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Survey on Implementation of Gesture Control Robotic Arm for Automation of Industrial Application

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ABSTRACT

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 project deals with the Design and Implementation of a "Wireless Gesture Controlled Robotic Arm with Vision". The system design is divided into 3 parts namely: Accelerometer Part, Robotic Arm and Platform. It is fundamentally an Accelerometer based framework which controls a Robotic Arm remotely utilizing a, little and minimal effort, 3-pivot (DOF's) accelerometer by means of RF signals. The Robotic Arm is mounted over a versatile stage which is likewise controlled remotely by another accelerometer. One accelerometer is mounted/joined on the human hand, catching its conduct (motions and stances) and hence the mechanical arm moves in like manner and the other accelerometer is mounted on any of the leg of the client/administrator, catching its motions and stances and in this way the stage moves as needs be. In a nutshell, the robotic arm and platform is synchronised with the gestures and postures of the hand and leg of the user / operator, respectively. The different motions performed by robotic arm are: PICK and PLACE / DROP, RAISING and LOWERING the objects. Also, the motions performed by the platform are: FORWARD, BACKWARD, RIGHT and LEFT. The system is equipped with an IP based camera also which can stream real time video wirelessly to any Internet enabled device such as Mobile Phone, Laptop, etc.

Keywords- DOF, Robotic Arm.

I. INTRODUCTION

An automated arm is a robot controller, which can perform comparative capacities to a human arm. Automated arms are the crucial piece of practically all the enterprises. In businesses, an automated arm perform different various undertakings, for example, welding, cutting, picking and putting and so forth. Besides the greatest favorable position of these arms is that it can work in unsafe regions and furthermore in the territories which can't be gotten to by human. For instance in NASA's strategic Mars, the Spirit and Opportunity ramble. It is additionally used to execute exceptionally exact clinical medications and so on. Numerous variations of these robots/mechanical are accessible or planned according to the prerequisite. Scarcely any variations are Keypad Controlled, Voice Control, Gesture Control, and so on. Notwithstanding, a large portion of the mechanical robots are still modified utilizing the run of the mill showing process which is as yet a monotonous and tedious undertaking that requires specialized mastery. Subsequently, there is a requirement for new and simpler ways for programming the robots. In this venture, the signal

based framework (utilizing Accelerometer) has been joined to control the mechanical arm just as its foundation utilizing two, little and minimal effort, 3-pivot accelerometers. The prime point of the plan is that the robot and stage begins the development when the administrator makes a motion or act or any movement. The Robotic arm is synchronized with the motions (hand stances) of the administrator and the stage part is synchronized with the motions (leg stances) of the administrator. The objective of this venture is to create systems that help clients to control and program a robot, with a significant level of deliberation from the robot explicit language for example to disentangle the robot programming. These days, mechanical technology arm getting one of the most progressive in the field of innovation. A Robot is an electro-mechanical framework that is worked by a PC program. Robots can be self-ruling or semi-self-ruling. A self-governing robot isn't constrained by human and follows up on its own choice by detecting its condition. Greater part of the mechanical robots are independent as they are required to work at fast and with extraordinary precision. In any case, a few applications require semi-self-ruling or human controlled robots. The absolute most usually utilized control frameworks are voice acknowledgment, material or contact controlled and movement controlled. A Gesture Controlled robot is a kind of robot which can be controlled by your hand gestures not by old buttons. You just need to wear a small transmitting device in your hand which included an acceleration meter. This will transmit an appropriate command to the robot so that it can do whatever we want. The transmitting device included a ADC for analog to digital conversion and an encoder IC(HT12E) which is use to encode the four bit data and then it will transmit by an RF Transmitter module. At the receiving end an RF Receiver module receive's the encoded data and decode it by and decoder IC (HT12D).

This data is then processed by a microcontroller and finally our motor driver to control the motor's. Now its time to break the task in different module's to make the task easy and simple any project become easy or error free if it is done in different modules. As our project is already divided into two different part transmitter and receiver. The applications of robotics mainly involve in automobiles, medical, construction, defense and also used as a fire fighting robot to help the people from the fire accident. But, controlling the robot with a remote or a switch is quite complicated. So, a new project is developed that is, an accelerometer based gesture control robot. The main goal of this project is to control the movement of the robot with hand gesture using accelerometer. The robot is usually an electro-mechanical machine that can perform tasks automatically. Some robots require some degree of guidance, which may be done using a remote control or with a computer interface. Robots can be autonomous, semi-autonomous or remotely controlled. Robots have evolved so much and are capable of mimicking humans that they seem to have a mind of their own.

II. LITERATURE REVIEW

In [4], a multimodal interface is combining head motion, speech recognition and tongue motion to control a computer. The combination of sEMG, eye-tacking and EEG is proposed in to manipulate a prosthesis with high dexterirty. Such approaches are deemed to provide many more degrees of freedom (DoF) then unimodal control systems, opening up the possibility of harnessing more potential control strategies better suited to each individual user.

Hand gesture recognition using image processing algorithms many times involve use of colour gloves. By tracking this colour glove different hand gestures can be interpreted as described by Luigi Lamberti1 and Francesco Camastra in their paper [7]. Here they have modelled a colour classifier performed by learning vector Quantization. In Paper [4] pattern recognizing algorithm has been used to study the features of hand.

There are many Papers where training of hands using a large database of near about 5000-10000 positive and negative images are considered. But this procedure is very tiring and time taking.

Usability is the main gauge of a control system's successfulness. In addition to low-power, convenience and flexibility concerns that has prevailed in the hardware architecture design phase, ease of use, intuitiveness and efficiency are among the key elements that were considered when designing the architecture and processing units of this BoMI. For safety issues, latency is very important as well, and should not exceed 300-ms for real time operation as recommended in [3]. The next subsections describe the software elements of the proposed controller, from the sensor firmware to the data fusion and control algorithms

There has been many research works in the field of Hand Gesture based Human Computer Interaction following different algorithms to develop a fast and reliable procedure for gesture recognition. In Paper [1] a three axis accelerometer has been used to read different types of Hand gestures. A combination of accelerometer and gyroscope and the reading are taken in to for analyzing the gesture. Here accelerometer is dedicated for collecting translational dynamic and static change in positional vector of hand and infer it to the movement of mouse whereas gyroscope has been used for rotation of virtual object. There are many papers where gestures are being analyzed using colour gloves [3]. A data glove is a type of glove that contains fiber optics sensor or flex sensors embedded in it to recognize the finger movements.

For Hand gesture recognition, some researchers have tried to perform the early segmentation process using skin colour histogram [6] used overlapping sub-windows which is useful to extract invariants for gesture recognition, and distinguish them with a local orientation histogram attribute description indicating the distance from the canonical orientation. This makes the process relatively robust to noise, however, much more time consuming indeed. Defined seven different stages of hand gesture recognition. It includes position of the figure-tip. This is not practically realistic when we have only pointing gestures, but also several gestures, like grasping[2].

III. METHODOLOGY

1. Software Architecture

Usability is the main gauge of a control system's successfulness. In addition to low-power, convenience and flexibility concerns that has prevailed in the hardware architecture design phase, ease of use, intuitiveness and efficiency are among the key elements that were considered when designing the architecture and processing units of this BoMI.

1.1 Sensor Nodes Firmware Architecture: Sensor nodes must minimize power consumption while guaranteeing adequate motion sampling rate for supporting robust and precise control schemes.

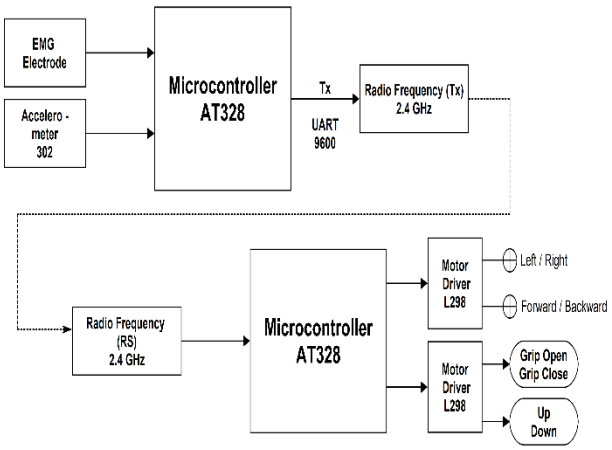

Fig 1. Block diagram of Proposed System

1.2 Wireless Sensor Network & Power Management: As mentioned in Section III-A, the nRF24L01+ is used for the wireless data link of the proposed controller. A star topology is used and the base-station receives the stream of measurement data sent by all the network's peripheral nodes (sensors + *Safety-key*).

1.3 Data Processing: All the data processing is done on the host platform. Voluntary muscle contractions are read from raw muscle activity signals when sEMG features are used whereas motion is sensed from IMU data.

2. Robotic Arm

This is the vital part of the system as it is this part which does the Pick and Drop task of the project. Both the Arm and Gripper are equipped with Servo Motor to control the movement. These movements are synchronised with the hand gestures of the user, operating the Robotic Arm.

3. Communication System

This part is the heart of the entire project. Without an effective and reliable communication system, no system / project can work. Similar is the case with this project also. Different parts of Robotic Arm Arm and Gripper in action.

4. System setup

The technical requirements chosen as a basis for the efficient functioning of the system are as follows:

- **Microcontroller**

ATmega 328 microcontroller is used as the hardware platform. It is the controlling unit, to which all other components (Accelerometers, Motors, RF modules etc.) are interfaced. Two such microcontrollers are used in this project, one at the Transmitting end and one at the Receiving end.

- **RF Module**

RF stands for Radio Frequency. This module consists of further two parts: Transmitter (Tx) and Receiver (Rx). It is available in different operating frequencies with different operating range. An Encoder Circuit and a Decoder Circuit is used along with the Transmitter and Receiver respectively in order to transmit and receive the message/signal [9]. The native communication task between the Robotic Arm, Platform and the different hand and leg gestures of the user is done by this module via RF signals. One such RF Module is required in this project. The RF Module used in this project works on the frequency of 315MHz with an operating range of 400-500 metres.

- **Accelerometer**

An accelerometer measures gravitational force or acceleration. By tilting an accelerometer along its measured axis, one can read the gravitational force relative to the amount of tilt. Most accelerometers available today are small surface mount components, so you can easily interface them to a microcontroller. There are three axes that can be measured by an accelerometer and they are labelled as X, Y and Z. Each measured axis represents a separate Degree of Freedom (DOF) from the sensor—thus a triple axis accelerometer might be labelled as 3 DOF. In this project, only 2 axes namely X and Y are used. The accelerometer used in this project is ADXL3xx [11].

- **Camera**

The system uses a smartphone with camera for continuous real time video streaming of the system and its surroundings. An IP-based Android application [13], running on the smartphone enables the system to transmit the real time video wirelessly.

IV. CONCLUSION

The project presents a Gesture Control Robotic Arm Using Flex Sensor with seven degrees of freedom. The robotic arm was made of low cost materials that were readily available. The model of the robotic arm was constructed and the functionality was tested. The robotic arm can be controlled over the internet by using Ethernet connectivity and a camera for visual feedback. Gesture based interfaces allow human computer interaction to be in a natural as well as intuitive manner. This project discussed hardware and software co-design of robotic arm controller using DC

motors employing microcontroller ATMEGA16. The mechanical hand has been intended to meet the entirety of the first particulars of the task. The fingers are taking into consideration full movement of the hand. Perceptions show that the venture creates the necessary movement of the fingers. Such sort of hand motion controlled automated arm is generally helpful for Industrial, Medical and Military applications. This kind of the hand motion innovation can be utilized where the people can't support in the troublesome or brutal situations. This may diminish a portion of the work that is utilized in industry and furthermore the existence hazard factor.

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