Robotic ARM Based on Haptic Technology

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Abstract— In the current generation robots have been used in different fields from the human society. Designing of robotic arm is used here to grab and drop the object in the provided location i.e. for the security purpose. To provide lifting of the objects, Servomotors with a torque of 11 kg are used. The programming is done on PIC18f4550 microcontroller using a microchip development board. The input is given using a hand, which is an arm, made of Polycarbonate fitted with Potentiometers with a certain angle of rotation which resides on the human hand is controlled by the haptic technology. The potentiometers detect the angle of the rotation and the signals are sent to the microcontroller accordingly. In order to represent the robotic technology in the field of human-machine interaction and wireless communication for allows interactivity in real-time with virtual objects. It is very necessary to develop some or the other technology that makes the maximum use of robot to help people do their work in an efficient way in their day to day life.

Key words: Haptic, Human-Machine, Interaction System, Robotic Arm Control, Robot, Transceiver Module

I. INTRODUCTION

Robotics is an essential part of engineering science which deals with designing, modeling, controlling, nowadays robots accompany people in everyday life and take over their daily routine procedures. As the advanced technology is progressed, robots were recognized as a system that have various purposes and usages. The paper describes an idea behind an execution and implementation of a robotic arm and control it using a human hand by means of haptic technology. Haptic means applying sense of touch and control to coordinate with physical or virtual applications. Nowadays haptic has become a vast growing areas which deals with sensory interaction with computers. The word haptic is derived from the Greek word haptikos which means involve the sense of touch. Haptic is used in engineering field to create virtual environment. It is a tangible feedback technology which provides sense of touch by applying vibrations, motions or forces to the user.

Human haptics – Is the study of sensing and its control through human touch. The sensors which are used in haptic technology works as a transducer as it converts the hand motions into the electrical signals. These hand movements can be retroflexed using a robotic arm. Our research is based on the principles and tools that needed to work on advanced robotic and human-machine systems capable of haptic interaction. This project is divided into two modules namely, Haptics glove (Transmitter) & Robot side (Receiver).

A. Haptics Glove:

Haptic glove are on the transmitter side. it is a device which fits over the user's entire hand like an exoskeleton having potentiometers on finger, wrist & picks up change in resistance with hand movement.

B. Robotic Arm:

Robotic arm are on the receiver side. A robotic controller is a device which allows moving in different directions (base, shoulders, elbow, yaw, pitch, roll directions) relative to base and controlled by Haptics. Its base is actuated by a D.C motor mounted beneath it. The *degrees of freedom*, or DOF, are a very important term to understand. Each degree of freedom is a joint on the arm, a place where it can bend or rotate.

II. SYSTEM OVERVIEW

A. Haptics Sensors:

A sensor also called detector- is a device that takes a physical quantity as an input and converts it into equivalent electrical signal. The user in order to move the robot should make a hand movement. This different movement is sensed by potentiometer & accelerometer attached to haptics gloves. Potentiometer is used in haptic suit along with ADC for position feedback of joints. It gives the feedback in the form of voltage. Accelerometer is connected to on other glove for position feedback of hand movement either left or right. The output of this sensors are in analog form, therefore they are connected to analog port of microcontroller.

B. Microcontroller-PIC18F4550:

The pic18f4550 is a low-power CMOS 8-bit microcontroller based on Harvard architecture. It has an inbuilt ADC. Thus electrical signal receive at RA0 to RA3 pins of ADC port are converted into required digital signal. The microcontroller encodes data using programming for this digital data. According to programming at a time anyone data (pin-25,) is transfer to Zigbee series 2 module (pin Din, Dout) for transceiver modulation purpose.

C. ZIGBEE Transceiver Modules:

The Zigbee series 2 is a low cost true single chip 2.4GHz transceiver manufactured for very low power consumed applications. Here it acts as transmitter module. Its carrier freq. is 2.4GHz.Hence data received at Din pins of series 2 from TXD (RC6) pins of microcontroller for long distance wireless transmission. The transmitting range of this module is 1.6km. For transmission over this distance an antenna should be connected. Hence this modulated data is send via antenna to receiver.

1) Zigbee series 2:

Systems that contain XBee Series 2 RF Modules inherit MaxStream Certifications. ISM (Industrial, Scientific & Medical) 2.4 GHz frequency band Manufactured under ISO 9001:2000 registered standards.

UART interface for transmission and reception of serial data at various baud rates i.e. 25000bps. It can be used for applications that need two ways RF Module and series are working at 3.3V level.

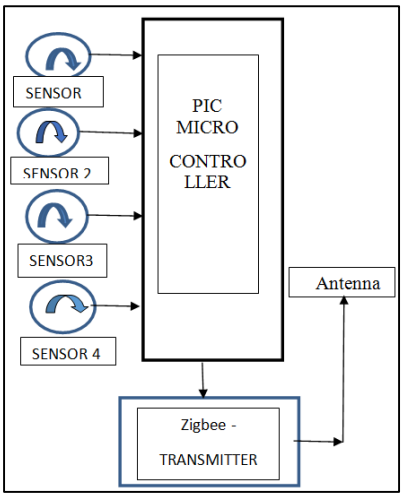

Fig. 1: Block Diagram Transmitter

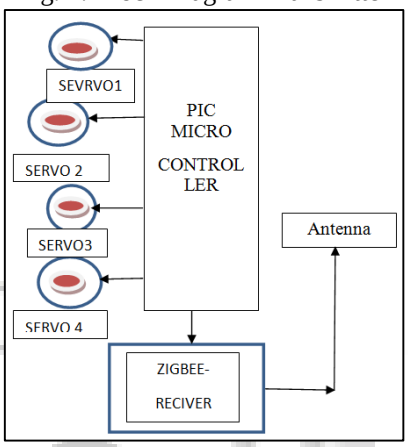

Fig. 2: Block Diagram Reciver

The operating RF module above 3.3V will definitely harmful to module. Through UART the module can be interfaced with voltage range 2.4 to 3.4V. Since it has a resistance of 1K in series to RXD which will drop down the 5V level of serial asynchronous data.

D. Antenna:

The receiver antennas receive the serial data sent by the transmission side. Antenna is connected to one of the transceiver module pin. And then data is further access with the help of receiver module.

E. ZIGBEE Transceiver Module:

Zigbee series -2 works as a receiver module. It demodulates received signal. Then this signal is passes serially to Atmega32A microcontroller on (RXD) port data. This decoded data is passes to Robotic arm.

F. Microcontroller-Atmega32A:

Then according to look up table, microcontroller gives command (pin-1 t0 6) through PB0 to PB5 of port B to the motor driver IC. Now driver IC operates motor connected to the arm. It has four PWM channel.

G. Servomotor:

There is a very simple set-up: a small DC motor, potentiometer and a control circuit. The motor's speed is proportional to the difference between its actual position and desired position. So if the motor is near the desired position, it will rotate slowly, otherwise it will rotate fast. Then this is called proportional control. Servos are controlled by sending an electrical pulse of different widths, or pulse width modulation (PWM).

The servo circuitry is built right inside the motor unit and has a positional shaft, which usually is fitted with a gear. The motor is controlled with an electric signal which determines the amount of movement of the shaft. When the shaft of the motor is at the desired position, power supplied to the motor is stopped. If not, the motor is turned in the appropriate direction. The desired position is sent via electrical pulses through the signal wire. As the motor rotates, the potentiometer's resistance changes, so the control circuit can precisely regulate how much movement there is and in which direction.

For this system we used four servomotors of two types:

1) Digital Servomotor VSD-18MB:

Control system with pulse width modulation, 1500us neutral. It operates on voltage range 4.8V to 6V DC counter clockwise/pulse traveling 800 to 2200 sec at 4.8V and at 6.0V operating speed 0.25sec/60°at no load, 0.20sec/60° at no load and it drives with an angle greater than and equal to 170 degree. It capability to pick up weight is 6.5kg.Important feature is three pole metal brush Motor and used for robotic application.

2) Dual Shaft Metal Gear RKI-1206:

This motor operates on 4.8V and default pulse width position is 1500usec.For this motor, there is no angle limit with torque 14kg.cm for voltage of 4.8V and 16kg.cm for voltage of 6.0V.Gear type of motor rotates at a 180 degree. Their weight is 59 gram and its current stalling capacity of 1200mA.

III. FLOW DIAGRAM

A. Transmitter:

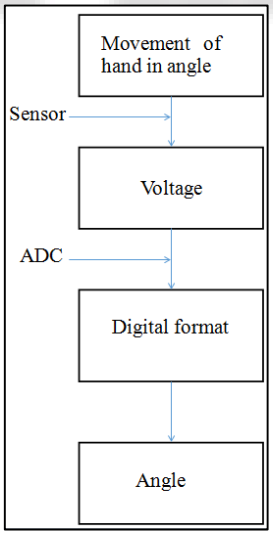

Fig. 3: Flow Diagram Of Transmitter

Steps:

1) The movement of hand in various angles on which sensors i.e. potentiometer (pot) is placed.
2) The conversion of angle to voltage quantity by using pot.
3) The potentiometer output is given to the ADC, for the conversion in digital format.
4) The digital data is convert to the angle form. And then transmission is done through transmitter module.

B. Receiver:

Steps:

1) The receiver module is received signal in form of angle.
2) The calculation is done in the form of percentage of digital format.
3) The percentage of digital output is given to the PWM generator.
4) The PWM produced output is given to servomotor.
5) The actual angle of hand motion is get through the servomotor

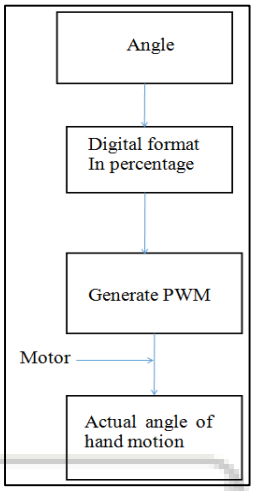

Fig. 4: Flow Diagram of Receiver

IV. ADVANTAGES

1) In real time application based system it interacts with virtual object.
2) Machines never get tired after a long time work also.
3) They never sleep neither they talk to their buddies.
4) The machine never hides themselves after seeing a heavy work load.
5) In rural areas also the operation can takes place.
6) For military people who live in high peak areas which are beyond doctors reach it can be used.
7) In application like bomb disposal the human life is at no risk.
8) In medical field also it is very beneficial like during operation there is a need of cutting skin then it can be reduces to less cutting of skin due to use of advance technology camera and tools.
9) While in Operation Theater, reduction of no. of people.
10) It does not affected by anger, hunger, revenge, fear, fatigue or stress.

V. DISADVANTAGES

1) For complicated decision makings robots cannot be used since, they involve in real time data analysis debugging issues are complicated.
2) To move the device into new location auxiliary controls are required.

VI. APPLICATIONS

- It is used as an external limb of a surgeon during complex heart surgeries.
- To lift the objects.
- To lift nuclear waste without harming the human body.

VII. RESULT

Hardware of this project was successfully run and measured. The working voltage is 5 volt with the degree of freedom 1. The capacity of carrying load is 0.3kg (maximum). PWM based servo motor is used as a drive system. Its Mounting type is "on stand" and the controller used is AVR ATmega 16(receiver side). The robotic arm movements is checked and controlled by haptic movements using PIC18F4550 controller and send using ZigBee series 2 RF transreceiver with 9600 baud rate.

Regarding output movements the hand joint action is basically a robotic motor action movement in degree. Shoulder and elbow can move 0 to 160 degree, grip is 0 to 180 degree and wrist movements can be take place from 0 to 100 degree.

VIII. CONCLUSION

The purpose of designing robotic arm based on haptic technology is to provide convenience to the users. The goals of haptic technology is to facilitate the learning of difficult human body movement's skills to induce desired motions.

The designed system is completely based on the arm movement so that according to its motion the robot will work. For the applications like critical field zone its performance is highly commendable.

Haptic devices are light in weight, small in size. So, it becomes easier to use.

IX. FUTURE SCOPE

The research is going on haptic based technology i.e. on brain signalling for the handicapped people. So that they can control the robotic arm using brain signal. Recently, the research took place in the cloth retail industry, where the user got a feel of cloth texture on internet.

REFERENCES

[1] Xinxing Tang, Hironao Yamada, Dingxuan Zhao, Tao Ni. Haptic Interaction in Tele-operation Control System of Construction Robot Based on Virtual Reality., IEEE, 2009.
[2] Nisha Sharma, Swati Uppal, Sorabh Gupta. .Technology Based On Touch: Haptics Technology", IEEE, 2011.
[3] Patrick R¨oßler, Timothy, A Novel Haptic Interface For Free Locomotion In Extended Range Telepresence Scenarios, Germany, IJERA-2008
[4] Rama Krishna, G. Sowmya Bala, A.S.C.S. Sastry, B. Bhanu Prakash Sarma, Gokul Sai Alla"Robotics Arm control using sensors. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com, May-Jun 2012.
[5] Ken'ichiro NAGASAKA, Atsushi MIYAMOTO, .Motion Control of a Virtual Humanoid that can Perform Real Physical Interactions with a Human, IEEE, 2008.
[6] Dzmitry Tsetserukou, .Naoki Kawakami and Susumu-iSoRA: Humanoid Robot Arm for Intelligent Haptic Interaction with the Environment. ASME Paper, 2009.

