ARDUINO ROBOTIC HAND: SURVEY PAPER

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***Abstract*— The Hand is a necessary part of the human being. Though the hand is used for everything in our day to day life, its strength and flexibility limits the use in extreme scenarios. The Robotic hand works on Arduino Uno micro-controller and is programmed using Arduino C (similar to Embedded C language designed especially for Arduino micro-controllers). The basic working of the robotic hand is based on conversion of flex input (from flex sensors) into rotational output (to Servo motors).The servo motors have strings that attach them to individual fingers , thus resulting in human like motion of robotic hand. The robotic hand can be designed to be more efficient and flexible than the human hand. The robotic hand may be connected to a network and used over long distances. The robotic hand may be automated for certain applications in Factories. The Robotic Hand can be designed to operate with precision over long distances using a network. It can be designed in such a way that heavy objects can be lifted which may be impossible for average humans. Further this paper describes the base projects used to make this paper and how this bot works using Arduino Uno microcontroller. Also the proposed plans for this robot in different fields of research and development and industrial or road safety are explained further.**

***Keywords* — Arduino Uno, Flex sensors, Servo Motors, long distance communication.**

I. INTRODUCTION

We usually find that people who are interested in robotics come up with ideas that may change the world. Robotics is one of the fields that combines the disciplines of electronics, computer science and mechanical engineering. The Robotic Hand is a basic project that if modified over-time, can be used in various places.

The mechanical robotic arm is a general equipment used in factories and laboratories. They reduce human effort to absolute zero. Basically robotic arm has a set of abilities that may be too difficult or impossible for humans to perform.

In the present world robotic hands are used everywhere. It depends on one's creativity and imagination to how to implement it.

The Robotic hand consists of an arduino uno micro-controller, seven servo motors, six flex sensors and 1 accelerometer. The flex sensors on the glove give an analog output to the arduino board and this output is converted to digital signal and given to the servo motors. The six flex sensors control the fingers and wrist motion of the bot. The Accelerometer measures the tilt of the hand in 3-Dimensions and gives the bot ability to rotate. This project may help people in day to day life or industries .

II. LITERATURE SURVEY

A robotic hand is a part of humanoid robot. Its applications and designs varies on the basis of application it is supposed to be used for. Humanoid bots like Honda's ASIMO and open source robot called InMoov have hands similar to that of humans[8]. These bots are made after long years of research and development.

Proposed work the Arduino uno robotic hand is a part of design of InMoov bot. The phase 1 of the hand includes just the movement of fingers controlled by glove .

The design looks simple enough but the trickiest part of it is to configure the flex sensors on the fingers and calculate the angle at which the servo motor should rotate. Since Arduino uno is used, the program embedded into the micro controller is typed in Arduino c.

The phase two includes adding motion to the wrist thereby increasing efficiency of the machine.

III. APPLICATION OF ROBOTICS HAND

SPACE:

When astronauts work outside the shuttle or station wearing the space suit, there is always risk of air tanks getting empty or getting hit by space debris. To avoid this there is always a robotic arm present outside the shuttle or station to help the astronaut, but if the repair or work requires precision then they need a tool that is as flexible and controllable as a human hand.

MEDICAL RESEARCH:

When there is a new virus or a dead body with a virus which needs research the scientists or doctors usually wear a sealed protective suit to work in close proximity of the subject. There is a risk of damage to the suit because of sharp tools used for dissection purposes or even air supply failure to the suit. The hand will allow scientist and doctors to work in close proximity of the subject without actually being close t the subject along with human precision.

LABOUR:

The hand if designed properly according to need, can be used to lift or push or pull heavy objects on construction sites and factories. They may also be used at home to do work which is not possible for average human to do with his/her strength.

LIMBS:

People who have lost their limbs in accidents or are born without them can be provided with electric limbs possible by the new field of bio robotic development called bionics.

MILITARY:

With the use of hydraulic pumps, a suit or a bag can be designed to help the soldiers lift their heavy bags and guns and with some more attachments and connection to a network of drones and sensors may help the soldiers be more alert and safe on the battle field.

IV. DESIGN CLASSIFICATION

There are many different types of robotic arms, they can be divided into six categories considering their robotic structure:

1. Cartesian (also known as Gantry) robots have three joints that are coincident with the standard X-Y-Z Cartesian axes.
2. Cylindrical arms have any number of joints that operate on a cylindrical axis, normally rotating about one fixed rod.
3. Spherical (polar) arms are those with joints that allow it full rotation throughout a spherical range.
4. SCARA robots have two parallel rotary joints to allow full movement throughout a plane, typically for pick-and-place work.
5. Articulated robots are used for complex assembly operations, and consist of three or more rotary joints.
6. Parallel robots have three concurrent prismatic or rotary joints, and allow for tilting of heavy or sensitive platforms.

V. PARAMETERS FOR CONSTRUCTION OF THE ARM

Following are the parameters considered while designing a mechanical arm:

1. Number of Axes – Two axes are needed to reach any point in a plane. Three are required to reach a point in space. Roll, pitch, and turn control are required for full control of the end manipulator.
2. Degrees of Freedom – Number of points a robot can be directionally controlled around. A human arm has seven degrees; articulated arms typically have up to 6.
3. Working Envelope – Region of space a robot can encompass.
4. Working Space – Area acquired by the robot while working.
5. Kinematics – Arrangement and types of joints (Cartesian, Cylindrical, Spherical, SCARA, Articulated, Parallel
6. Payload – Amount that can be lifted and carried
7. Speed – May be defined by individual or total angular or linear movement speed
8. Acceleration – Limits maximum speed over short distances. Acceleration is given in terms of each degree of freedom or by axis.
9. Accuracy – Given as a best case with modifiers based upon movement speed and position from optimal within the envelope.
10. Repeatability – More closely related to precision than accuracy. Robots with a less repeatability and high precision usually need only to be recalibrated.
11. Motion Control – For certain applications, arms may only need to move to certain points in the working space. They may also need to interact with all possible points.
12. Power Source – Electric motors or hydraulics are typically used, though new methods are emerging and being tested.
13. Drive – Motors may be hooked directly to segments for direct drive. They may also be attached via gears or in a harmonic drive system
14. Compliance – Measure of the distance or angle a robot joint will move under a force.

VI. COMPARISON BETWEEN INTEGRATION-ORIENTED APPROACH VS. MODULAR APPROACH

The integration-oriented approach for building a robot :-

It's well understood that building a robot is a technically challenging task. Engineers often face situations where the *integration effort of the robot, generally composed by diverse* sub-components, supersedes many other tasks. The hardware upgrades during developing the robot has further integration.

This method for developing robots produces results that are useful only for a short period. Moreover, modules within the robots aren't reusable in most of the cases since the integration effort makes reusability an incredibly expensive (manpower-wise) and time-consuming task.

The modular approach:-

The existing growth in robotics is producing a considerable number of hardware devices. Although there's an existing trend towards using the Robot Operating System (ROS), when compared to each other, these components typically consist of incompatible electronic components with different software interfaces. Consider building robots by connecting different modules together. Storage, sensors, modules, User Interface devices, etc. provided everything works together; the entire development effort could be ignored. The overall process of building robots could be simplified and the development effort and time will be reduced significantly.

VII. CIRCUIT DIAGRAM AND HARDWARE CONFIGURATION

The following are the main components used in the proposed project:

1. *Arduino micro-controller:*

   Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2. *Flex sensors*:

   A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. Usually, the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. Since the resistance is directly proportional to the amount of bend it is used as goniometry, and often called flexible potentiometer.

   The fig.1 shows the connection of flex sensors with arduino uno where each flex component is attach from port 2 to port 6 and ground and vcc is connected at port 9 and port 10.

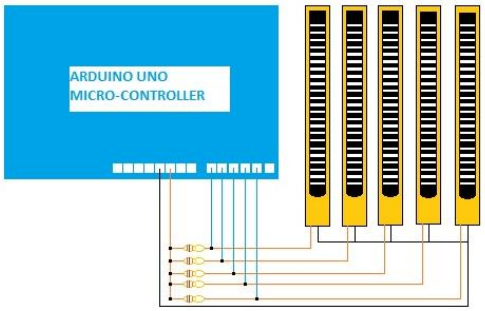

Fig. 1.Connections of flex sensors with Arduino uno

3. *Servo Motors:*

   A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of a motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

   Fig.2 displays the connection of servo motors with arduino uno and battery. All the components are connected using bread board. As servo motors need regular power to run smoothly the are connected to battery. The quality of battery should be higher as servo motor drains battery faster

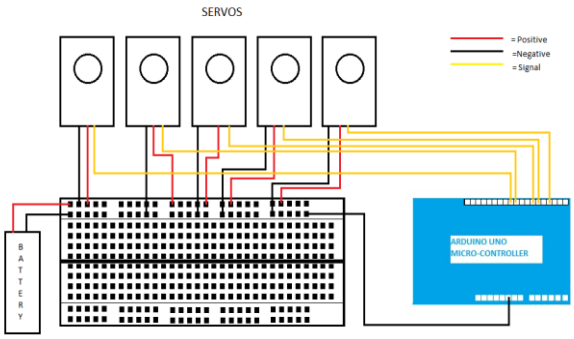

Fig. 2. Connections of servo motors with Arduino uno and battery

4. *Bread board*

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solder less breadboard (AKA plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these.

VIII. WORKING

The flex sensors on the glove are used to measure the flex.
Flex sensors transfer the Analog input to the ARDUINO UNO micro-controller
ARDUINO UNO micro controller converts the Analog input to digital output.
In this step the Analog input of the flex sensors is converted to a digital output and the degree of rotation and speed is calculated which will be transferred to the servo motors [3].
The Digital output is transferred to the 5 servo motors.
The string that is attached to the fingers of the robotic hand are pulled because of the rotation of servo motors
The strings attached between the servos and fingers result in a real-like human hand motion.

IX. IOT BASED ROBOTIC ARM

The major misconception about robots is they are used only for industrial operations but it can also be used in space projects, household operations etc [6]. Imagine we are able to control the bot sitting miles away from the machine. It is possible to control a robotic arm through internet (IOT) [7] [2].Robots can be connected to internet simply by a web server, client can get the data or web pages launched on web server [5]. The web pages can contain a detailed monitoring of the robot and might also be used to give commands. A live video monitoring delivered by the robot on web server would be helpful to take immediate decisions in time of emergency. Visual support provided to the robot can help consider the environmental conditions in areas where climatic changes are frequent.

X. PROPOSED IDEA OF THIS PAPER

The basic idea of this paper is to operate this robotic hand over a network on a mobile robot so that the range of application can be increased.
Using such robots on roads or mainly highways over specific intervals may help in reducing deaths by accidents.
The basic design of these bots will include a robot which has two robotic hands that can operate over a network and a camera for the human controlling the hands , too see and control the hands as required.
These bots may be designed for different search and rescue operations .
For example:-
1. Bot with a water tank to extinguish fire.
2. Bot with a medical kit or a first aid kit to help people injured in an accident. May be used by doctors to provide first aid from a far distance before medical help arrives.

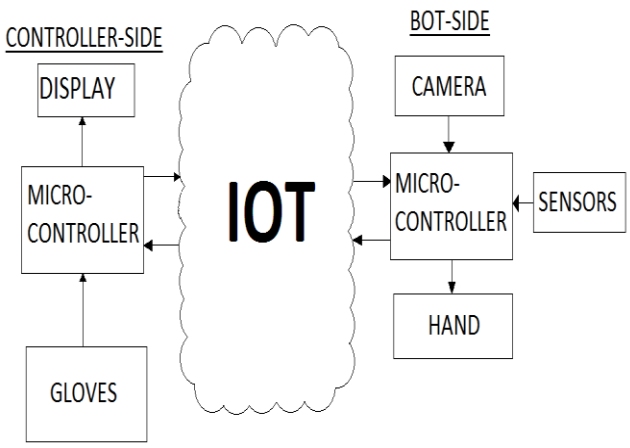

Fig.3.Block Diagram for Flow of control

The above Fig.3 gives us a whole idea about the implementation of IOT in robotic hand. The two sides i.e controller-side and bot sides are used for co-ordination with the server. On the controller side micro-controller plays an important role as it helps in displaying the recording done by the camera as well as UI software on the display component, also the gloves present contains flex sensors which transmits the movement signals to the server via micro-controller. The other side i.e. bot side contains various components. The camera is used to give input to the controller of the ongoing environmental situation. The sensors present include various sensors such as proximity sensors, temperature sensors, infrared sensors, ultrasonic sensors etc. These sensors pass the information to the server through micro-controller. The commands to the hand component are given through micro-controller based on the movements performed through flexes in gloves on controller side.

XI. CONCLUSION

The basic idea of the Robotic arm is to make the tasks easier for humans. Making desired modifications to the basic design will help users to use the robotic arm more efficiently and increase the area of application. We have classified various design of robotic arm along with the construction parameters.
The hardware configuration and circuit diagrams describe the construction and design of the proposed project. Working describes the flow of control of all connected equipments with the micro-controller. The next phase of the project includes wireless control of the project over a network and other modifications to be added to implement the final phase of the project i.e. Rescue bot.

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