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A Review on Robot Arm Using Haptic Technology

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ABSTRACT: Robots are playing a very important role in our day to day life. The main idea behind making any robot is to reduce human effort. Depending upon the requirements, different types of automated and self-controlled robots are being implemented. As many robots which are already existing in the market suffering from controlling issues and to overcome this one of the emerging technology named Haptic Technology is discussed in this paper. This paper also discusses an approach for demonstration of a robot arm for physically disabled people who cannot walk. For those people who cannot easily lift simple things (e.g. lifting a glass of water). So the development of a Robot Arm which is controlled by the wireless medium is the theme of the paper and to make this done haptic technology is going to play a crucial role as far as implementation is concerned. Basically, a robot arm is divided into two parts i.e. Haptic glove and robot arm. The area in which robot arm moves, depends upon the range of Zig-bee module and robot arm is controlled by the haptic glove. So by keeping all constraint and limitations this paper is going to discuss a review on the implementation of a low-cost robot arm using Haptic technology which performs multiple tasks using less number of resources and it is easy to use.

KEYWORDS: Cognitive Degree of freedom, Haptic technology, Sensors, Microcontroller, RYP motion and machine interaction.

I.INTRODUCTION

In 320 BC Greek philosopher Aristotle made his famous quote:“If every tool, when ordered, or even of its own accord, could do the work that befits it... then there would be no need either of apprentices for the master workers or of slaves for the lords”[15]. This line describes the complete definition of robotics. Whenever any machine is implemented so the major requirement is that it works continuously without taking any break and also beneficial for the mankind.

In the field of robotics, many researchers have contributed an idea and work in a different area depending upon the requirement. After some many research was starting focusing on implantation robot arm which is going to be useful for one of the special categories of the society and they are disabled people. Many disabled cannot move from one place to another for their major or minor requirement. For that, they require getting the help of another person. For example, if the person is disabled by legs and he/she needs to get a glass of water from the table which is placed in the table [11]. For those people, robot arm plays the major role to overcome this limitation. The controlling the robot arm is to be done by HAPTIC TECHNOLGY. This is one of the newly invented technologies which is already being used many industries.

According to Wikipedia [16] Haptic words, is derived from the Greek word “haptesthai”. Haptic technology, haptics, or kinaesthetic communication, is tactile feedback technology which recreates the sense of touch by applying forces, vibrations or motions to the user. Haptics is the science of applying touch sensation and control for interaction with virtual or physical applications. In combination with a visual display, haptics technology can be used to train people for tasks requiring hand-eye coordination, such as Robotic Tele Surgery and Space-ship maneuvering. It can also be used for games in which you feel as well as see your interactions with images. The Haptic technology promises to have wide range of application and some of them is already being used in industry.For example, haptic technology has made it possible to investigate in detail how the human sense of touch works by allowing the creation of carefully controlled haptic virtual objects. Haptic is "the newest technology to arrive in the world of computer interface devices."After many years of over-emphasis on the visual elements of computing, for example, in PCs and video game consoles, the other senses are beginning to become important[3][8][10].

Haptics can be divided into three areas: [2][9]
A. **Human Haptics-**It is related to human sensing and its control via touch.
B. **Machine Haptics-**It is related to design, demonstration and use of machine to replace or augmented human touch
C. **Computer Haptics-**It is related to algorithms and software associated with the generation of touch to feel for virtual objects.

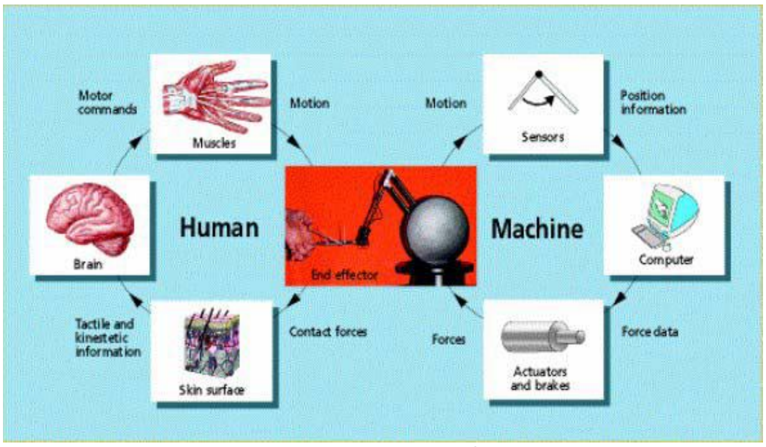

Figure (1): Basic diagram of haptic[10]

From the above figure (1), the basic working of human part (left) control the hand and machine part (right) expert the force the hand to simulate contact with the virtual object. If we consider human body then eyes are used as sensors. An eye looks the object and it sends the signal to the brain. The Brain will execute the signal. After execution of the signal, the brain will send a signal to hands and hands are used as actuator. The Hand will perform the task and again sends a signal to the brain. The same working is being followed in machine part as well. Here all the functions are performed by encoders, computer and motors respectively. Apart from all these haptic technology haptic also used in many industry such as tactile electronic display, teleoperator and simulators, video games, personal computers, mobile device and virtual reality etc[6][15].

II.RELATED WORK [1][4]

The robot arm which is discussed in this paper is a 3-axis articulated robot arm (pick and place).The arm has a spherical shoulder, spherical wrist which is connected by an elbow. The wrist-shoulder joint has 180 degree of motion to work comfortably (e.g. to pick the object from the floor).The complete arm is fixed of the base, it is also called chassis. So this section discusses the motion and structure of robot arm.

A.RYP Motion:

RYP motion is called as Yaw-Pitch-Roll. The RYP motion is one the important part before designing any robot. The RYP motion gives the information about the rotation of the robot. Consider figure (2) which gives the detailed information of RYP motion. Here Yaw, Pitch and roll has got X, Y and Z axis respectively. Each motion is defined mobile co-ordinate frame M(m1,m2,m3) about its own unit vectors of the mobile co-ordinate frame M(m1,m2,m3).Roll motion is performed by rotating the tool (M-frame) about the fixed axis m3 of M. It is the rotation of the tool about the arm axis. Pitch motion is performed by rotating the tool (M-frame) about the fixed axis m2 of M. It is the up-down motion of the tool. Yaw motion is performed by rotating the tool (M-frame) about the fixed axis m1 of M. It is the up-

down motion of the tool. The order in which the YPR motions are performed determines the final orientation of the tool or the gripper or the end effectors.

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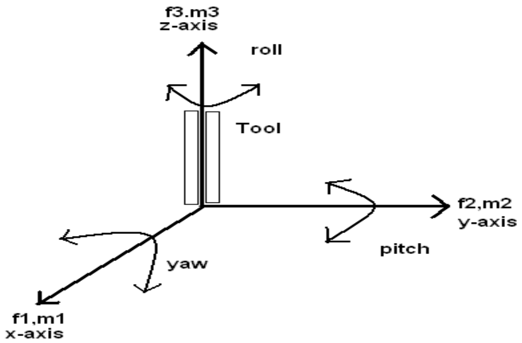
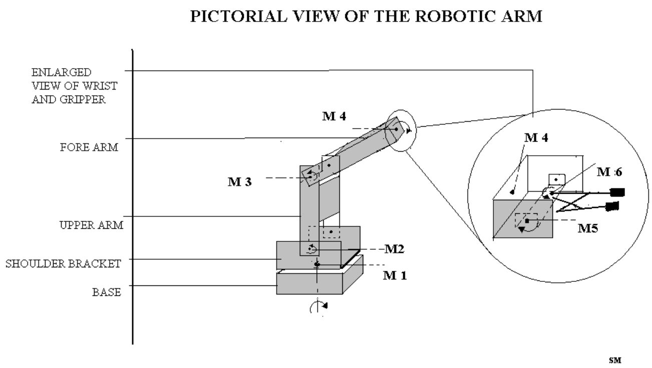


Figure(2) Yaw,Pitch and roll

B.Links and Joint: The robot body consists of several links and joints. All joints gives the information based kind of degree of freedom which can be used for implementation of robot arm. These links and joints depend on the basic structure of robot arm. The figure (3) shows robot with several links and joints.



Figure(3) Links and joints

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In the above figure M1, M2, M3 and M4 are various joints that connect the links between them. Links are defined as the rigid members who are connected between two successive joints. Axis is defined as an imaginary straight line about which the two links will rotate with respect to each other or an imaginary line which the two links will translate with respect to each other.

Axis1: Axis1 is located at the base of the robot and allows the robot to rotate from left to right. This sweeping motion extends the work area to include the area to either side and behind the arm. This axis allows the robot to spin up to a full 360 degree range from the centre point.

Axis2: Axis2 allows the lower arm of the robot to extend forward and backward. It is the axis powering the movement of the entire lower arm.

Axis3: Axis3 extends the robot's vertical reach. It allows up-down motion of the upper arm. It allows the upper arm to reach behind the body. This axis gives the upper arm for better part access or motion.

The section of a 3-axis articulated robot (pick and place) is discussed below.

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Base: A robotic manipulator is a device capable of moving in different directions relative to the base and controlled by a haptic glove. This base is actuated by a D.C motor mounted beneath it. Base consists of 4 wheels and each one is equipped DC motor for the motor. Sometimes 2 DC motor can also be but it comes more power and gives less speed.

Arm: The next important member of the robot is the arm which is the link between shoulder and elbow. The arm is made up of number of joints and links. One end of the arm is attached to the base and the other end is free to move and is attached to end-effectors which are used to perform a number of tasks (gripping, painting etc.). The arms are actuated by D.C geared motors. A gripper or end effectors or tool is attached to the arm which is used to hold objects, to pick from one place and to place it on the other as commonly observed in the industry work floors.

Gripper: Grippers are the devices which are attached to the end of the robot arm and used to grip/pick/grasp an object from one place to another place. Generally two-fingered grippers are used in most applications because it is proved that two fingers are sufficient to grip an object properly. There are varieties of grippers classified according to mechanical type, suction type etc. The two jaw gripper, of one which the tool tip position is variable and the two fingers, move in or out. As the finger opens and closes, the fingertips extend and retract. A parallel jaw gripper is one which tool tip position is fixed and the two finger move parallel to each other. The disadvantage of this parallel jaw gripper is that it cannot pick up the lengthy objects. It can pick up only those objects whose sides are parallel in nature such as containers, boxes. So depending upon the requirement of the industry work floor we can just vary the design of grippers keeping the entire assembly same.

Haptic glove: This is the transmitter part of the robot arm and fits over human hand completely. The motion of robot arm is controlled by the potentiometer fitted at the fingertips. Haptic gloves can be designed with the potentiometer, switch, and MEMS gyros and accelerometers.

III.BLOCK DIAGRAM

The figure (4a) and (4b) shows the block diagram of Transmitter and receiver of the robot arm.This block diagram gives the basic working of wireless controlled robot arm. A robot arm project is divided into two parts i.e. Haptic glove and robot arm. Here Zigbee module used for wireless communication [8]. Description of each block is given as follows,

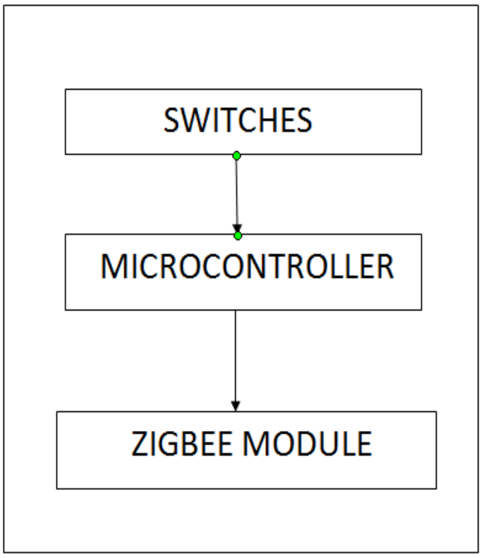

Figure :(4a) Transmitter

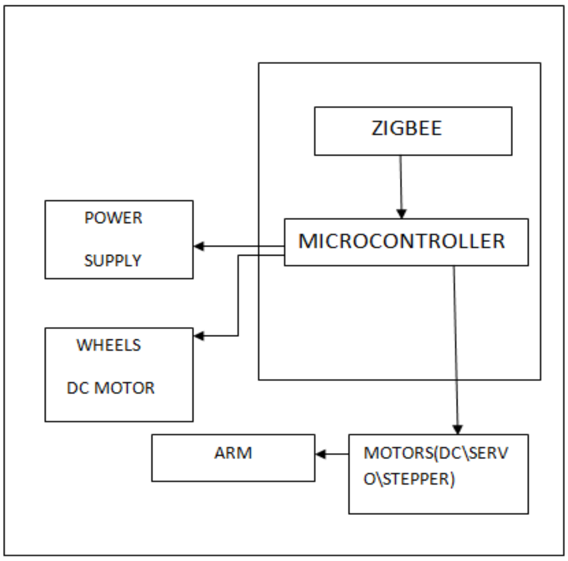

Figure :(4b) Receiver

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A. Haptic Glove (Transmitter): This part is used by the user to control the robot arm. The glove is similar to the human hand and for the instruction each finger has got some function. After pressing or giving instruction the signal will come into the microcontroller, it reads the information and send it to Zigbee module which is working as transceiver in glove section.

B. Robot Arm: The robot arm is one of the major parts which is responsible for performing each and every task. After receiving the signal from gloves side, the data/signal is again received by Zigbee module, its send the signal into the microcontroller. Microcontroller fetches the data and sends a signal to respective motor section. Depending upon the instruction, the motor section performs the movement and task is being completed.

IV. HARDWARE COMPONENTS [1][5][12][14]

As already discussed in the previous section that this robot arm is divided into two parts i.e. haptic glove and robot arm; So for hardware implementation we have divided the hardware information into two parts and the configuration of and assembly both are given as follows;

Haptic gloves: This part is mainly used for controlling the robot arm. The design of the gloves is completely same as the human hand. But here we are discussing potentiometer based gloves. The potentiometer used to control the position of the robot arm, these are connected to each and every finger of gloves and when we move the hand same output will be done by the robot arm. This sensor is the device that measures a physical touch into an electrical signal. MEMS (Micro-Electro-Mechanical Systems) potentiometer is one frequent sensor can be used [13].

Robot arm: The body complete robot arm is fixed on the base. The hand is made up of acrylic fiber. The pick and place capacity totally depends upon the kind of motors used.

Microcontroller AVR 8535: Every automated system has got microcontroller as base. This paper used AVR microcontroller. The AVR8535 microcontroller has high performance and low cost. It is 8-bit microcontroller and it has a power consumption capacity with best speed. This is present on both side i.e. glove and robot arm side.

RF transceiver module: This is acting as transceiver. It has got CC 2500 chip which 2.4 GHz transceiver.

ST 3654 –CC 2500 Zig bee Based Trans/Receiver Module: This module is installed at both the ends for input and out of signal. Zig Bee module is used for two way communications.

Zig bee Module: Zigbee is the most promising wireless communication technologies because of it high reliability, good data rate, easy to use and low cost. Zigbee is the name for a collection of high-level communication protocols for devices based on the IEEE802.15.4 standard. Zigbee is an RF (radio frequency) communication standard that makes it very simple to transmit digital information between devices. The simplest way to implement Zigbee in your robot is by using Zigbee modules. Zigbee modules are inexpensive components which integrate an antenna, amplifier, transmitter/receiver, and circuitry that allows you to send and receive data between the Zigbee and a microcontroller over a standard serial connection. Zigbee modules are perfect for applications like building a remote control unit for your robot, or allowing your robot to wirelessly transmit data such as sensor readings and internal states. Zigbee is a protocol stack based on the 802.15.4 wireless network communication standard. It is low-cost, low-power and all-in-all perfectly suited for low-bandwidth communication needs. The bandwidth is on the order of tens to hundreds kilobits per second, and the range is up to about a kilometer, depending on equipment.

Motors

A. Motor driver Section: The microcontroller receives the code for left, right, up, down of robot from PC at port 1. It checks the code and according to that provides the data to motor on port o. To run the motor we have used L298 motor driver IC. Two motors on the left side of the robot are connected in parallel combination & other two in the right side are connected in parallel combination.

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B.IC L298: The L298 Motor Driver has 4 inputs to control the motion of the motors and two enable inputs which are used for switching the motors on and off. To control the speed of the motors a PWM waveform with variable duty cycle is applied to the enable pins. Rapidly switching the voltage between Vs and GND gives an effective voltage between Vs and GND whose value depends on the duty cycle of PWM.

C.OPERATION OF DC MOTOR: In any electric motor, the operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As we are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

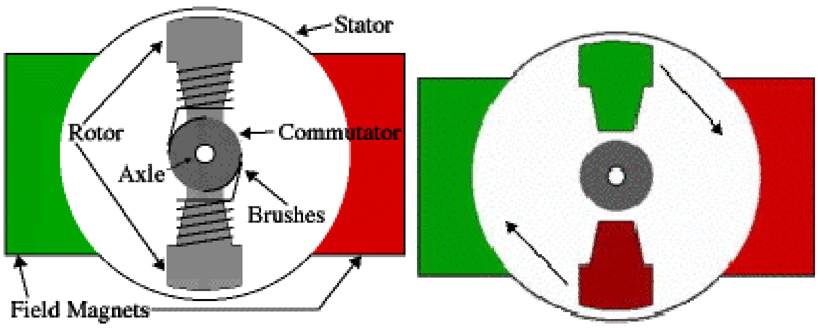

Figure (5).Design of DC motor

In a simple 2-pole DC electric motor, as shown above (here red (right side) represents a magnet or winding with a "North" polarization, while green (left side) represents a magnet or winding with a "South" polarization).Every DC motor has six basic parts axle, rotor (a.k.a., armature), stator, commutator, field magnet(s), and brushes. In most common DC motors (and all that Beamers will see), the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above shows a common motor layout with the rotor inside the stator (field) magnets. The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.

D. DC motors advantages and disadvantages over AC motors

This paper also proposes the use of DC motor over Ac motor because of some features which will be useful for the implementation of robot arm and they are given as follows;

(1)DC motor has great a speed control over AC motor.

(2)DC motor has high torque.

(4)It has a quick starting, reversing stopping and acceleration.

(5)It has reactivate power consumption and it's free from harmonic as present in AC signal.

V. ADVANTENGES AND DISADVATEGES

Advantages

(1) Gives the real time action with objects.

(2) It works continuously and won't take any rest.

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(3) Precise control of tool during operation.
(4) Very useful for disabled people who can't walk.
(5) Controlling is also very easy as it is controlled by haptic gloves.

Disadvantages:

(1)Implementation cost of Haptic technology is very expensive.
(2)Haptic applications can be very complex design and it's also required specialized hardware and accordingly processing power
(3) Debugging issues.

VI. FUTURE SCOPE AND CONCLUSION

With the increase of the computation power of office and home PC, one-day haptic mouse and interface device will be a common item in the house. The haptic development helps the sense impaired people to experience a new way of operating computers in a way they never do Haptic could be used in medical, training, e-commerce, or even games. These are just some rough uses for haptic, the possibility is so much more and right now haptic is helping NASA[1] to explore planets in the Solar system by controlling the robots. Though the technology is still quite unfamiliar to the general public but once haptic is introduced. The primary goals of haptic guidance are to facilitate the learning of complex human motor skills by providing haptic cues that are helpful to induce desired movements. In this, the motion index system indexes the human arm motion using the force and position stored by the motion saving system. This system is able to create the motion dictionary, which includes the desired indexed motions. Meanwhile, the motion search system searches the motion of human operator according to the indexed motions. Because of the increasing applications of haptics, the cost of the haptic devices will drop in future. It is the next important step towards realistically simulated environments that have been envisioned by science fiction authors. Haptic devices must be smaller so that they are lighter, simpler and easier to use. The proposed system is utilized to recognize the human motion. Controlling the robot arm using Haptic technology is discussed in this paper. The concept which is discussed here will be the implementation of 3-DOF based robot arm using less number of resources. The main focus of the implementation is going to be how it will be easily operated by disable people. As literature survey continues more advanced feature may be part of this implementation such as obstacle detection and how the concept of image processing will be used in robot arm is considered to be future work.

VII. ACKNOWLEDGEMENT

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