International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-4, April 2013

Wireless Control of a Robotic Arm Using Inertial Sensor

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Abstract-The development of wireless sensing control unit operation is base on wearable inertial sensors. Inertial sensors are of tri axial accelerometer and MEMS. It extends to the control of an anthropomorphic robotic arm. Accelerometers used to measure the orientation and angular velocity of the lower arm. The data processing has been carried out on low cost micro controllers. The movement of the user arm was mimicked by the anthropomorphic robotic arm. The orientation of the control unit is tracked and displayed using MATLAB. Applications include industrial operation, remote operation in hazardous area, medicine and undersea recovery.

Keywords- accelerometer, inertial sensors, MEMS, motion sensing, robotic arm.

I. INTRODUCTION

Robot is an integral part in automating the flexible manufacturing system that one greatly in demand these days. Robots are now more than a machine, as robots have become the solution of the future as cost labour wages and customers' demand. Even though the cost of acquiring robotic system is quite expensive but as today's rapid development and a very high demand in quality with IS0 (International Standard Organization) standards, human are no longer capable of such demands. Research and development of Suture robots is movingly at a very rapid once due to the constantly improving and upgrading of the quality standards of products. Robot and automation is employed in order to replace human to perform those tasks that are routine, dangerous, dull and in a hazardous area. In a world of advanced technology today, automation greatly increases production capability, improve product quality and lower ~production cost. It takes just a few people to program or monitor the corn outer and came out routine maintenance.

II. RELATED WORK

A. Project background

The robot arm is controlled by a DC controller circuit board. The controller circuit board is based on Atmel 89S52 flash programmable microcontroller, and it receives servo position commands from any device using a 2400-baud serial connection. This means that the arm can be used with any of the popular microcontroller systems available on the market or with a PC. The serial servo controller board will be connected to the serial port on a PC running the Microsoft Windows operating system.

Manuscript published on 30 April 2013.
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The robot arm control software that runs on the PC will be written in Visual Basic 6.0. The Atmel 89S52 can also be programmed to run robot arm sequences independently.

B. Overview of system sensors

A wearable sensor system based only on tri axial accelerometers was developed to obtain pitch, yaw and roll angles of human limbs the cost and size of accelerometers have been reduced with advances in Micro Electro Mechanical System (MEMS) technology. Wide applications have been found in inertial navigation system, hard disk drive, hard positioning control system, virtual –reality system, automobile control system and smart phones accelerometers and also used in sophisticated remote controls in gaming system like Wi-Fi remote.(1) To drive down cost, accelerometer designed and fabricated using low cost PCB processes and materials are explored and compared with the ADXZ 330 by analog devices, which is used to sense the player's hand position in three dimensions and is a MEMS silicon accelerometer. When accelerometers are used in toys, remote controls for video game, or applications in human limbs, the requirements of motion sensing are varied for different parts of human limbs.(2)
An accelerometer measures acceleration, either due to motion or due to gravity and it measures acceleration using an inertial frame of reference. This can also be used to measure its orientation. The orientation can be calculated from the three axis roll, pitch and yaw.

III. LITERATURE SURVEY

A. Overview of Zigbee protocol

ZigBee technology has recently become one of important and significant options for Wireless Sensor Network (WSN), since it possesses many advantages such as low power consumption, low data rate, low cost and short-time delay characteristics. Therefore, ZigBee network applications are rapidly spread out to the many areas: the home automation, industrial control, and commercial fields, for example. Presently, a great deal of literature is focused on studying the network development and management. However, the dynamic structure of ZigBee network is changeable and configurable and lead to the ZigBee network management to be difficult and complex. Furthermore, the system reliability and efficiency of ZigBee network will play the key role and technology to achieve the requirement and stability of system performance.
ZigBee is low power consumption, low cost and moderate range. This range is suitable for our application where we want to wirelessly transmit data from human controller to the Database Server, Another most important reason for using ZigBee module is that these modules come with serial interface therefore it will be easier for us to use these modules.

IV. SYSTEM DESIGN

A. Hardware design

A three axis accelerometer is used in the control unit. Another analog device accelerometer is strapped to the user arm. Zigbee transceivers are used for wireless transmission and reception of data.(8) The data processing is carried using low cost microcontroller rather than digital signal processing. Atmel AT89S52 microcontroller was used for data processing one in control unit and one at the receiving end to control the robotic arm.

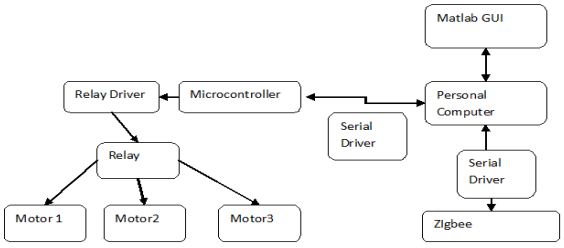

Fig1-Blockdiagram

B. Control unit

The work has been chosen with the lower arm joints – from the elbow to the hand. The prototype for a control unit is built with the PCB board, microcontroller, accelerometer and zigbee module. The accelerometer can be strapped to the user arm. The user arm can be moved and the data are measured by the microcontroller from the sensor and send these values to the zigbee transceiver. The sent values are in a packet with a header bit and a checksum bit(7). All the measured readings were transmitted from the microcontroller to the zigbee transceiver.

C. Electronic Circuit Design and Software Programming

The electronic part is used to control the movement of the arm component. For this purpose, Atmel 89S52 the microcontroller is used.(3) The Atmel 89S52 needs to have its own electronic circuit and needs to be programmed to enable it to control the arm movement and interface with the software to control the arm. Problem occurs in order to program the Visual Basic in PC to interface or communicate with the circuit through Atmel.

D. Robot Software and Interfacing with the Robot Arm

The next main objective is to design robot interface application using Microsoft's Visual Basic 6.0 to control the servo controller circuit board to run the robot arm.(4) The Visual Basic program sent servo position to the Atmel89S52 on the controller circuit.

V. TEST SCENARIO- RESULTS

The control unit output were measured and processed in real time using matlab by connecting a zigbee transceiver to the serial port of a computer.

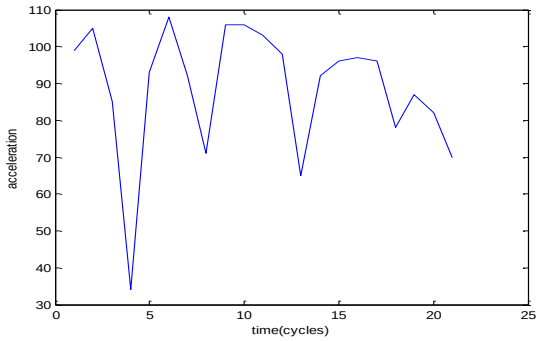

Fig 2 shows the plot of x axis accelerometer readings using matlab GUI.

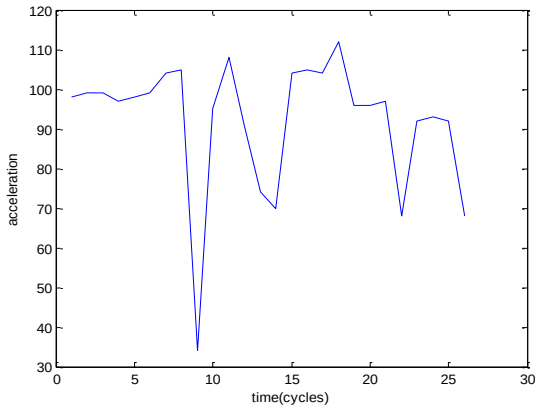

Fig 3 shows the plot of y axis accelerometer readings using matlab GUI.

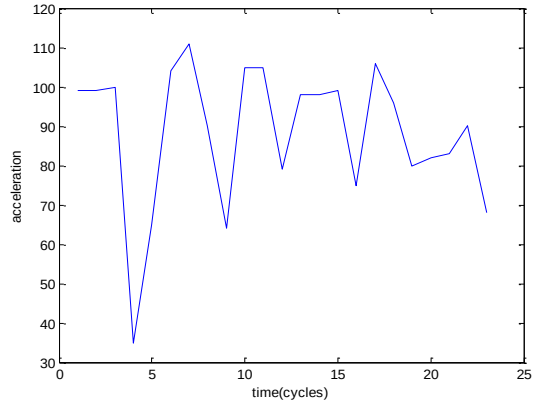

Fig 4 shows the plot of z axis accelerometer readings using matlab GUI.

VI. CONCLUSION

This paper presented a biomechatronic approach to the design of an anthropomorphic artificial hand, trying to address the requirements coming from two specific application fields, i.e., prosthetics and humanoid robotics. The work specifically addressed the optimization of an existing artificial hand prototype by identifying the detailed refinements needed on the design of one finger in order to obtain an improved biomorphic behavior with respect to the natural hand. Motivations and basic features of the initial mechanical design were reported in this paper.

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