DEVELOPMENT OF ARTIFICIAL ARM USING PNEUMATIC ARTIFICIAL MUSCLE

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Abstract - *Artificial pneumatic arm, besides safety, can assist old age people, weak people and also the disabled people while handling heavy work. The objective of this work is to develop Artificial Pneumatic powered arm using PAM(Pneumatic Artificial muscle) actuator. Compared to the other actuators PAM has advantage in power to weight ratio, lightweight and high degree of safety is offered by PAM. They are easy to manufacture, low cost and interact with human without any large scale safety required. The arm is developed using aluminium frame which is accomplished by different components such as PAM, muscles sensor, pneumatic tubes, etc. Factors as shape and size, pressure input and output has impact on overall force generated by PAM. It is known for the wide application in various aspects such as military, hospital, robotics, automation, etc.*

Key Words*: Pneumatic artificial muscle, muscle sensor, actuator.*

1) 1. INTRODUCTION

Robots become significant to serve and assist human, especially for older people and disabled people. However, high rigidity of robot joints will be hazardous to a human because a human has soft arms and compliant joints activated by numerous muscles. Necessity for human-like actuators system, many researchers have motivated to study in this field and created the Pneumatic Artificial Muscle (PAM). PAM is pneumatic actuator for converting pneumatic power to pulling force.

2. LITERATURE REVIEW

The arm movement was experimented by various researchers. The methods used for manufacturing are gear and cable driven arms, electric motors, hydraulic and pneumatic.

The table 1 shows the work done by various investigator in developing artificial arm for the various purpose. Limitations of the existing was more complexity and power to weight ratio. To overcome this limitations the PAM (Pneumatic air muscle) can be experimented as it has properties of high power to weight ratio, and can be easily manufactured

Table 1 Investigation on artificial arm

Ref.	Location	Actuator	Transmission	Purpose
6,9	Shoulder ,elbow and wrist joint and forearm Motion	DC servo motor	Cable and gear drive	Power assist
7	Shoulder Joint	Servo motor	Geneva mechanism	muscle atrophy and accelerate recovery
8	Shoulder Elbow Wrist joint and Forearm motion	motor	Cable drive, Linkage mechanism and gear drive	Rehabilitation, and power assist
9,10	Fingers	DC motors	Cable and gear drive , Tendon drives	Hand exercise, Finger Rehabilitation

3. COMPONENTS FOR PNEUMATIC ARM

Pneumatic arm consist of following main components.

3.1 FRAME

Aluminium strips, to reduce weight, of 2 mm thickness and 30 mm width were used for the frame of pneumatic arm. For support circular rings are provided at certain distance.

Fig 3.1.1 design of frame

3.2 PNEUMATIC AIR MUSCLE

PAMs were first developed (under the name of McKiben Artificial Muscles) in the 1950s for use of artificial limbs. They are contractile and extensional devices operated by pressurized air filling a pneumatic bladder. And they can handled pressure upto 50 psi .

PAM are used as a actuator. It consist of latex rubber tube surrounded by a tubular braided fiber mesh sleeve known as flexo tube as shown in fig.1. When the bladder is inflated the mesh expands radially and contracts axially shortening the overall length of muscle and subsequently producing pulling force.

Fig 1 Pneumatic air muscle

3.3 THE FITTING PUSH (6MM)

Union push-to-connect fittings are available as shown in fig. 2 for use with 3/8. 5/32, 5/16 and ½ inch tube. Tubing connection and tightness are made possible by stainless steel griping collect and o-ring inside fitting. Once inserted to the bottom of the fitting the stainless steel collet grips the tube prevents it from being disconnected until the release button is pushed.

Fig 2 Composite union tee

3.4 SOLENOID VALVE 3/2 VALVE

A 3/2 way solenoid valve has three ports and tow switching states as shown in fig. 3. By activating solenoid, the valve switches state and different connection between the valve port is established.

Fig 3 3/2 solenoid valve

3.5 MUSCLE SENSOR

Muscle sensor are used to send signals to the arduino. EMG muscle sensor as shown in fig 4 records the movements of our muscle.

Fig 4 EMG muscle sensor

3.6 ARDUINO UNO

Arduino uno is used for programming, it is an open source microcontroller board bases on microchip. The board is equipped with set of digital and analog i/o pins that may be interface by circuits.

3.7 AIR COMPRESSOR

In both home and commercial application, one of the main roles of an air compressor is to provide power for pneumatic tools.

4 DEVELOPMENT OF PNEUMATIC ARM

The PAM actuated pneumatic arm is fabricated with the help of aluminium frame, pneumatic air muscle, muscle sensor, arduino UNO, solenoid valves, and air compressor as shown in fig 5. The signals from the hand is collected via muscle sensor and send to the arduino. Analog signals from muscle sensor are converted into digital signals and then processed by arduino and accordingly valves are controlled and pressurized air is passed through PAM and movement of arm is accomplished.

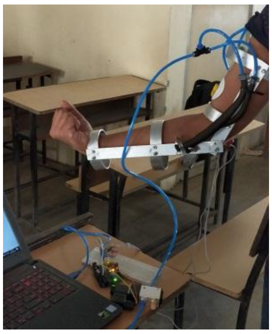

Fig .5 Assembly of pneumatic arm

5. EXPERIMENTATION

The working of the arm is demonstrated eith following.

5.1 AIR COMPRESSOR

Manufacturing company:
Capacity of compressor

5.2 PNEUMATIC AIR MUSCLE

Dimension of latex tube: Diameter is 9.5mm and length is 280 mm
Dimension of flexo tube : Diameter is 9.5mm and length is 320 mm
Hose clamps

5.3 SOLENOID VALVE

Body: Aluminium Anodise.
Pressure: 0.15 to 0.8 Mpa
Volt: 12 V

6. RESULTS

The arm developed has working Pressure of 6 Bar The change in length Of Pam and deflection due to load is observed 6 Cm each. The maximum load bearing capacity of the arm is 30kg.

7. CONCLUSION

The design and fabrication of pneumatic arm for lifting load is completed with economic and effective consideration. It is mainly actuated by PAM (Pneumatic air muscle) and the movement of PAM is controlled by electro pneumatic valves. The signals are sent through muscle sensor attached with hand to arduino and program actuates the valves. The PAMs has a wide choice for application in automation , robotics and material handling device. It gives quick response and flexible compared to hydraulic and electrical type of exoskeleton arm. This is achieved while maintaining simplicity, ease of use, implementation and maintenance. The model is expected to lift object of 30 kg weight. The entire system proved successful in building an air muscle actuated arm to accomplish the task of lifting heavy loads.

8. REFERENCES

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