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Design and Development of Robotic Arm for Special Purpose

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Abstract—Robotics has been acknowledged as a mainstay in the industrial automation domain for decades. The idea is to change the perception of remote controls for actuating manually operated Robotic-Arm. A robot is a system combining many subsystems that interact among themselves as well as with the environment in which the robot works. In robotics, end effectors are a device at the end of a robotic arm, designed to interact with the environmentIt is gradually making its headway into the domains of military, medical and vehicle applications domain. The use of robotics in industry is becoming more popular in recent years. The trend seems to continue as long as the robotics technology meets diverse and challenging needs of the producers. Rapid developments in digital computers and control systems technologies have significant impact in robotics like any other engineering fields. By utilizing new hardware and software tools, design of these complex systems that need strong integration of distinct disciplines is no longer difficult compared to the past.

Keywords*: - 6-DOF, ATMEGA-328 Microcontroller, Arduino, End Effectors, Gripper, Spur Gears.*

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1. Introduction:

A robot is an automatic or virtually intelligent agent that can carry out any desired tasks automatically or with some supervision, typically with the aid of a remote control. In practice, a robot is usually an electro-mechanical machine that is guided by means of computer and electronic programming. Robots can be autonomous, semi-autonomous and also remotely controlled [1]. Robots are used within an increasingly wide variety of tasks such as for household appliances like vacuuming floors, mowing lawns, cleaning drains, building cars, in warfare, and in tasks that are too expensive or too dangerous to be performed through humans such as exploring outer space or at the bottom of the sea and for different special purpose used.

While developing the robot and implementation of work, the software consists of the commands that control a robot's actions and provide necessary information regarding required tasks. When a program is written by means of software, the robot is able to implement commands and achieve the particular task [4]. Programming robots is be a intricate and difficult process, and while it has become easier over the years, the lack of cross-platform industry principles has affected the development of software tools for robots compared to other automated control systems such as programmable logic controllers (PLCs) [4]. This mechanical stimulation can be used to assist in the creation of virtual objects in a computer simulation, to control such virtual objects, and to enhance the remote control of machines and devices (telerobotics). Robotics involves elements of mechanical and electrical engineering, as well as control theory, computing and now artificial intelligence (Selig, 1992). According to the Robot Institute of America, "A robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks" [1]. The robots have to interact with their environment, which is an important objective in the development of robots. This interaction is commonly accomplished by means of some sort of arm and gripping device which is also called end effector's [3]. In the robotic arm the arm has a few joints, similar to a human arm, in addition to shoulder, elbow, and wrist, coupled with the finger joints; there are many joints [2]. Hence a Robot can be Design for special purpose work and desired work can be obtained by developing it.

2. Design of the Robotic Arm:

The Robotic Arm is designed using the Micro-controller i.e. ATMEGA -328 Micro-controller using Arduino programming. This works on the principle of interfacing various links, gear, LED'S, PCB's, microcontroller, potentiometers and servomotors, etc... This is done using Arduino Board. The remote is fitted with potentiometers and the servos are attached to the body of the robotic arm. The potentiometer converts the mechanical motion into electrical motion. Hence, on the motion of the remote the potentiometers produce the electrical pulses,

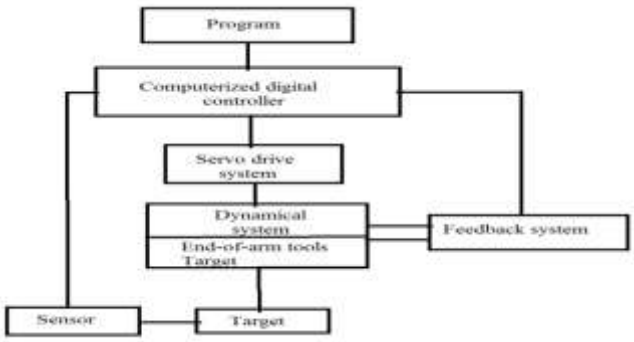

Figure 1: Basic elements of robots arm

The board process the signals received from the potentiometers furthermore convert them into requisite digital pulses that are then send to the servomotors. This servo will respond as per the pulses and the moment of the arm occurs. In short, the micro controller interfaces all these components specified above.

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3. Material Requirement to Construct the Robotic arm:

Normally the hardware sections would be separated into areas, which are as given below:-

1. Servo Motors
2. Aluminium (Body structure)
3. Potentiometers
4. Atmega-328 Microcontroller
5. PCB's
6. Arduinoduemilanove
7. LED (Light Emitting Diode)

2.1 Servo motors: -A servomotor is a motor, which forms part of a servomechanism. The servomotor is paired with some type of encoder to provide position/speed feedback [7]. A stepper motor is one type of servomotor. A stepper motor is actually built to move angular positions based upon each possible step around the entire rotation, and may include micro-steps with a resolution such as 256 micro-steps per step of the stepper motor. A servomechanism may or may not use a servomotor. It is clearly shown that an encoder or resolver positive feedback signal is sent to the digital controller from the servomotor. In addition, a velocity feedback signal is sent to the corresponding amplifier to provide an efficient functioning of the servomotor. The power and control are given as input to this circuit and then system is powered.

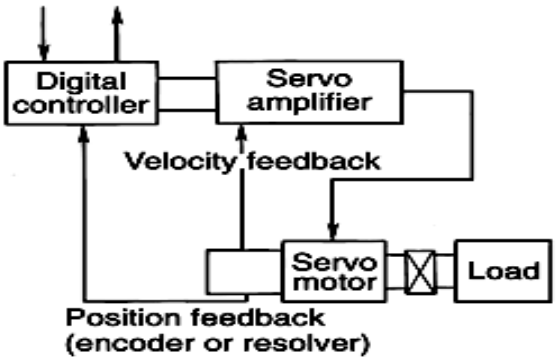

Figure 2 Servomotor interfacing with Amplifier and Digital Controller

2.2 Potentiometer: -A potentiometer informally, a pot, within electronics technology is a component, a three-terminal resistor with a sliding contact that forms an adjustable voltage divider [1]. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. A potentiometer is essentially a voltage divider used for measuring electric potential (voltage) [1]. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment.

2.3 Arduinoduemilanove: - Arduino is an accepted open-source single-board microcontroller designed to formulate the process of using electronics in multidisciplinary function more easily to get [6]. A simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input / output support [5] is used in the hardware part of the design process. On the other hand, programming language compiler, which is a standard one and the boot loader are there with in the software that runs on the board. Arduinoduemilanove circuit top views with the help of the wiring-based language (syntax and libraries) similar to C++, Arduino hardware is programmed using some simplifications and modifications, and a Processing based integrated development

- USB connector
- Power connector
- Automatic power switch
- Digital pins
- Analog pins
- Reset switch
- Power pins

2.3 Communication: -The ArduinoDuemilanove has a number of facilities for communicating with a computeror with another Arduino, or microcontrollers. The ATmega328 provide serial communication, which is available on digital pins 0 (RX) and 1 (TX). An "FTDI FT232RL" on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor, which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Duemilanove's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a wire library to simplify use of the I2C bus. For SPI communication, the SPI library is used [6].

2.4 LED (Light Emitting Diode):-A light-emitting diode (LED) is a semiconductor light source that is used as indicator lamps in many devices and are increasingly used

for other lighting [7].When a light-emitting diode is forward biased (switched on), electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the energy gap of the semiconductor determines the colour of the light (corresponding to the energy of the photon) [7]. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, and faster switching [7]. Bring the reset line „LOW" to reset the microcontroller. Typically, this is used to add a reset button to shields, which block the one, on the board.

4. Software Requirement:-

1. Express Sketch: - The software is use for circuit designing
2. Express PCB: - This software is used for Printed Circuit Board (PCB) designing.
3. Keil uV-3:- The software is use for programming of Microcontroller.
4. Proteus: - This software is use for Simulation.

5. Implementation Process:-

Working Principle: - The ArduinoDuemilanove can be powered via the USB connection or with an external power supply [6] and the power source is selected automatically. External (non-USB) power can come from either an AC-to-DC adapter or battery. The adapter can be connected by plugging a 2.1mm centre-positive plug into the board's power jack. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. Therefore, the recommended range is 7 to 12 volts is used as an input or output. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k Ohms. In addition, some pins have specialized functions. There is a built-in LED connected to digital pin 13. When the pin is "HIGH" value, the LED is on, when the pin is "LOW", it is off. The Duemilanove has six analog inputs, each of which provides 10 bits of resolution.

6. Degree of Freedom:-

The degree of freedom, or DOF, is a very important term to understand. Each degree of freedom is a joint on the arm, a place where it can bend or rotate or translate. You can typically identify the number of degrees of freedom by the number of actuators on the robot arm. Now this is very important - when fabricating a robotic arm we want as few degrees of freedom allowed for our application. Because each degree requires a motor, often an encoder, and exponentially complicated algorithms and this result in increased cost.The robot workspace (sometimes known as reachable space) is the place where the end effector (gripper) can reach. The workspace is dependent on the DOF, angle/translation limitations, the arm link lengths, the angle at which something must be picked up at, etc.The workspace is highly dependent on the configuration of the robot.Since there is many possible configurations for robotic arm.Let us assume that all joints rotate a maximum of 180 degrees.

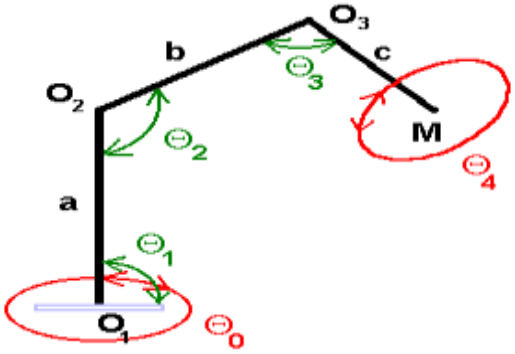

Figure 3. View of degree of freedom

To determine the workspace we have to trace all locations that the end effector can reach as in the image.

7. Conclusion: -

This paper has undergone various aspects to design a robotic arm based on the haptic technology considering various aspects of it, and the basics of machine designing are observed that are explained clearly. These robots have a wide range of industrial and medical applications such as pick and place robots, surgical robots etc. They can be employed in places where precision and accuracy are required. Robots can also be employed where human hand cannot penetrate. The screen shot shows the designed robot and its functionality.

8. Future Scope:-

We have done our best efforts to make the work feasible, simple and reliable for the local industrial usage. There can be modification in this robotic system that can be more efficient and effective like;

- The robotic system can be modified by implementing vision system and artificial intelligence to avoid obstacles in between the path.
- The vision system can also be implemented to check whether the biscuits are properly baked or not.
- The microcontroller programming can be replaced by PLC, as a new technology.

- Making magnetic gripper more powerful can increase the payload property of the robot.
- The gripper can be modified for different operations in different industries.

9. Applications:-

Industrial robots:- These robots bring into play in an industrialized manufacturing atmosphere. Typically these are articulated arms particularly created for applications like- material handling, painting, welding and others.

Domestic or household robots: - Robots which are used at home. This sort of robots consists of numerous different gears for example- robotic pool cleaners, robotic sweepers, robotic vacuum cleaners, robotic sewer cleaners and other robots that can perform different household tasks.

Medical robots: - Robots employed in medicine and medicinal institutes. Also, a number of robotic directed automobiles and perhaps lifting supporters.

Service robots:- Robots that cannot be classed into any other types by practice. These could be various data collecting robots, robots prepared to exhibit technologies, robots employed for research, etc.

Military robots – Robots brought into play in military & armed forces. This sort of robots consist of bomb discarding robots, various shipping robots, exploration drones. Often robots at the start produced for military and armed forces purposes can be employed in law enforcement, exploration and salvage and other associated fields.

Entertainment robots: - These types of robots are employed for entertainment. This is an extremely wide-ranging category. It begins with model robots such as robosapien or the running photo frames and concludes with real heavy weights like articulated robot arms employed as movement simulators.

Space robots: - I would like to distinct out robots employed in space as a split apart type. This type of robots would consist of the robots employed on Canadarm that was brought into play in space Shuttles, the International Space Station, together with Mars explorers and other robots employed in space exploration & other activities.

Hobby and competition robots: - Robots that is created by students. Sumo-bots, Line followers, robots prepared merely for learning, fun and robots prepared for contests.

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