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3 Axis Robotic Arm

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***Abstract*: In this project, we are developing a 3 Axis Robotic Arm. This work is carried out by ARM microcontroller, here ARM controller collect data from bluetooth module and gives the corresponding commands to the three different motors for their movements. The robot used in the project types with arm joint and can move in 3 axis directions and also can hold and swing motion thanks to the holder on it. The microcontroller is used to provide optimal control of the robot arm.**

***Keywords*: 3 axis, robotic arm, servomotor arm.**

1. Introduction

Some tasks of robot arms may relate to simple mechanisms of picking an object and placing it somewhere. An automated pick and place robot arm, which can reach an object in a given domain or range of space, grip it precisely, change its orientation and place it in a given position will ease the functions mentioned earlier. Thus it could be named as a Robot Arm with a Three Dimensional Reach. Robotic arms are mechanically controlled devices designed to replicate the movements of a human arm. These devices are used for lifting heavy objects and carrying out tasks that require extreme concentration and expert accuracy. The robotic arms are often used for industrial and nonindustrial purposes. Robotic arms by definition have multiple degrees of freedom that must be all directed in a kind of electromechanical ballet.

Unimate introduced its first robotic arm in 1962. The arm was invented by George Devol and marketed by Joseph Engelberger. The first industrial arm was installed at the General Motors plant in Ternstedt, New Jersey, for automated diecasting. Ultimately, approximately 8,500 units were sold. Industrial robots graduated from the laboratory to the factory. It is interesting that in this process the robotic arm's movements and the degrees-of-freedom incorporated nautical terms for robotics—pitch, yaw, and roll.

Engelberger developed the first robotics company, called Unimation (from Devol's Universal Automation robot), to sell their two-ton robotic arm, the Unimate. Unimation eventually sold 8,500 Unimates. Kawasaki bought the license to manufacture industrial robot arms from Unimation in 1966. Competition came quickly, the Cincinnati-based Milacron appeared, and by 1963 AMF Hermatool brought out their commercially available Versatran industrial robot which Japan imported in 1967. A whole host of academic centers became interested in the applications of microelectronics and the potential for these robotic arms. A Stanford Research Institute investigator, Victor Scheinman, began working on electrically powered articulated arms that could move through six axes, which he called the Stanford arm. More complex tasks could now be given to the robotic arms. Marvin Minsky, then from MIT, built a robotic arm for the once of Naval Research, for possible underwater exploration. Twelve single-degreeof-freedom joints were used to actuate this electro-hydraulic high-dexterity arm. Scheinman continued his work on robotic arms and, with backing from General Motors, Unimation developed Scheinman's technology into a Programmable Universal Machine for Assembly.

2. Related Work

In paper [1], This paper presents a model for gesture controlled user interface (GCUI), and identifies trends in technology, application and usability. We present an integrated approach is real time detections, gesture based data which control vehicle movement and manipulation on gesture of the user using hand movements. 3 axis accelerometer is adaption. As the person moves their hand, the accelerometer also moves accordingly. The gesture is capture by accelerometer and processed by gesture. Today human machine interactions is moving away from mouse and pen and is becoming pervasive and much mouse compatible with the physical world. With each passing day the gap between machines and human is being reduced with the introduction of new technology is easy the standard of living. Its having future scope of advanced robotic arms that are designed like the human hand itself can easily controlled using hand gesture only. It also having proposed utility in field of construction, medical science, hazardous waste disposal etc.

In paper [2], Sign Language is one of the widely used methods of communication within the hearing impaired people. Sign language is a mode of communication that provides a way of interaction to those hard of hearing, using a collection of gestures and symbols. Hand gesture recognition is a major step for sign language recognition which uses the gestures and symbols to interpret the thoughts of the person. Hand recognition by conventional methods using 2-D cameras suffer

from instability due to lighting and skin colour variations. The upcoming depth sensors overcome the limitations of the conventional cameras. A Leap Motion controller helps to obtain descriptive information of hand gestures. It tracks the hand and finger movements in digital format and gives few key points associated with each gesture. These key points are used for training and recognition.

In paper [3], In general, the problems of robots can be divided into two sub-problems of motion planning and motion control. A motion planning problem is solved where a geometrical model is given. Furthermore, motion planning problems can be fundamentally divided into path, trajectory and task planning problems. These planning have many constraints concerning kinematics and dynamics of the robot as well its environment. This paper introduces path, trajectory and task planning methods for wheeled mobile robots. Wheeled mobile robots are becoming increasingly important in industry as a means of transport, inspection, and operation because of their efficiency and flexibility. The motion of a wheeled mobile robot, in general, be subject to non-holonomic constraints due to the rolling constraints of the wheels, which render a motion perpendicular to the wheels impossible. These non-holonomic constraints give rise to highly nonlinear mathematical models of the mobile robots, and the control problem is not trivial although the full state is measured. Feedback control of non-holonomic mobile robots is, therefore, a challenging problem which combines nonlinear control theory and differential geometry. Path planning in mobile robots must ensure optimality of the path. The optimality achieved may be in path, time, energy consumed etc. Path planning in robots also depends on the environment in which it operates like, static or dynamic, known or unknown etc. Global path planning using A* algorithm and genetic algorithm is investigated in this paper. A known dynamic environment, in which a control station will compute the shortest path and communicate to the mobile robot and the mobile robot will traverse through this path to reach the goal.

The framework [4] In robotics, for accomplishing simple and complex tasks, manipulation is a very important aspect. Manipulation is achieved by different movement of the robotic arm. Here we are trying to design a Robotic Arm based on robotics arm concept to perform heavy task and lift weight using less power and efficient handling. In this abstract we are implementing some technique to automatically sense the object and perform relevant task on it. Some of the input technique used in this paper are object sensing based on colour and shape using sensors. Robotic arm movement is achieved using DC geared motors attached in different directions and angle. Each geared DC motor act as joint and helps in providing various movements to different directions. Microprocessor controls the movement of the robotic arm by sensing the position and location of the object in the 3d space with the help of IR sensor and colour sensor (object colour detection, identification and interpretation). Knowing the location of the object we can then easily orient the arm to pick the object. The robotic arm picks the object and place it elsewhere in the vicinity of the arm. Thus, enabling the robotic arm capable of picking and placing the objects in the sequence based on the input and object sensed. The robotic arm is independent and can be integrated with other modules. We are using geared DC motor rather than servo motor to increase the angular rotation of the arm. DC motors are easy to interface and maintain as compared to servo motors. This whole set up consume less power and provide efficient working by using various modes.

In paper [5] robots are programmed to perform specific tasks which humans cannot. To increase the use of robots where conditions are not certain such as firefighting or rescue operations, robots can be made which follow the instruction of human operator and perform the task. In this way decisions are taken according to the working conditions by the operator and the task is performed by the robots. Thus, we can use these robots to perform those tasks that may be harmful for humans. This paper describes about the gesture control robot which can be controlled by your normal hand gesture. It consists of mainly two parts, one is transmitter part and another is receiver part. The transmitter will transmit the signal according to the position of accelerometer and your hand gesture and the receiver will receive the signal and make the robot move in respective direction. Here, the program is designed by using Arduino IDE.

In paper [6] In today's world there is an increasing need to create artificial arms for different in human situations where human interaction is difficult or impossible. They may involve taking readings from an active volcano to diffusing a bomb. Here we propose to build a robotic arm controlled by natural human arm movements whose data is acquired through the use of accelerometers. For proper control mechanism and to reduce the amount of noise coming in from the sensors, proper averaging algorithm is used for smoothening the output of the accelerometer. The development of this arm is based on ATmega32 and ATmega640 platform along with a personal computer for signal processing, which will all be interfaced with each other using serial communication. Finally, this prototype of the arm may be expected to overcome the problem such as placing or picking hazardous objects or non-hazardous objects that are far away from the user.

[7] This Paper deals with robotic arm embed controller system, with distributed system based on protocol communication between one server supporting multiple points and mobile applications through sockets. The proposed system utilizes hand with glove gesture in three-dimensional recognition using fuzzy implementation to set x, y, z coordinates. This approach presents all implementation over: two raspberry PI arm based computer running client program, x64 PC running server program, and one robot arm controlled by ATmega328p based board.

[8] Pneumatic robots are essential for material handling in chemical industries where electric or hydraulic robots are unsuitable due to fire hazard. A 3 axes (3 Degrees of Freedom)

articulated pneumatic robotic arm was designed and assembled in this project along with its control system. Pneumatic rod less linear actuators were used as the main drive system for the robotic arm and were controlled by pneumatic 5/3-way proportional directional control valve. The design of the arm for this project implements crank mechanism to convert linear actuation displacement to angular displacement about the joint. Two control systems were designed for the robotic arm: Programmable Logic Controller (PLC) and Arduino UNO microcontroller. It employed open loop control with PLC at first and closed loop PID control using Arduino UNO in the latter part of the study. MPU-6050 sensor was used for feedback signals to the Arduino UNO. Point to point motion control method was adopted for this robot arm and simple pick and place applications were carried out using a pneumatic gripper as the end effector. Mainly, the compressibility of air and the overall nonlinearity of the pneumatic servo system made it very difficult to achieve accurate positioning and control with PLC. Closed loop PID control with microcontroller and accelerometer and gyroscope enabled better control with joint angle accuracy of ±1degrees. The force required by the pneumatic linear actuator to move the robot arm about its joint varied nonlinearly due to the design of the arm. Also, 5/3 directional control valve proved to be ineffective compared to 5/3 proportional valve in controlling the position of the actuators. The joint's angular displacement was found to be varying roughly linearly with the stroke of the linear actuator and the pressure required to move the arm without any load was found to be around 2.75 bars. In paper [9] This thesis focuses on design, implementation and control of a five degree of freedom (DoF) robotic arm using servo motors. The control of robotic arm is achieved by a PIC 16F877A microcontroller. The main duty of microcontroller is to generate pulse width modulation (PWM) signals which are applied to servo motors for achieving the desired rotation. Each servo has a different specification. Therefore, a PWM pulse could have a different effect on servos. Most of the time, it is crucial to apply the exact PWM pulses for achieving the desired rotation. The main advantage of controlling the servo motors with PWM signals is that they can be programmed to have an initial position and to rotate with an exact degree with respect to the requirements. In this study, six servo motors are employed to realize the robotic arm. Four servos are utilized to control the body motion including base, shoulder and elbow and two smaller servos are employed for the motion of end effector. In this thesis, a general formula is derived for finding the pulse duration (pulse width) so as to achieve the desired rotation in each servo motor. The main advantage of this formula is that it can be used for any servo motor with different specification. The operation of designed robotic arm has been experimentally verified. Simulation and experimental results are presented and discussed.

In paper [10], A robot is used for the purpose of picking the object and placing it into another place. The robot setup is controlled by the android mobile with the blue-control application. Tele-manipulation allows human to perform operations in a remote environment. This system provides human operators with the ability to see, touch, and feel objects from a remote location. Haptic shared control is a promising approach to improve tele-manipulated task execution, by making safe and effective control actions tangible through guidance forces. The tele-manipulator serves as a tool to transfer movements from a human operator on a local station (the master) to a remote station (the slave), through a controller. Haptic shared control gives the visual information about the position, external and environmental forces acting on the robot to the human operator. Robot setup is used to pick and place the objects. There are many applications based on haptic shared control definition. Here, Tele operation of arm robot is implemented. This is used for the purpose of assembly in wireless manner controlled by human guidance. A wireless connection between remote and arm robot for picking and placing of objects.

3. Methodology

First, a historical research on robot arms was carried out and the basic information required to establish the system was obtained. The robot used in the project types with arm joint and can move in 3 axis directions and also can hold and swing motion thanks to the holder on it. The microcontroller is used to provide optimal control of the robot arm. The reason for preferring this microcontroller is that it is more accessible to be able to get a solution to a possible error because the open source code is easier to use than the other microcontrollers and the number of users is higher. After these studies, detailed information has been obtained about the servo motors to be used. The servomotor is preferred because it can be carried out smoothly in the robot project, the motor can be operated precisely and it must be at high torque. The robot arm, 3 servo motors are formed. Servo motors are numbered from top to bottom in order to explain their tasks because of the excess.

A. Components

1) Bluetooth HC05

This module enables you to wireless transmit and receive serial data. It is a drop in replacement for wired serial connections allowing transparent two-way data communication. You can simply use it for serial port replacement to establish connection between MCU or embedded project and PC for data transfer.

Fig. 1. Bluetooth

2) Servomotor

The servo motor is most commonly used for high technology devices in the industrial application like automation technology. It is a self-contained electrical device that rotates parts of a machine with high efficiency and great precision. The output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars, airplanes etc. indefinitely.

Fig. 2. Servomotor

4. Proposed system

The 3 axis robotic arm acts like replica of human arm. Its directions are controlled by Bluetooth module in which three different servo motors are implemented for three different actions. First motor is used for hold and release purpose. Second motor is used for the elevation of arm and the last motor is used for right and left motion. It adapts serial communication between arm and the controller.

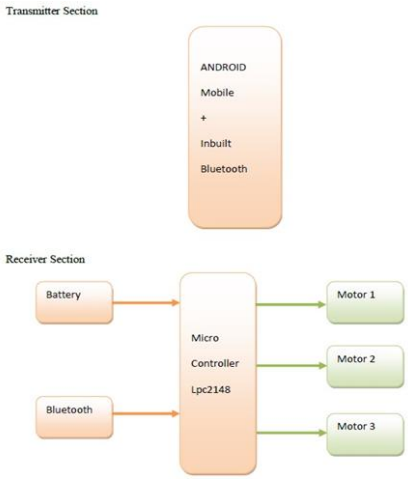

Fig. 3. Block Diagram

5. Results and Discussion

1. The force applied on to the object at the point of contact would depend on the torque of the motor.
2. It can perform the lifting task properly.
3. 90 degree is the default position of servo motors. Automatic orientation of the arm at 90 degree when not in use.

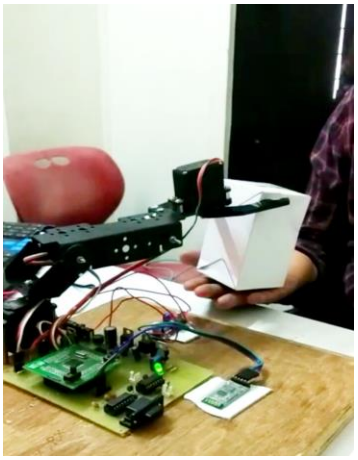

Fig. 4. Actual system Image

6. Conclusion and Future Scope

In this, the procedure of building an articulated arm robot using a microcontroller and servo motors with the help of PWM has been discussed. The building procedure consists of building the kinematic structure of robotic arm, hardware design and implementation, software design and implementation and microcontroller programming. The motion of the robot is controlled via PWM signals which are generated with the microcontroller and discussed the effect of these pulses on the servo motors. Also, a general formula which facilitates the design and motion control of the robots has been proposed. It is important to recall that each servo motor has a different pulse width range where a pulse can have different effects on each servo.

In future scope, this robotic arm can be mounted on the small vehicle using L293D integrated in the circuit of robotic arm. L293D is driver IC used to drive DC motor and Stepper motor. These motors are operated as wheels of the vehicle.

Additional functionalities can be added on the vehicle mounted robotic arm such as camera for precise movement of the vehicle and arm mounted on it.

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