ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Gesture Based Object Handling By Robotic Arm Using MEMS Accelerometer Sensor

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Abstract- ***Due to rapid growth of Gesture recognition techniques for friendly hardware designing, introduced an integrated approach to real time detection, tracking and direction recognition of hands, which is intended to be used as a human-robot interaction interface for the intelligent handling of robotic arms for pick and place objects. Gesture recognition is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Current focuses in the field include emotion recognition from face and hand gesture recognition. This paper demonstrates that accelerometers can be used to effectively translate finger and hand gestures into computer interpreted signals. For gesture recognition the accelerometer data is calibrated and filtered. The tri-axial accelerometers can measure the magnitude and direction of gravity in addition to movement induced acceleration. In order to calibrate the accelerometers, we rotate the device's sensitive axis with respect to gravity and use the resultant signal as an absolute measurement for robotic arm and robot directions control.***

Key words: ***MMA 7260Q MEMS sensor, DC motors, PIC Microcontroller***

I. INTRODUCTION:

Highly interaction in human machine in daily lives has made user interaction progressively very important. Expansion of sensor based advanced technology sophisticated human force and stress in electronic circuits has been greatly reduced the weight and area of consumer electronics products . Automation is the most frequently spelled term in the field of electronics and electrical. The hunger for automation brought many revolutions in the existing technologies. These had greater importance than any other technologies due its user-friendly nature.

During the movement controls of any mechanical equipment like robots, robotic arms, the work of miniature accelerometer based recognition system which acknowledges hand gestures or motions will be recognized. MEMS accelerometer measures the acceleration of the signal in three co-ordinates such as x-axis, y-axis, and z-axis. To capture the hand motions online, the general MEMS sensor which can be operated without any external reference and limitation in working conditions is used.

A robotic arm is a robot manipulator, which can perform similar functions to a human arm. Robotic arms are the vital part of almost all the industries. In industries, a robotic arm performs various different tasks such as welding, trimming, picking and placing etc. Moreover the biggest advantage of these arms is that it can work in hazardous areas and also in the areas which cannot be accessed by human. For example in NASA's mission to Mars, the Spirit and Opportunity drone.

It is also used to implement highly precise medical treatments etc. Many variants of these robots/robotic are available or designed as per the requirement and few variants are Keypad Controlled, Voice Control, Gesture

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Control, etc. However, most of the industrial robots are still programmed using the typical teaching process which is still a tedious and time-consuming task that requires technical expertise. Therefore, there is a need for new and easier ways for programming the robots.

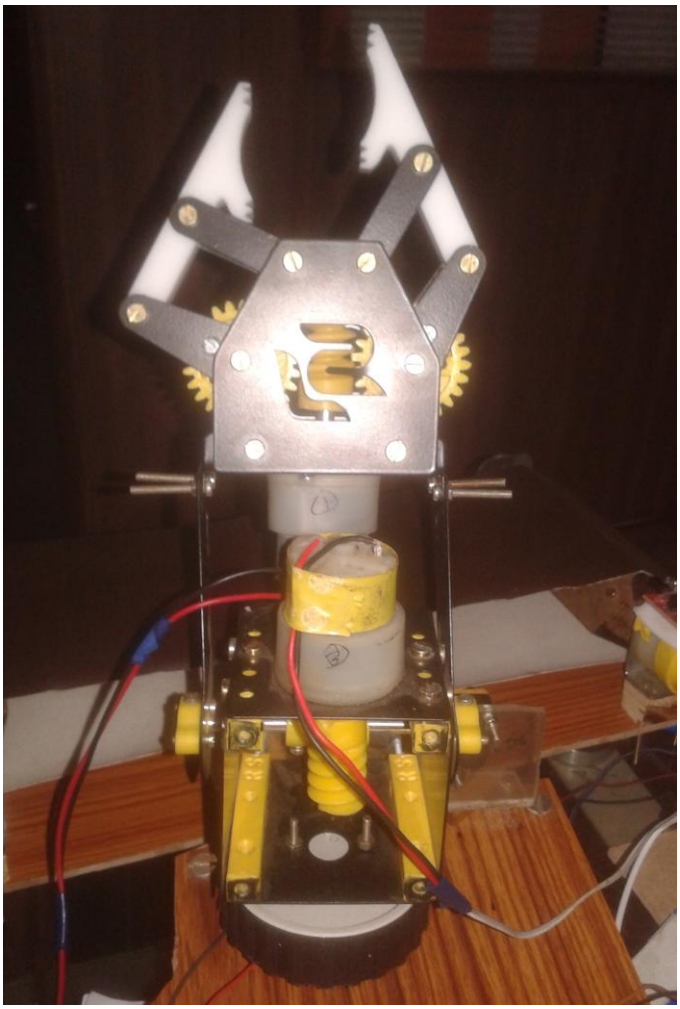

Fig-1 Image of Object handling robot model

II. RELATED WORK:

Accelerometers can be used to effectively translate finger and hand gestures into computer interpreted signals. Integrating a single chip wireless solution with a MEMS accelerometer would yield an autonomous device small enough to apply to the fingernails because of their small size and weight. Accelerometers are attached to the fingertips and back of the hand. Arrows on the hand show the location of accelerometers and their sensitive directions.

The sensitive direction of the accelerometer is in the plane of the hand. Micro-electromechanical systems (MEMS) are free scale's enabling technology for acceleration and pressure sensors. MEMS based sensor products provide an interface that can sense, process or control the surrounding environment. MEMS-based sensors are a class of devices that builds very small electrical and mechanical components on a single chip. MEMS-based sensors are a crucial component in automotive electronics, medical equipment, hard disk drives, computer peripherals, wireless devices and smart portable electronics such as cell phones and PDAs.

MEMS technology provides the following advantages: cost-efficiency, low power, miniaturization, high performance, and integration. Functionality can be integrated on the same silicon or in the same package, which reduces the component count. This contributes to overall cost savings.

In this proposed model, the gesture based system (using Accelerometer) has been incorporated to control the robotic arm as well as its platform using small and low-cost, 3-axis accelerometers. The prime aim of the design is that the robot and platform starts the movement as soon as the operator makes a gesture or posture or any motion. The Robotic arm is synchronized with the gestures (hand postures) of the operator and the platform part is synchronized with the gestures (leg postures) of the operator. The goal of this paper is to develop methodologies that help users to control and program a robot, with a high-level of abstraction from the robot specific language i.e. to simplify the robot programming.

Today, there are a number of robotic arms used in robotics research, many with unique features and design criteria. In this section, brief of some recent widely-used and/or Influential robotic arms is given. In the robotics field, several research efforts have been directed towards recognizing human gestures.

Few popular systems are:

A. Vision-based Gesture Recognition This Recognition system basically worked in the field of Service Robotics

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and the researchers finally designed a Robot performing the cleaning task. They designed a gesture-based interface to control a mobile robot equipped with a manipulator. The interface uses a camera to track a person and recognize gestures involving arm motion. A fast, adaptive tracking algorithm enables the robot to track and follow a person reliably through office environments with changing lighting conditions. Two gesture recognition methods i.e. a template based approach and a neural based approach were compared and combined with the Viterbi algorithm for the recognition of gestures defined through arm motion. It results in an interactive clean-up task, where the user guides the robot to go to the specific locations that need to be cleaned and also instructs the robot to pick up trash.

B. Motion Capture Sensor Recognition This recognition technique made it possible to implement an accelerometer based system to communicate with an industrial robotic arm wirelessly. In this particular project the robotic arm is powered with ARM7 based LPC1768 core. MEMS is a three dimensional accelerometer sensor which captures gestures of human-arm and produces three different analog output voltages in three dimensional axes. And two flex sensors are used to control the gripper movement.

C. Finger Gesture Recognition System based on Active Tracking Mechanisms The prime aim of the system (based on the above mentioned recognition methodology) proposed by the author is to make it feasible to interact with a portable device or a computer through the recognition of finger gestures. Apart from the gestures, speech can also be other mode of interaction because of which this system can form part of a so-called Perceptual User Interface (PUI).

The system could be used for Virtual Reality or Augmented Reality systems. 2.4 Accelerometer-based Gesture Recognition This Gesture Recognition methodology has become increasingly popular in a very short span of time. The low moderate cost and relative small size of the accelerometers are the two factors that makes it an effective tool to detect and recognize human body gestures. Several studies have been conducted on the recognition of gestures from acceleration data using Artificial Neural Networks (ANNs).

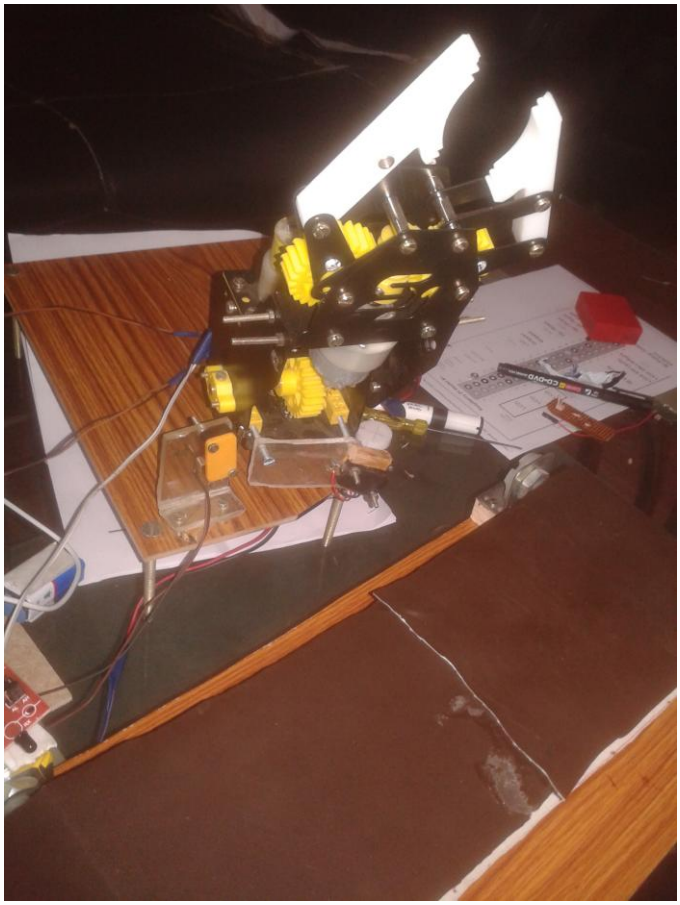

Fig-2 Gesture recognition for robotic arm

III. PROPOSED METHODOLOGY:

In the Proposed system we used (i) Tri-axial MEMS accelerometer sensor: The device consists of an accelerometer and feds this information as input to microcontroller about the tilt of the accelerometer sensor. This information is in the form of analog and the information of the tilt is in the form of x, y,z. the x, y, z axis information is indicate the position of the sensor. The data from the accelerometer is given to the ADC controller.

The ADC controller can convert the analog information to the digital information for the micro controller understands. The micro controller can take the

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information from the ADC controller and spit the data in three forms. The three forms are mentioning the identical position in third directionally of the pointer. The micro controller can sends the position of the pointer with the basic information from the accelerometer. The reset logic is used to protect the internal program of the micro controller when the power spikes are present in the line current. And the oscillator is used to generate the clock for the micro controller to run the internal programs and clock of the micro controller three forms are mentioning the identical position in third directionally of the pointer. The micro controller can sends the position of the pointer with the basic information from the accelerometer.

Fig-3 MEMS accelerometer sensor

The reset logic is used to protect the internal program of the micro controller when the power spikes are present in the line current. And the oscillator is used to generate the clock for the micro controller to run the internal programs and clock of the micro controller.

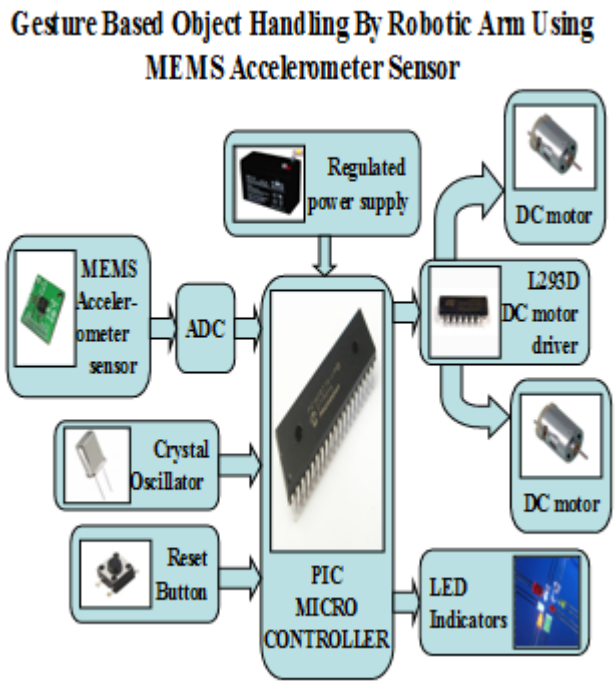

Figure-4. Block diagram of Proposed Model

The presented application is a low cost solution for Bluetooth android based automation system. The project aims in designing a system which makes operating of electrical appliances in home through Android mobile phone possible. The controlling of electrical appliances is done wirelessly through Android smart phone using the Bluetooth feature present in it. Here in this project the Android smart phone is used as a remote control for operating the electrical appliances. The present system uses an onboard mini computer named as PIC microcontroller which consists of number of input and output ports. The input and output port of the micro controller are interfaced with different input and output modules depending on the requirements. The proposed solution can be used in other types of home or industrial automation based applications.

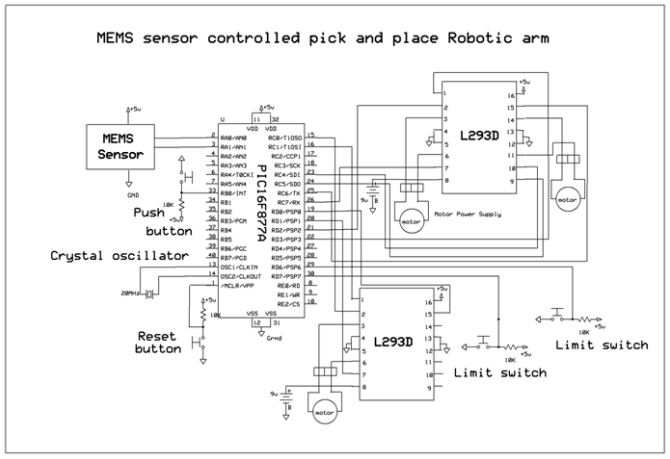

Figure- 5.Schematic diagram of interfacing section of all components to the PIC microcontroller

IV. HARDWARE DESIGN OF PORTABLE DEVICE

In today's world, in almost all sectors, most of the work is done by robots or robotic arm having different number of degree of freedoms (DOF's) as per the requirement. This paper deals with the Design and Implementation of a "Gesture based object handling by Robotic Arm using MEMS accelerometer sensor". The system design is divided into 3 parts namely: Accelerometer Part, Robotic Arm and PIC Microcontroller. It is basically an

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Accelerometer based system which controls a Robotic Arm using a, small and low-cost, 3-axis (DOF's) accelerometer. An MEMS accelerometer sensoris mounted / attached on the human hand, capturing its behavior (gestures and postures) and thus the robotic arm moves accordingly. The different motions performed by robotic arm are: PICK and PLACE / DROP, RAISING and LOWERING the objects.

The portable Electronic automation and Robotic arm control models consists of PIC microcontroller, MEMS accelerometer sensor module, DC motors interfaced with Robot model along with driver, and Battery. The microcontroller (PIC16F877A) collects the data of MEMS sensor and sends as input to the microcontroller. This enables the controlling and the directions of robotic arm movements. The controller acts accordingly on the DC motors interfaced along with drivers to switch according to the users input from gestures recognition. In achieving the task the controller is loaded with a program written using Embedded 'C' language.

Robotic Arm is the vital part of the system as it is this part which does the Pick and Drop task of the object along with handling it. The robotic arm is equipped with a Gripper (for picking and placing the objects) and an Arm (for raising and lowering the objects). Both the Arm and Gripper are equipped with DC Motor to control the movement. These movements are synchronized with the hand gestures of the user, operating the Robotic Arm. The accelerometer mounted on hand, which captures the hand gestures, and acts accordingly on the DC motors equipped with Robotic arm.

GESTURE 1: To Lower the Arm
GESTURE 2: To Raise the Arm
GESTURE 3: To close the Gripper Mouth so that it can pick the object
GESTURE 4: To open the Gripper Mouth so that it can place / drop the object

Robotic arms are becoming increasingly popular in several fields such as industrial automation, medical applications such as remote key-hole surgeries and military applications because of its preciseness and accuracy. In certain critical applications such as performing surgeries or diffusing a bomb, robotic arms could be of tremendous use to save lives. In such applications, controlling the robotic arm precisely is of utmost importance. Currently, such robotic arms are typically controlled using a joystick that is wired to the robotic arm.

We have designed a robotic arm with 2 degrees of freedom that is wirelessly synchronized to a human arm and can emulate the movements of a human arm. We have used an inertial measurement unit connected to a MEMS accelerometer sensor for gesture recognition, to measure the exact position of a human arm. This information (in the form of Euler angles row, pitch and yaw) is then transmitted to the controlling section of the robotic arm. To demonstrate pick-and-place functionality, we fixed a gripper at the end of the frame.

V CONCLUSION:

The Proposed paper presented a design and implementation of "Gesture Based Object Handling by Robotic Arm Using MEMS Accelerometer Sensor" has been successfully designed and implemented. Integrating features of all the hardware components been used and developed in it. The Presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for a tracking of vehicle security system has been designed perfectly. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. The microcontroller which acts as the mediator between the input module and output module has been successfully programmed using PIC C compiler software using Embedded C language. This proposed model finds its major applications while we are monitoring larger areas like political canvassing, cricket stadiums, international conferences, worship places, banking etc. This project assures us with more reliable and highly secured system.

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