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Hand Gesture Controlled Robotic Arm for Industrial Application

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Abstract: ***The recent days have seen robotics reach such a level that robots are being used in day to day tasks. Hence, real time controlling and automation is important to increase the human robot interaction levels. They are also shown to have a positive effect on human psychology. This paper revolves around the different steps included in building a robotic arm and the ways to control the robotic arm through gesture recognition. The robotic arm can be built by using various 3D printing technologies like PLD, FDL etc. This is done due to the presence of different gear mechanisms present in the design. The movements are achieved by using metal geared servo motors with high torque output. The robotic arm is simulated as a CAD model before it's construction. The hardware subdivision includes the design and synthesis of a robotic arm whereas the software subdivision includes the control of the robotic arm through hand gesture recognition and also the different ways in which communication can be established. The result was a 4 DOF robotic arm which was controlled by hand gestures gained by different sensors and sent via wirelessly through communication established by a long-range module.***

1. Introduction

Robotics is ruling almost all domains like health, military, home automation, etc. Introduction of robots influenced-industrial fields drastically. The continuous development of robotics attracted most of the engineers. One such purpose of introducing a robot is to perform a given set of repetitive tasks, which cannot be done by humans because of physical and mental limitations nowadays gesture-based controlling the process is starting to grow in everyday products like TV, cell phones, etc. However, these types of applications use image processing. In the image processing technique, a camera is used to capture the gesture images. This captured image is compared with a static image to find the position of gesture. Different algorithms are used to implement this concept, such algorithms are HMM (Hidden Markov Model), SAD (Sum of Absolute Difference) and ANN (Artificial Neural Network). The major drawback in implementing this technique is the complexity of algorithms and the size and cost of the system. More importantly, a PC is required to operate. In the glove technique, sensors are placed on gloves or in different parts of the arm to detect the gesture with the help of different sensors. Each sensor is interfaced in the ADC module before sending the digital signal to a microcontroller. Based on the output level of sensors, the controller can detect the position of gestures. In this technique, the complexity of the algorithm is less when compared to the image processing technique.

2. Methodology Adopted

The hand gesture controlled robotic arm system connected to STM-32 microcontroller with all the sensor and transceiver to establish the connection and control the arm with flex sensor and accelerometer though LoRa transceiver. The first goal is to convert the hand and finger movements to readable electrical signals. This is done by the aid of flex sensor, gyroscope and accelerometer. The flex sensor detects bending of a finger and the gyroscope detects the angular motion of the hand. The accelerometer detects any accelerations caused to the sensor. Both the gyroscope and the accelerometer would be within the mpu-6050 sensor. These values would be obtained by the STM-32 controller. This controller then sends these values serially to another STM-32 using LoRa transmitter and receiver. LoRa uses the proprietary and patented chirp spread-spectrum (CSS) modulation. Once these values are decoded by the receiver, the STM-32 controller then controls the robotic arm based on these values . The motion of the arm is due to servo motors. The servo motor is a motor which moves to a particular angle and, stays in that angle for a particular PWM.

3. Experimental Details

The block diagram, shown in the Fig.1, shows the communication between the two STM-32 through LoRa.

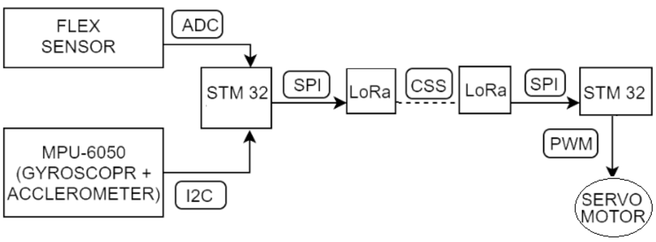

Figure 1: Block Diagram of hand gesture controlled robot

Flex sensor and MPU-6050 are connected to the STM32 as showed in the Fig 2. STM32 operate from a 2.0 to 3.6V power supply and the voltage is an analogue value given by the flex sensor are analog and cannot precisely be determined by a digital circuit. This is where we configure the ADC of STM-32. This ADC is a 10 channel 12 -bit ADC. Here the term 10 channel implies that there are 10 ADC pins using which we can measure analogue voltage. MPU-6050 is a Micro Electro-mechanical system (MEMS), it consists of a three-axis accelerometer and three-axis gyroscope

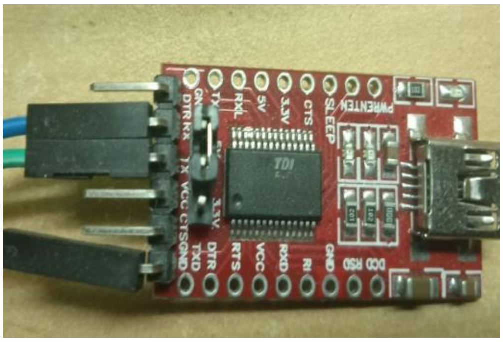

Figure 2: STM232 interface

It helps us to measure velocity, orientation, acceleration, displacement and other motion like features. It consists of a digital Motion Processor (DMP), which has property to solve complex calculations. It has a 16-bit ADC thus giving the values of angular displacement and acceleration in a very high precision, it works from voltages range 3V to 5V. The values are then stored in pre-fixed registers, which can be read using the I2C protocol. MPU-6050 sensors can be interfaced to a Microcontroller using the AD0 pin as showed in Fig 3.

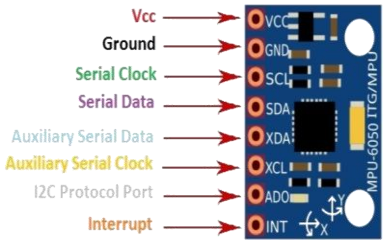

Figure 3: MPU6050 pin details

For the I2C communication, the clock speed is set to 100000 cycles per second. Here the I2C channel 2 has been used. The general call mode, dual addressing mode and the no stretch mode have been disabled. All the values are transmitted to LoRa using SPI and LoRa interact with other LoRa through CSS as the connection showed in the Fig 4. The servo motor is connected to STM32 as shown above Fig 1.

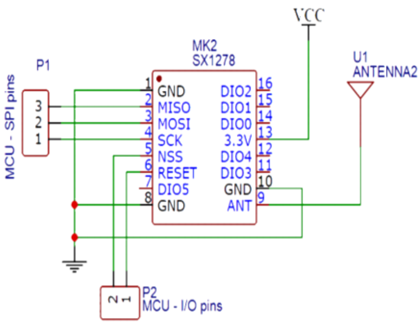

Figure 4: LoRa Connection

The servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position, the servo motors used are SG90 and MG995. Servo motors can rotate 180 degrees (90 degrees in each direction). The operating voltage of both the motors is around 5V. SG-90 gives a torque of 1.80 kg -cm, and MG-995 can give a torque of 9.40 kg-cm if connected to 4.8V source, 11.00 kg-cm if connected to 6V source. The angle of the servo motor is determined by the PWM given by the controller. The period must be 20ms, the angle varying from 0 degrees to 180 degrees depending upon the duty cycle. The duty cycle must be between 1ms to 2ms. The frequency of the cycle must be 50Hz.

Figure 5: Robotic Arm

4. Results

1) The sensor values can be considered as successful conversion of hand motions to electrical signals. The flex sensor which is connected to a voltage divider, gives the value of voltage in analogue. This is then converted to digital in 12 bits, by the 12 bit ADC in the controller. These three nibbles are sent as flex sensor values.

Figure 6: Flex sensor values

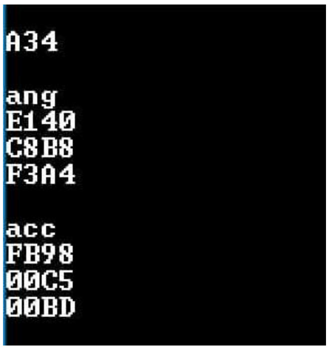

Figure 7: Gyroscope values

2) The MPU-6050 has both gyroscope and accelerometer. The x, y and z axes angular displacement values from gyroscope and the acceleration values from the accelerometer are stored continuously form register address 0x30 in mpu6050. Both of the values are converted to 16 bit values in all 3 axes by the ADC in

mpu-6050. Thus we have 3 16-bit values of angular displacement and 3 16-bit acceleration values in 3 independent axes.

3) Totally we have 108 bits of primary data to be transmitted

5. Conclusion

The robotic arm that is hand gesture controlled is successfully developed. The different sensors used in the model show the correct position of the arm using flex sensors and gyroscope and CSS for showing the change in hand position. The proposed wireless communication-based methodology can easily provide the information and the proposed hardware can serve the purpose for different robot types. The technology is robust, cost effective and easy to use. The following conclusions are arrived at based on the experimental results: Hand gestures are developed using STM32 microcontroller and MPU6050 and flex sensor. Real-time displacement and acceleration data of the hand is obtained by connecting the set up LoRa module. The system signals wirelessly whenever a displacement is found. In the case of robotic arm, initial topology is user specified.

References

[1] K. Megalingam, N. Saboo, N. Ajithkumar, S. Unny and D. Menon, "Kinect based gesture controlled Robotic arm: A research work at HuT Labs,"2013 IEEE International Conference In MOOC, Innovation and Technology in Education (MITE), Jaipur, 2013, pp. 294-299.doi: 10.1109/MITE.2013.6756353..

[2] P. Nebot and E. Cervera, "A framework for the development of cooperative robotic applications," ICAR'05.Proceedings., 12th International Conference on AdvancedRobotics,2005.,Seattle, ,2005,pp.901906.doi:10.1109/ICAR.2005.1507514.

[3] D. Bendale and V. J. Kharat, "A design of gesture controlled mobile robot with robotic arm for nuclear environment,"2017 International Conference on Nascent Technologies in Engineering (ICNTE), Navi Mumbai,2017,pp.1-6.doi: 10.1109/ICNTE.2017.7947918..

[4] P. Sarker, F. Abedin and F. N. Shimim, "R3Arm: Gesture controlled robotic arm for remote rescue operation," 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Dhaka, 2017, pp. 428-431. doi: 10.1109/R10-HTC.2017.8288991.

[5] T. Fegade, Y. Kurle, S. Nikale and P. Kalpund, "Wireless gesture controlled Semi-Humanoid Robot," 2016 International Conference on Recent Advances and Innovations in Engineering (ICRAIE), Jaipur, 2016, pp.1-5. doi: 10.1109/ICRAIE.2016.7939511.

[6] R. W. Lucky, "Automatic equalization for digital communication," *Bell Syst. Tech. J.*, vol. 44, no. 4, pp. 547–588, Apr. 1965T. D. Bendale and V. J. Kharat, "A design of gesture controlled mobile robot with robotic arm for nuclear environment,"

[7] P. P. Sarker, F. Abedin and F. N. Shimim, "R3Arm: Gesture controlled robotic arm for remote rescue operation,"

[8] R3Arm: Gesture controlled robotic arm for remote rescue operation

[9] R. K. Megalingam, N. Saboo, N. Ajithkumar, S. Unny and D. Menon, "Kinect based gesture controlled Robotic arm: A research work at HuT Labs,"

[10] P. Nebot and E. Cervera, "A framework for the development of cooperative robotic applications,"

[11] V. Kamath and S. Bhat, "Kinect sensor based real-time robot path planning using hand gesture and clap sound,"

[12] S. Devine, K. Rafferty and S. Ferguson, "Real time robotic arm control using hand gestures with multiple end effectors

[13] A. Mishra, P. Makula, A. Kumar, K. Karan and V. K. Mittal, "Multi-modal controls of a smart robot

[14] J. Nagi, A. Giusti, G. A. D. Caro and L. M. Gambardella, "Human Control of UAVs using Face Pose Estimates and Hand Gestures,.