ADVANCED ROBOTIC ARM – FOR VERSATILE AND PLIANT APLICATIONS

K. Hepsibah Persis
Assistant Professor,
P. Banumathi, B. Gayathri, B. Vinodhini, Student,
Dept of Electronics and Communication Engineering,
Velammal Engineering College,
hepsibah@velammal.edu.in

***Abstract*— this study represents a novel approach to force feedback in robot assisted applications. Limited haptic feedback is reputed to be among the reasons that impede further spread of surgical robot. Since bilateral control systems are strongly required to apply to surgeries, the system should have enough Degree Of Freedom (DOF) for applying various operation procedures including endoscopy surgery, maxillofacial (Dentistry) surgery. When degree of freedom of system is increased, the amount of control calculation is also increased. At first glance advanced robotic arm works like a flexible gripper arm, which is modeled on elephant's trunk in terms of structure and overall function. This system works in an easy, freely moving, flexible way. It is even safe if there is direct contact between man and machines. In the event of collisions the bellow structure gives way immediately and as a result does not have to be protected from humans as a conventional industrial robot. The biologically inspired robots apart from acting as surgical robots for doing minimally invasive surgery (MIS), they can be designed to act as vacuum cleaning robots, spray painting robots, 360 degree image capturing robots and watering robots.**

Keywords— bilateral control, haptic.

I. INTRODUCTION

The existing method of prosthetic and haptic hand has only linear response. It requires a complex control algorithm. Maximum displacement is limited to (20-30) % contraction. Low force output. The biggest drawback is the cost of prosthetics, it is very expensive and some people who need it the most are not able to afford it. Any prosthetic limb is time consuming you are going to adjust to the new part and work slowly. Just like any product it has flaws. Some of the limbs are creating apps that you can adjust the grip, that means if someone gets hold of that, that could be deep trouble and the person would have no control over their arm. There are 24 grips and that get into wrong hands that could cause a lot of trouble. The limbs are difficult for some people to learn to use, regular repair and maintenance are needed. The degree of flexibility is major problem in haptic and prosthetic hand.

In existing method many number of motors are used, but in our proposed method it is drastically reduced. Robotic surgery is transforming the current surgical practice thus reducing the work of clinicians. The device consists of four degrees of force feedback (X, Y, Z and grasping) capability and multi degree of position feedback capability. Our robotic arm consist of only nine stepper motor for isometric (120degree)that is of three way directivity with delta connections. The robot arm consist of three 3D printed basic elements a movable hand axis and a gripper with adaptive fingers which are connected mechanically with a middle tendon. The use of compressed air as a drive medium means that the robotic arm is essentially flexible and poses no danger in direct contact with people of factory.

Service robots show increasing demands for automation solutions in private households. The implementation of smart factories means changing all process as automated with robots.

II. PROPOSED METHOD

Bionic hand is mainly concerned with its load bearing capacity, expandability and computing power. It is equipped with complete necessary equipment for air preparation and control of manipulator. The height of the arm can be adjusted using electric linear axis using a tilting device. These two additional degrees of freedom expand the working space significantly. This robot hand pick up object and put them on a shelf. For example: In combination with a bendable bellows and an adaptive gripper it fulfills the requirements for the use as a safe and mobile manipulator.

III. EASE OF USE

A. Light weight design

The use of modern, generative production meets the particular production conditions for bionic hand. This production technology allows the tool cost-free production of individually movable production parts made of 3D printing with high flexibility and low cost.

B. Mobile self- supply

The piezo proportional valve terminals precisely feed compressed air into air chambers of the gripper arm. It is generated in a mobile piston compressor achieving an adjustable pressure level. SNMP supply the valve terminal, controller and motors.

C. Form fitting gripping

The adaptive gripper consists of a pneumatic parallel drive and three fingers derived from movement of fish's tail finger. The gripper's flexibility and resilience come to force in particular when holding and transporting sensitive objects or objects with varying contours.

IV. DESIGN OF ROBOTIC ARM

The arm was designed specifically to be safe on interaction with humans which will make it useful in locations such as medical center, manufacturing plants, home, mechanical repair works and schools. The advanced robotic arm consists of three basic elements for spatial movement, hand axis and a gripper with adaptive fingers.

A. Inspired by elephant trunk

The elephant trunk has 40,000 bundles of muscles. These muscles make the trunk, highly flexible and compliant. The elephant trunk provides an enchanting model for technology. The trunk like arm is made of soft, compliant segment that were created by plastic using 3D printing technology and it's driven by pneumatic system of tiny air chamber lining the interior of the arm. The air chambers are arranged in two rows and connected sequentially to provide the required movements. The arm has enough spacing between the 3D structures to limit its movement and avoid collisions..

B. Adaptive Gripper

The gripper structure at the end of the arm is based on fish fins. The gripper has a novel shape consisting of three fin shaped fingers constructed from compartments that collapse when fingers enclose an object, trapping it. The fin finger design means very little force is required for grasping an object, again reducing the risk of injury. It provides more flexibility compared to other grippers like hydraulic gripper, Conventional grippers are very heavy in weight. But this fin type gripper is very light weight in design. The fin finger is already being tested on production lines and three different sizes are being developed, to handle objects from grape fruit size down to hazelnut size. Previous robot designed using bionic learning network includes other example of bio mimicry such as penguins, jelly fish, aquatic rays and flying fins. Segments to provide x curve dexterity and because air chambers in the segment can be inflated separately, sections of the arm can be made to bend in opposite directions. The gripper is very economic which is created by 3D printing technology.

C. 3D Printing Technology

3D printing can be used to prototype, create replacement parts and is even versatile enough to print prostheses and medical implants. Different approaches are there. Mostly all 3D printers create objects using an additive method. Here we use Fused Deposition Modeling (FDM) method for making trunk like arm and gripper. The material used here is plastic. This is the cheapest material and feasible method. The part is printed by squeezing the molten stings of material that melt together. Fused Filament Fabrication (FFF) and FDM – both describe the same technique. Advantages of 3D printing are speed and ease of prototyping, less waste, cost efficient production. We can create complex designs in 3D Printing. Applications of 3D printing are aero-space and defense, architecture, medical, research, commercial products, education, entertainment. 3 steps to print a 3D model:

1. Design a model in 3D modeling software that is CAD.
2. Import the 3D model file into CURA.
3. 3D Print the model using the 3D printer.

3 D models are created by using software called Computer Aided Design (CAD). 3D models are nothing but the mathematical representation of any three dimensional surface of the object (fig.1). This software is to assist in the creation, manipulation, analysis or optimization of a design. This software can generate a variety of 3D file formats. CAD modeling is mostly used in enormous variety of industries. CAD has the capability to produce very accurate designs. We can draw efficiently using CAD, compared to other manual drafting. CAD is software tool used for designing the system parts but the designed parts are in graphical model and these are need to be changed to model that is understood by printing machine. A tool known as CURA is used to convert the graphical model into encoded model that is understood by the machine. CURA creates a seamless integration between hardware, software and materials for best 3D printing experience around. CURA features its own slicing engine, G-Codes sender and other tools to provide an "all in one" function for 3D printing. It can print multiple objects at once with different settings for each object. CURA supports STL, 3MF and OBJ file formats.

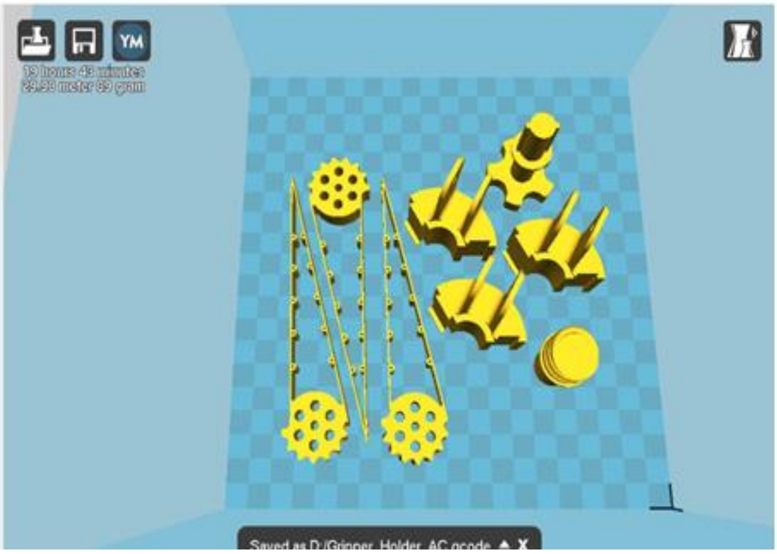

Fig. 1. Gripper-3D model

V. HARDWARE AND SOFTWARE REQUIREMENTS

A. Stepper Motor

Here we use stepper motor that converts digital pulses into mechanical shaft rotation. The stepper motors are DC motors that have capability to move in discrete steps. There are multiple coils called "phases" in this motor that are organized in groups. The motor rotates one step at a time, when each phase is energized in sequence. A very precise positioning and speed control can be achieved with computer controlled stepping. Thus for this reason, stepper motors are the choice for precise motion control application. Our robotic arm consist of only nine stepper motors for isometric (120degree)that is of three way directivity with delta connections. We use two stepper motors for adaptive gripper part. Totally we use eleven stepper motor. For a complete stability, a stepper motor is better choice than other type of motors. The advantage of stepper motor is that it generates torque at safe voltage.

L298 Motor Driver IC is a dual bidirectional motor based on the very popular L298 dual H-Bridge Motor Driver IC. This module allows for easy and independent control of two motors of up to 2A each in both directions. It suits well for robotic applications and for connecting microcontroller requiring just a couple of control lines per motor. L298 2A dual Bridge Driver IC is TTL compatible. Here the two H-bridges can be connected in parallel to increase its current capacity to 4Amp. It can be used for conjunction with stepper motor controller for driving one/two phase stepper motor. The device has over temperature protection, current sensing output and is available in 15-lead Multi watt package.

An H-bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are used in robotics and other applications to allow DC motors to run in forward or backward direction

B. Bluetooth Module HC 05

This system can be made to work both manually and automatically based on application requirement. In manual part, an app is created through which the system can be controlled, for this purpose we use Bluetooth technology as an wireless medium to transfer control signals. Here it is an input device for this system. HC-05 module is Bluetooth Serial Port Protocol (SPP) used for transparent wireless serial port connection setup which is easy to use. This module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps modulation for faster file transfer with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluetooth 04-External single chip with CMOS technology which is designed to reduce the number of external components used and thus production cost is minimized and auto-calibration is incorporated by this device. This module also has an Adaptive Frequency Hopping (AFH) feature which reduces the effects of interference between Bluetooth and other types of devices. It has the footprint as small as 12.7mmx27mm and simplifies the overall development cycle. Atmega 328 Controller Here we us Atmega 328 controller. It has more number of input and output pins compared to other controller.

C. Switch Mode Power Supply

Here we use Switch Mode Power Supply (SMPS) which is an electronic power that incorporates a switching regulator to convert electrical power efficiently and it transfers power from a DC or AC source to DC loads such as personal computers, while converting current and voltage characteristics. The pass transistor of this switching-mode supply continually switches between low-dissipation, full-on and full-off states, and it spends very little time in the high dissipation transitions, thus minimizing wasted energy. Thus SMPS ideally dissipates no power.

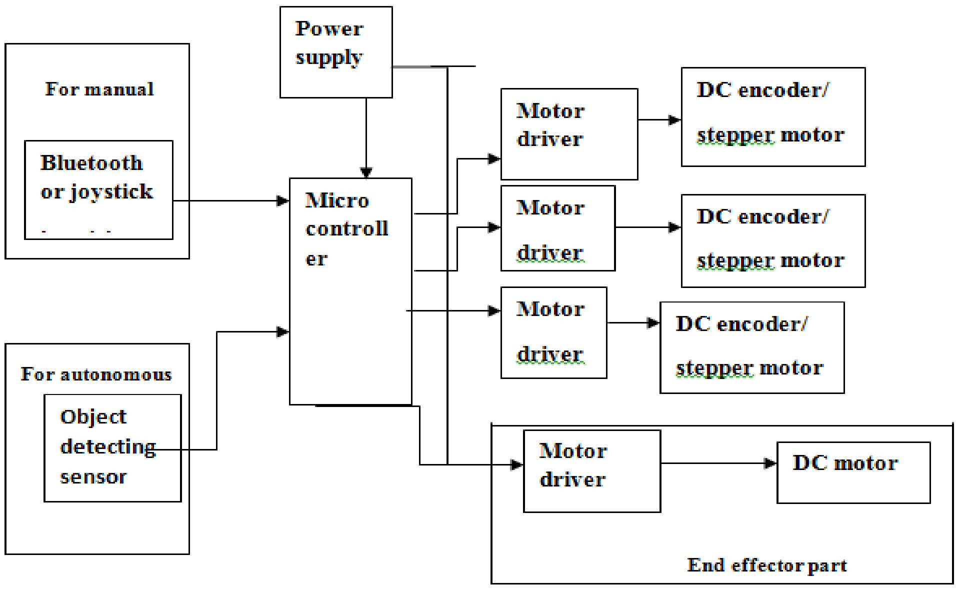

Fig.2. Block Diagram of Advanced Robotic Arm

VI. DESCRIPTION

Robotic arm is highly flexible as its design was inspired from elephant's trunk, this flexibility is possible as all its parts were made from 3D printing and design is done by necessary spacing to avoid collision of parts and high degree of freedom. Because of this degree of freedom it has numerous applications. It is used to carry heavy loads easily. Complexity in programming is less. Cost of the system is feasible. It is a light weight system as all its parts were made in 3D printing. As the gripper was inspired from fish tail's fin it is highly adaptive to hold any kind of object with any shape, this is important because there should not be any discomfort for holding an object, if so then there will be damage to the object. The usage of motors is drastically reduced in this arm design which is the greatest advantage when compared to existing methods.

Due to the degree of flexibility, this system has vast application in medical surgeries especially in dentistry, endoscopy etc. It is used for industrial application, particularly in hazardous places where human working is highly risky, this system is used to transfer heavy loads, pick and place objects etc. The proposed system is used in many automation applications such as drilling, suction, spraying paints, water etc.

VII. CONCLUSION

This paper presents a method for using a Robotic Arm for versatile and pliant applications. This Robotic arm is highly flexible as its design was inspired and designed from elephant's trunk, and this flexibility is possible as all its parts were made from 3D printing and necessary spacing is done to avoid collision of parts. The concept of Degrees Of Freedom (DOF) in this system which is responsible for flexibility and lowering the system's complexity has numerous applications in the field of automation, such as drilling, suction, spraying paint, watering etc., and in industrial application, particularly in hazardous places where human working is highly risky, this system is used to transfer heavy loads, pick and place objects etc., and also this Degrees Of Freedom concept has paved way to use our system in vast applications of medical surgeries especially in Dentistry, Endoscopy etc.

Robot technologists need to provide clear evidence of clinical benefits to convince medical system procurers and surgeons, to adopt robot-assisted systems despite of their cost and complexity. However, showing an improvement in outcomes and cost effectiveness is not always trivial, but our system's cost is feasible and it is light weight system as all its parts were made by 3D printing.. The usage of many motors is drastically reduced in this arm design which is the greatest advantage when compared to existing methods. And another advantage is that this system can be made to work both manually and automatically based on application requirement. The wide combination of surgical robots will stimulate the research towards innovation that can change the robotics technique usage in the coming years. In total, the advanced robotic arm offers eleven degrees of freedom. These open up a host of task specific transport directions, which is in contrast to conventional handling system are not restricted to linear axis.

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