Implementation of a Humanoid Robotic Hand

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Received: 31.05.2017 Accepted: 27.12.2017

Abstract- In the robotic, bionic robots intended to be used in the medical field are currently very popular and many researches have been performed about this area. These robot studies started with robotic arm were developed as robot hands, robot legs and humanoid robots. In the medical sector, they were inspired by prosthetic arms, legs and hand products and took their place in robotics systems. With the development of 3-D printer technology, robotic researches which are made at the medical field have accelerated. In this study, it is aimed to communicate with a mobile robot application to make movement in accordance with commands which is produced with a 3D printer and. All five fingers of a human hand with natural bends are designed and implemented with using 3D modelling and printing technologies.

Keywords- android, robotics, mechatronics, robot hand, arduino.

1. Introduction

The new developments on mechatronics and robotics have brought many new technologies and innovations such as making easier of the human life, increasing autonomy in the manufacturing sector, protecting people from working in risky places, providing robotic limbs that can replace to prosthesis. In addition to ABS disease, there are many reasons that prevents limb development or causes orthopedic disturbances in hand/finger development. The accidental loss of the limb is also seen at very high rates especially in the finger and hand areas. Robot hands are useful for both adults and children and young people because they are both cheap and functional. Robot studies in the medical sector are very important developments for surgery, prosthesis and sudden interventions, and intensive studies are being carried out. Robot studies in the medical sector are very important for the detection of mistakes during surgery, prosthetic hand, arm and leg exercises where people can use more comfortably and healthily, injured, injured and emergency patients who have lost their patients and limbs. In this direction, Brian White designed a robot that senses motion with flexible sensors and works with sensors [1]. In a study, a robotic arm was designed and performed experimentally as inspried by octopus arm. Mathematical models were obtained and design criteria of robotic arm was discussed [2]. Jong H.L. et al. is performed a research about brain-machine interface via real time fMRI. Two-dimensional movement of this robotic arm is controlled with regulation of regional cortical events in the primary motor area. Polygerinos P. researched the finger joints in the human hand and designed a glove that could be worn by hand. In another study, a robotic arm that can be controlled by arduino has performed by Elfasakhany A. et al [3]. Attenberger A. and Buchenrieder K. have used arduino uno to simulate matlab on a dentist robot hand [4]. Pahuja R. and Kumar N. who used microprocessor control with Android program have made a robot car with bluetooth protocol and this robot has run the car with android software [5]. In another study, a haptic robot arm was developed by A. Rama Krishna et al. using with arduino [6]. Doshi M.A. et al. [7] designed and developed a robotic hand with real time control for leprosy patients as a prosthesis. In another study, Hartopanu S. et al. conducted servo motor control with the movement of flex sensors mounted on gloves using arduino microprocessor [8]. Shamsheer Verma has implemented a robotic arm that is operated and controlled with help of hand gestures using wireless. An arduino mega microprocessor, gyroscope, accelerometer, gloves, servomotors are used in this research [9]. The glove provided robot hand movements from the 3D printer, which can be operated by the

movement of the flex sensors placed on the glove [10]. In another research, Kayisli K. et al. worked on a robot tank communicating with arduino microprocessor using bluetooth protocol with Android application [11].

In this study, a humanoid robotic arm is designed and implemented with using 3D printer, Arduino microcontroller, some sensors and android software. Firstly, the parts forming the arm and hand were modelled in Solidworks program. Secondly, parts were produced by using 3D printer technology. At the last, the parts were combined, servomotors were placed and connections were made. The microcontroller Arduino was programmed for the movements and placed to arm.

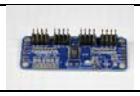
2. Methodology

Firstly, the human hand and its skeleton structure were taken individually as reference. Secondly, the parts of the hand were drawn and modelled by using solidworks program. The implementation of the five fingered dexterous humanoid robotic hand is impressed by the open source 3D printed project InMoov [12]. The pre-designed 3D design of the human hand with 5 fingers is further modified to suit the need using 3D designing software and 3D printed locally. Servo motors with pulleys were selected as the relevant actuator to control the movement of each finger while mobile control were used to capture the finger movements of the real human fingers [10]. The body of the hand is made by 3D printer. This humanoid robotic hand contains three parts as mechanical system, electronics system and software.

2.1. Design of Electronic System

For the motion of the parts of hand, there are five 6V Analog Servo Motors used in this robot. In addition to the motors, 4 rechargeable 1.5 AA battery is preferred to support enough voltage to these motors. Every finger has a motor to open-close itself. List of the electronic materials used for the humanoid robotic hand is given in Table 1.

Table 1. List of the electronic materials used in the tank.

Battery	4 AA battery 6 V(Nominal Voltage) 
Voltage	6 V Servo Motor 
Motor driver	Adafruit PCA9685 16 channel I2C PWM/Servo motor driver
	
Micro Controller	Arduino Uno 
Wireless shield	HC-06 Bluetooth module 

2.2. Design of Software

An android program is prepared to move the fingers of humanoid robotic hand on desired directions. There are twelve buttons placed on interface of program and it is shown in Fig. 1. For connecting to the humanoid robotic hand with Bluetooth, Bluetooth button at the top side of interface has to be clicked. After the synchronization, the robot can be moved using android software by clicking the buttons on the directions [11]. In Fig.2, the flowchart of the program which developed to move the fingers with Bluetooth module.

Fig. 1. Interface of Hand Robot Android Application

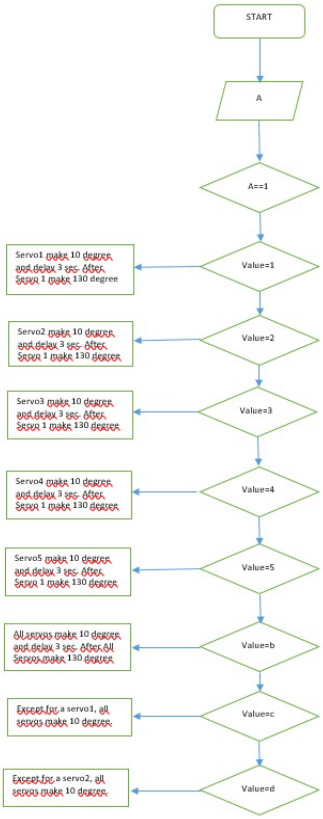


Fig. 2. Flowchart of Hand Robot Android Application

3.Results

There are five servo motors used for the robotic hand. The servo motors which placed in the robotic arm and the controller card are shown in Fig.3. The blue circles connected to the rotor of motors are used as motion transfer. This transfer parts are connected to the fingers with using rob braids. When the motors turn left or right, the finger which connected that motor opens or closed depend on the speed and the turn rate. This humanoid robotic hand is controlled smart mobile device by using android software. Fig. 3 and Fig. 4 illustrates the finalized design of the humanoid robotic hand.

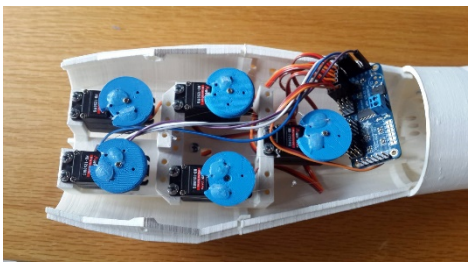


Fig. 3. Inside of Hand Robot

Fig. 4. The final state of the humanoid robotic hand

For a realistic stance of the humanoid robotic arm, the static state of a human is preferred and implemented as shown in Fig.5.

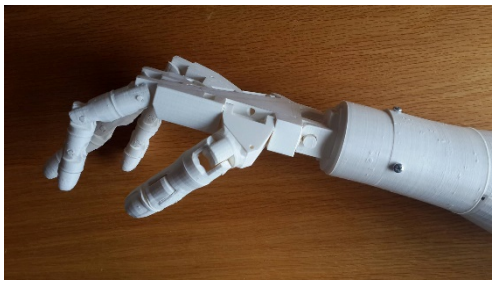


Fig. 5. Hand robot in action

In Fig.6, there are ten motions are shown. The first line shows the motions of the fingers which move independently from the others. The (okay) motion, want a word motion, wolf motion, punch motion and perfect motion are ensured with the hand and it is shown in Fig.6, respectively.

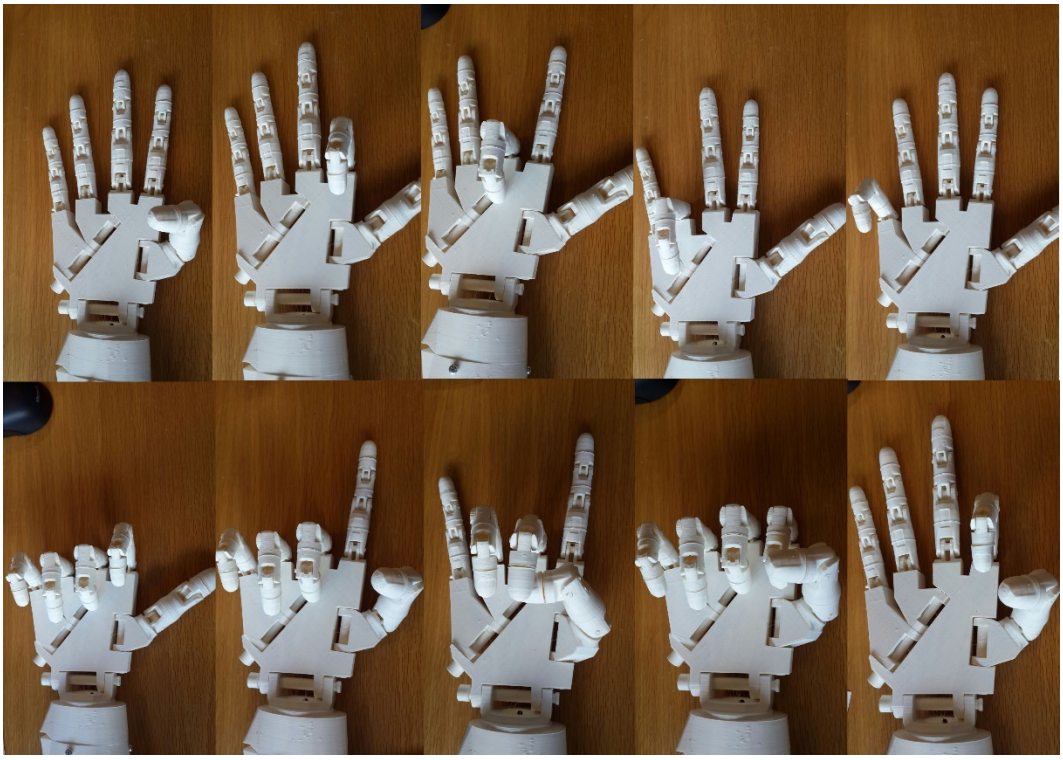


Fig.6. The different type motions of hand

4. CONCLUSION

In this paper, implementation of a hand robot is explained. A five fingered dexterous humanoid robotic hand was designed, implemented and prototyped. There are many motions like the original human motions were performed by using this prototype. The response time is very high that the robotic hand can done quickly what the operator want. In future, authors highly believe this application can be further improving for healthcare, military applications and prosthetics fields. This application can be improved by other wireless technologies and can be used another fields easily.

References

[1] B. White, P. DeSante, T. Trask, D. Cox, Development and Implementation of a Mechatronic Haptic Hand System University of North Florida Jacksonville, FL 32224

[2] P.Polygerinos, Z. Wang, K. C. Galloway, R. J. Wood, C. J. Walsh, Robotics and Autonomous Systems Volume 73, November 2015, Pages 135–143

[3] A. Elfasakhany, E. Yanez, K. Baylon, R. Salgado, Design and Development of a Competitive Low Cost Robot Arm with Four Degrees of Freedom. Modern Mechanical Engineering, 2011, 1, 47-55

[4] A. Attenberger, K. Buchenrieder, An Arduino-Simulink-Control System for Modern Hand Protheses International Conference on Artificial Intelligence and Soft Computing ICAISC 2014: Artificial Intelligence and Soft Computing pp 433-444

[5] R. Pahuja, N. Kumar, Android Mobile Phone Controlled Bluetooth Robot Using 8051 Microcontroller International Journal of Scientific Engineering and Research (IJSER) www.ijser.in ISSN (Online): 2347-3878 Volume 2 Issue 7, July 2014

[6] Krishna A.R., Bala G.S., Sastry A.S.C.S., Sarma B.B.P., Alla G.S., Design and IMplementation of a Robotic Arm based on Haptic Technology, International Journal of Engineering Research and Applications (IJERA), Volume 2, Issue 3, May-Jun 2012, 3098-3103.

[7] M. A. Doshi, S. J. Parekh, M. Bhowmick, Wireless Robotic Hand Using Flex Sensors International Journal of Scientific & Engineering Research, Volume 6, Issue 3, March-2015 1471 ISSN 2229-5518

[8] S. Hartopanu, M.Poboroniuc, F. Serea, D. Irimia, G. Livint, New Issues on FES and Robotic Glove Device to

Improve the Hand Rehabilitation in Stroke Patients. 6TH INTERNATIONAL CONFERENCE ON MODERN POWER SYSTEMS MPS2015, 18-21 MAY 2015, CLUJ-NAPOCA, ROMANIA

[9] S. Verma, Hand Gestures Remote Controlled Robotic Arm, Advance in Electronic and Electric Engineering, Vol. 3, Number 5, 2013, 601-606.

[10] A.Salman , A.Seeni, Y.M.T.Yapa Bandara Low Cost Dexterous Teleoperation Humanoid Robotic Hand With Wearable Remote Controller, International Research Symposium on Engineering Advancements 2015, 154-154, Pioneer Institute of Business & Technology (PIBT), Sri Lanka.

[11] K. Kayisli, C. Tezel, O Gunay, E. Demir, Design and Implementation of a Tank Rescue Robot Controlled with Android Software INTERNATIONAL JOURNAL of ENGINEERING SCIENCE AND APPLICATION K. Kayisli et al., Vol.1, No.1, 2017

[12] nMoov » open-source 3D printed life-size robot, 2014 [online], Available at: http://www.inmoov.fr. [Accessed 01st June 2014].