DEVELOPMENT of PROSTHETIC ROBOTIC ARM USING ARDUINO UNO

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***Abstract*—This paper shows the developmental procedure for prosthetic robotic arm, which is design using the Arduino uno and servo motor. The proposed system is controlled using the switches/buttons which is operate by the user's other hand. This system changes the idea of remote controlling of robotic arm. Robotic hand is design which can perform daily life activities for physically disabled person. In this paper Arduino board is programmed to control the whole functioning of the system, in which input is connected through keypad and output to the servo motor for the movement of fingers and successful functioning of prosthetic hand. This prosthetic hand is not only useful in daily life activities but also in industries where some dangerous chemical products are used which may be harmful to the human skin. So, this technology has many applications in medical field, manufacturing field etc.**

Keywords— Arduino Uno, keypad, Prosthetic, Servo motor, Robot

I. INTRODUCTION

The term "prosthetic" comes via new Latin word from Greek "prostithenai" meaning "to add to, or to put in addition", this describe the addition of artificial body part, such as a limb, a heart. Most of the systems are designed for the peoples who lost their hand or leg in accident or who are handicap by birth.

The introduced paper is deal with the development of artificial body part I.e. hand, as the name "prosthetic" indicate. The proposed system has input as keypad/switch, a robotic hand which is the main part of the system and last is servo motors.

The main idea is Arduino board is programmed using the programming-language in which the analog pin is connected to keypad which is connected externally to the system. In this system 5 keys are used which control servo motor for movement of fingers through command given in the programming and for elbow movement DC gear motor is used which performs the right and left movement of the hand. The traditional robotic hand is control using the remote which increase the complexity of the design and also faces the difficulty in operating mechanism, and that robot was made up of metallic material which makes it very heavy for the user. While in this project Robotic hand is made up of 3D - PRINTED parts. The 3D-printed technique is used because this technique gaining high interest at the consumer-level and becoming very popular. Comparing this proposed system to the previous proposed system which are very expensive to the users, the person who are in need may cannot afford this invention. So, this proposed prosthetic-hand provides less expensive approach to the consumers, and also have many advantages over the previous system like they are very light in weight and very user friendly with a satisfied speed. Apart from the cost, another problem in the previous proposed system is controlling mechanism, they use electromyography technique, which calculate the electrical signal comes from the forearm muscle of the body which is used to control prosthetic hand. So, problem with this system is that person with non-functioning forearm cannot take advantages of it, whereas this proposed 3D-printed is easy in controlling mechanism and no need to calculate the electrical signal, it operates directly through simple controlling mechanism.

Furthermore, the performance of prosthetic robotic arm is increasing rapidly at consumer-level in past few years. The 3D-printed prosthetic hand has advantage that this system can be easily understand and used by children also.

The main perspective of this paper is to prepare a affordable, user friendly robotic-hand with affective functionalities of daily life work like grasping, lifting etc.

II. METHEDOLOGY

Fig1. Shows the block diagram of the proposed system, which includes Arduino uno, LCD screen, regulated power supply, total six servo motor (SG90), keypad/switch.

Arduino boards are broadly used because it has feature that it can read various types of input like light on a sensor, pressing of a button by finger and turning ON/OFF of a motor/LED, etc. So, this board is very suitable for this project. In this system SG-90 servo motor is used because it provides low speed with exact position which is very important for the useful functioning of the hand. Servo motors are present in many size and shapes. Servo motors have three wires one is for power supply, one is for ground and one more is for angular rotation (0-180 degree) readings and this wire of servo motor is connected to the Arduino board. The 2*16 LCD is used to display the result of the system which verify the proper

functioning of the system. It consists of two rows with 16 character in each line.

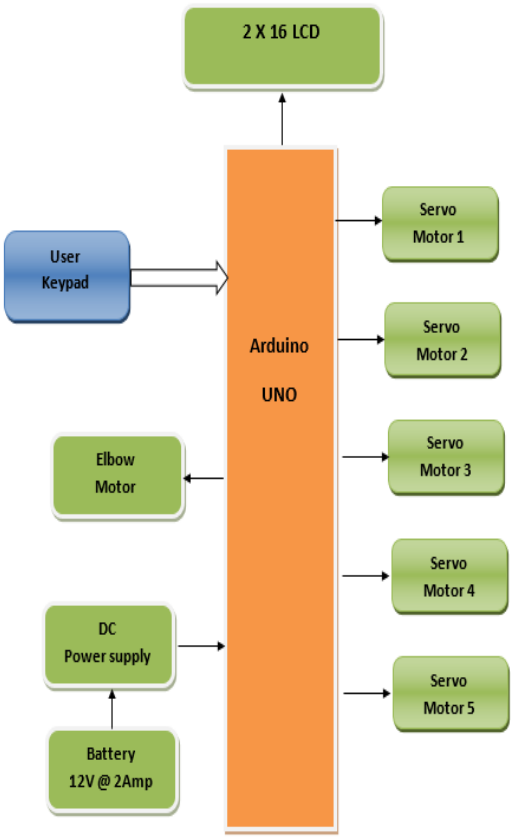

Fig 1 Block diagram of proposed system

General construction of the proposed system:

1. The arm is made up of 3D-printed parts which is the connected or packed with servo motors
2. The input of the prosthetic-system is keypad/switch which is connected to the A0-A4 analog pin of Arduino uno board.
3. The servo motors, which provides the position to the fingers of hand are connected to the pin-number 2 to 7 of Arduino board.
4. Programming of Arduino board is done using the Arduino uno IDE-software.
5. When is key is pressed, an analog signal is passed to the ADC-channel, which converts the analog value into digital value.
6. The converted digital value is given to servo motor pin which is used to present the angular-position for movement of fingers.
7. LCD-screen displays the commands given to the system.
8. So, the proposed system performs the respective function.

Arduino Uno board has total 6-ADC channels among which we are using five ADC pin. Each ADC-pin have resolution of 10 bit that is from 0-1023(2^10) and default voltage of 0 to 5V.

Some of the instructions we have used in Arduino - programming is as follows.

1. <servo.h> :- this is the header file to initialize the servo motor.
2. <liquid_crystal.h> ;- this is the header file to initialize to LCD.
3. “pinmode (pin number, input)” :- this instruction is used to set the selected pin number as a input, here “pinmode” is a keyword.
4. “digitalread (pin number==low&& pos <180)” :- this instruction is used to read the input value from “pin number” and comparing it with angular position which should be less than 180-degree. Here, “digitalread” is keyword.
5. “servo.attach()” :-this instruction is used to connect the servomotor to pin of the Arduino board.
6. “LCD-print(“servo-cw”)” and “LCD-print(“servo-ccw”)” :- these instructions are used to display or print the rotation of the motor which may be either in clockwise or counter clockwise direction.
   “cw-clockwise”, “ccw-counter clockwise”.

A 12V battery is used which connected to the regulated power supply which coverts 12V to 5V because Arduino board works on 5V power. The Regulated power supply contain rectifier, low pass filter (LPS) and regulator to convert the 12V to 5V.

The most important factor which should be studied while designing the robotic arm is speed, acceleration, accuracy, etc.

III. DESIGNING OF PROSTHETIC HAND

In this paper, we are aimed to developed a prosthetic-arm which should be same as human hand that is with five fingers. In the proposed system each finger is made of four parts. This system is design such that it can perform routine life functions because it reduces the complexity of the system design and ensure the proper functioning of the result.

The 3D-printed parts of a prosthetic arm are design using CAD (computing aided design) software tool. This software create very sophisticated design and it is very easy to join them together using features of software. This software shows very accurate and clear drawing of parts. So, with the help of CAD- software we can prepare a robotic hand which is same as human hand.

The figure 2 represents the graphic view of four parts of fingers and servomotor socket in 3D-PRINTED form and table I represents the measurement of each finger by considering the unit in mm in X, Y and Z direction.

Fig 3 represents the complete hardware system of the system. The material used to prepare the hand is PLA (polylactic Acid) because it is very light in weight. The whole project represents that keypad/switch and LCD screen is connected externally and each finger is connected to palm

through servo motor. In servo motor socket four servo motor are joined which is for four fingers and for thumb, motor is connected directly to it.

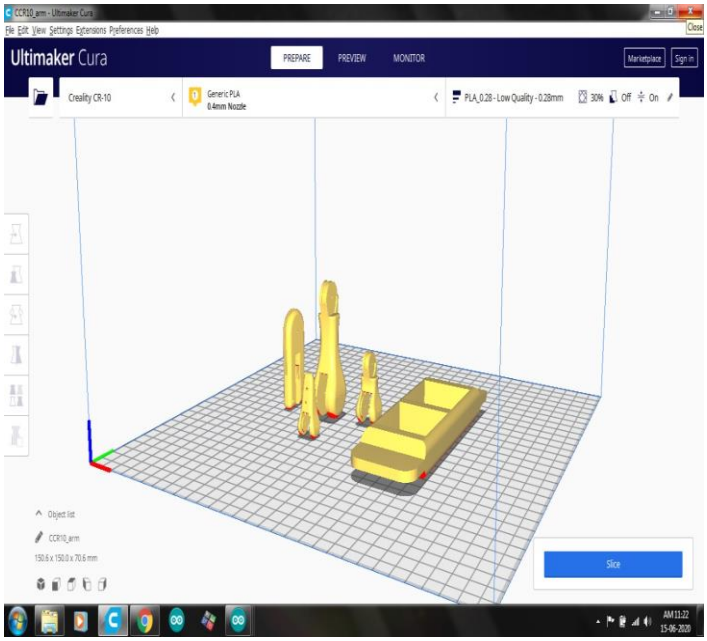

Fig. 2. 3D printed parts of prosthetic robotic arm

TABLE I

Sl.no	Names	X-Direction	Y-Direction	Z-Direction
1	Servo motor case	8	23.448	52.6434
2	First part	15.4099	12.498	31.7881
3	Second part	18.0596	17.0005	37.081
4	Third part	23.1106	24.4985	70.5756
5	Fourth part	8	23.448	52.6434

Fig 4 and 5 shows the complete open and close view of the prosthetic robotic arm. When the respective key for opening the finger is pressed arm opens completely, and it is same for the closing function. This system can also open and close each finger separately when the respective key is pressed.

This hand can attach to handicapped person with the help of belt, to modify the view of this system we can cover it with gloves so that it exactly looks like the human hand. In fig 3 we can see that apart from the main component which is mention above some capacitor, resistors/potentiometer are used. These components are used to control the voltage across the circuit and to control the speed of the system with an acceptable acceleration.

So, this paper increases the use of artificial body parts because of its easy functioning mechanism, no chemical or other material damage this hand which can damage the human skin. After the 3D PRINTED parts are join together which resemble like an hand then hardware connection will be given to it after which the whole system looks like in fig3.

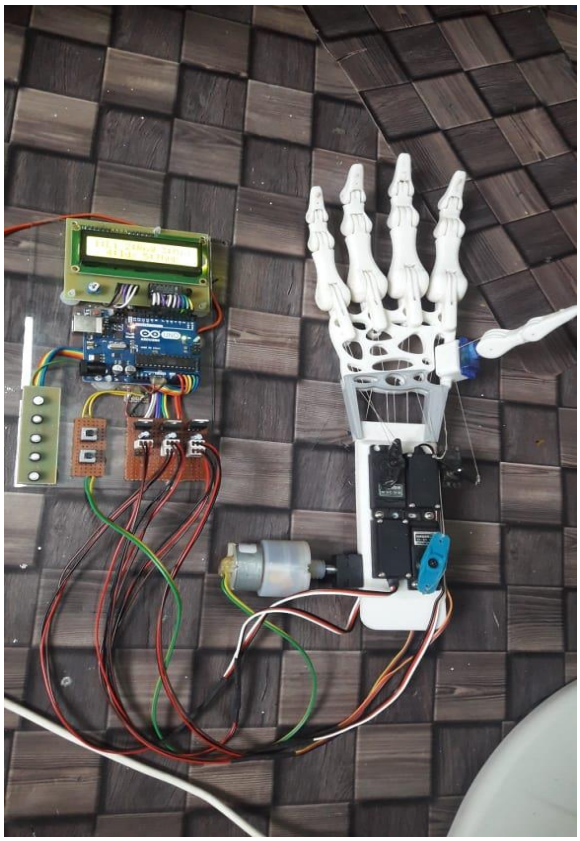

Fig. 3. Prosthetic robotic hand system

Fig. 4 open view of prosthetic arm

Fig. 5 closed view of prosthetic arm

IV. EXPERIMENTATION AND RESULTS

This whole system of prosthetic robot arm works with battery. This basic frame is formed with 3D -PRINTED parts which makes the connection with servo motors, which are controlled by the Arduino board through input signal given by the keypads. The prosthetic arm is mounted on the handicap person, whenever person presses the key with other hand, this hand start functioning.

The evaluation of prosthetic robotic hand is conducted using the basic activity of daily life.

1. Experimentation task: The task includes 1) grasp a bottle that is placed on a table 2) lift up the bottle, as shown in fig6.
2. Discussion: Since, the system is made up of light weight material it can carry only small objects like bottle, cup etc. The hand can attach and remove from the body any time.

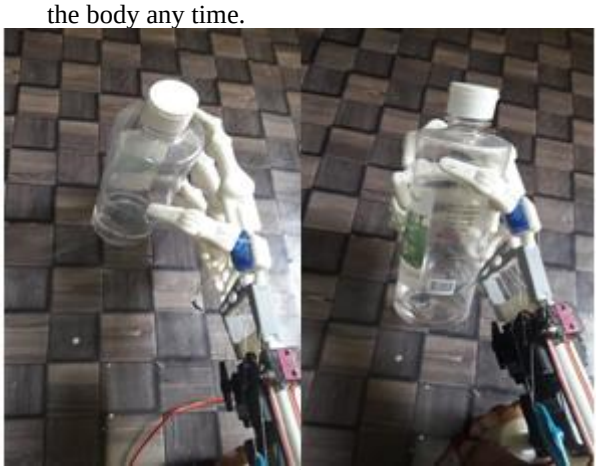

Fig. 6.Experimentel task for grasping and lift the object

V. ADVANTAGES DISADVANTAGES and APPLICATION

Advantages:

1. Increased prosthetic use.
2. Better movement comfort.
3. No skin problems.
4. Stable and safer operation.
5. Easy and quick attachment and removal.

Disadvantages:

1. Need to charge battery frequently
2. Cannot carry large weight
3. Cannot be quick as human hand

Applications:

1. Daily life activities
2. Manufacturing industries.

VI. CONCLUSIONS

In this we have prepared the light weight 3D-printed prosthetic robotic hand which consist Arduino, servo motor and keypad/switch. Using Arduino board programming the whole system is controlled to perform the daily life activities. This system helps the disabled person to overcome with their struggle is daily life and also have many applications in manufacturing industries, medical field and many more. The proposed model is of low cost and the hardware component of the system are easily available.

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REFERENCES

[1] B. Siciliano and O. Khatib, Handbook of Robotics. Springer, 2016, ch. 24. Visual Servoing and Visual Tracking.

[2] A. Verl, A. Albu-Schaffer, O. Brock, and A. Raatz, ¨ *Soft Robotics. Springer*, 2015.

[3] S. Haddadin, Towards Safe Robots, ser. Springer Tracts in Advanced Robotics. Springer Berlin Heidelberg, 2014, no. 90.

[4] Open Hand Project, Bristol (United Kingdom), Dextrus Hand, 2014.

[5] Belter JT, Segil JL, Dollar AM, Weir RF. "*Mechanical design and performance specifications of anthropomorphic prosthetic hands: A review"*.J Rehabil Res Dev.;50(5):599–618, 2013.

[6] M. Johannes, J. Bigelow, J. Burck, S. Harshbarger, M. Kozlowski, and T. Van Doren, "*An overview of the developmental process for the modular prosthetic limb,"* JHAPLTD, vol. 30, no. 3, 2011.

[7] M. Bridges, M. Para, and M. Mashner, *"Control system architecture for the modular prosthetic limb,"* JHAPLTD, vol. 30, no. 3, 2011.