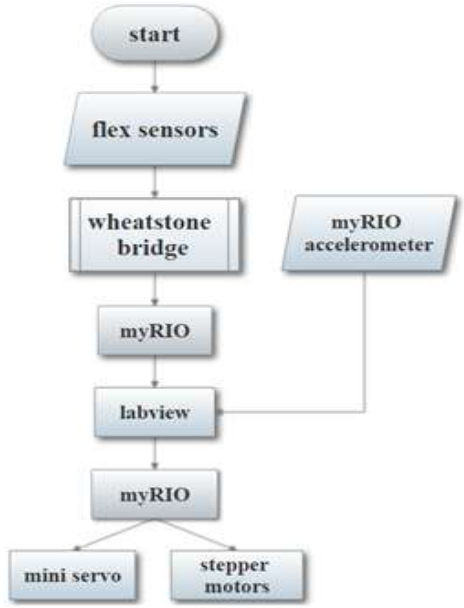
Figure 2: Different units that combine to make a finger.

Also Implementation was costlier and would require a number of valves and programmatic complexity would increase [7]. Each finger is a combination of three units/sections, making 2 joints (just like in our human anatomy) exception being the thumb finger which has only two units. All the units are fastened using tiny pins with 3 mm diameter. In each unit, there is a provision for inserting pins so as to tie the string from the mini servo motors. The bottom most unit in all the fingers, have a protrusion and diametrically opposite ends to attach them to the sleeves in the palm.

IJIRMET ISSN (Online): 2456-0448
International Journal Of Innovative Research In Management, Engineering And Technology
Vol. 3, Issue 2, February 2018

Working

The flow chart below represents the work flow of the system that is proposed.



We have divided the working into two subsections [1] based on the processes involved. The first step would be to acquire the gestures made by the human hand, followed by actuation of actuating elements so as to mimic the motion of the hand.

A. SENSOR TECHNOLOGY

There are numerous ways, both invasive and non-invasive, in which the gestures of human body can be captured. One such non-invasive method is using flex sensors. Since these sensors possess lightness, compactness, robustness, measurement effectiveness and consume less power it is very useful [8]. We have acquired signals from only three fingers (thumb finger, middle finger, and small finger) because the pairs of fingers, i.e. Index finger and middle finger, ring finger and small finger motion are almost interdependent. Each does not move greatly with respect to each other, i.e. the motion of one finger does affect the position of another.

A flex sensor or a bend sensor is a sensor that measures the amount of deflection or bending in terms of resistance. Usually, the sensor is stuck to the surface(in this case, it is stitched on the glove), and whenever there is a change in the bending(here, he position of the finger) of the surface, resistance of sensor element varies.

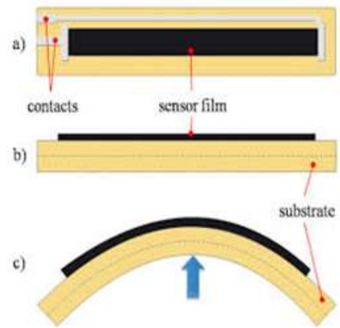


Figure 3: flex sensors

The motion of the hand itself is registered using the change in the output of the on-board 3-axis accelerometers of the myrio (my reconfigurable input output).

Accelerometers are essentially a free mass suspended on a spring. When the accelerometer experiences acceleration, the mass on the spring also accelerates at the same rate. The acceleration of this mass is converted to electrical quantity and hence sensed as output voltages.

These two sensors are used to acquire the postures made by the human hand as a whole.

B. PROCESSING AND ACTUATION

As discussed earlier, myrio is used for acquiring signals and labview (laboratory virtual instrument engineering workbench) is used for processing them.

as shown in the flow chart, the whetstone bridge set up is used to convert the resistance output of the flex sensor into voltage because, myrio or any microprocessor for that matter does not take resistance as input. Since resistance is a temperature dependant parameter, to compensate for ever changing surrounding temperature, compensations are both programmatically and by the use of potentiometers in the whetstone bridge arrangement.

mini servo motors are used for actuating the fingers. The gears in the motor are attached to the loose ends of the string that is attached with the fingers at the other end. Mini servos are used because of their precise motion. They can move 90^o in either direction, effectively moving 180^0. Their motion is controlled by the pwm (pulse width modulation) given out by the myrio.

based on the resistance value, the duty cycle is varied (in turn varying the pwm) to turn the motor in the desired direction. This causes the fingers to close and open accordingly.

the rotation of the bionic arm about the z-axis (to mimic the motion of the fore arm) and about the y-axis (to mimic the motion of the elbow) two phased stepper motors are used. It has a step increment of $1.8^{0.}$ Its operating voltage is 5v and requires a maximum current of 1a. So it cannot be driven by the myrio because the maximum current output is only a few hundred milliamps. Therefore, it is necessary to use a driver circuit (l298n, full h-bridge, accepts up to 36v, 2a) to operate this servo motor.

Figure 4: Stepper motor

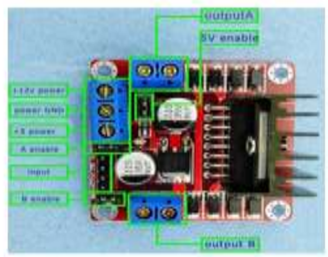


Figure 5:L298N

Based on the output of the on-board accelerometer's y-component and z-component, the two phases of the motor are excited in a certain sequence to run the motor in the desired direction. The same applies for both the motors each acting independently based on the values of the respective axes.

III. CONCLUSION

The bionic arm was designed and 3D printed. The fabrication and assembling time is only a few days with 3D printing of components taking a chunk of the time. We have designed only the elbow and the forearm section of the arm. To incorporate the full arm design, it is enough to modify the mechanical structure and incorporate two more stepper motors. The existing sensor technology is sufficient to sense those movements as well. Though we couldn't achieve the same amount of dexterity, their degree of freedom is comparable to that of human anatomy. It is able to hold, lift objects of nominal load up to 1 kg. Since we have used cheap plastic, the palm cannot withstand high impacts. This entire set up can be built using resources of not more than 12,000 INR excluding the myRIO kit which is quite costly.

In this exploratory venture, we were able to mimic the motion of the human hand in the bionic arm. Since the thinking capability rests with the operator, the end product is as good as the operator. The applications for these systems are innumerous.

REFERENCE

[1] Hongyi Liu, Lihui Wang "Gesture recognition for human-robot collaboration: A review" International Journal of Industrial Ergonomics xxx (2017) 1e13

[2] Rong Wen, Wei-Liang Tay, Binh P. Nguyen, Chin-Boon Chng Chee-Kong ChuiHand "Gesture guided robot-assisted surgery based on a direct augmented reality interface" Computer Methods and programs in biomedicine xxx (2014) xxx–xxx

[3] Green, S.A., Billinghurst, M., Chen, X., Chase, G., 2008. Human-robot collaboration: a literature review and augmented reality approach in design. Int. J. Adv. Robot. Syst. 1e18

[4] Krüger, J., Lien, T., Verl, A., 2009. Cooperation of human and machines in assembly lines. CIRP Annals-Manufacturing Technol. 58, 628e646.

[5] M. Cianchetti , A. Arienti , M. Follador , B. Mazzolai , P. Dario , C. Laschi "Design concept and validation of a robotic arm inspired by the octopus" Materials Science and Engineering C 31 (2011) 1230–1239

[6] Bryan A. Jones, Ian D Walker "Practical Kinematics for Real-Time Implementation of Continuum Robots" IEEE TRANSACTIONS ON ROBOTICS, VOL. 22, NO. 6, DECEMBER 2006

[7] Mata Amritanandamayi Devi, Ganesha Udupa, Pramod Sreedharan, "A novel underactuated multi-fingered soft robotic hand for prosthetic
application" Robotics and Autonomous Systems 100 (2018) 267–277

[8] Giovanni Saggio, Francesco Riillo, Laura Sbernini and Lucia Rita Quitadamo "Resistive flex sensors: a survey" Smart Mater. Struct. 25 (2016) 013001 (30pp)