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Prosthesis ARM Using Bluetooth (HC-05)

Mrs. Tanwin M. S. Ashrafi[1]
[1]*Assistan Professor, Department of Physic, G.M.Momin Women's College, Bhiwandi, Maharashtra, India*

Abstract: *Prosthetic are the very old field of study. Earlier record shows that the Egyptians were early pioneers of the idea. It becomes very important field of research in world wars. Now a day a very less attention is given to this field. In this paper, a Prototype is design to make the replica of the movement of the fingers. Three flex sensors are used to sense the movement of the thumb, main finger and ring finger. This data was send via Bluetooth (HC 05) to the prototype, with the help of three servo motor the prototype shows the replica movement of the fingers.*

Key Words: *prosthetic, flex sensor, Bluetooth (HC 05)*

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I. Introduction

In the Rigveda, there is a reference of women named as Vishpala, she lost her leg in battle but was gifted by a leg f iron to run. The Egyptians were early pioneers of the idea, as shown by the wooden toe found on a body from the New Kingdom. Herodotus mention but a man Hegesistratus, he had been captured by the Spartans and put in bonds. He escaped by cutting off a piece of his own foot and replaced it with a wooden one. In 1508, German mercenary Gotz von Berlichingen had a pair of technologically advanced iron hands made after he lost his right arm in the Battle of Landshut. Kevin Warwick is a British engineer and Deputy Vice-Chancellor (Research) at Coventry University in the United Kingdom. He is known for his studies on direct interfaces between computer systems and the human nervous system, and has also done research concerning robotics. Mechanical arms are composed of multiple beams connected by hinges powered by actuators. One end of the arm is attached to a firm base while the other has a tool. They can be controlled by humans either directly or over a distance.

II. Design Methodology:

The main objective of this research work was to do an investigation of prototypes for feasibility. After Reading a lots of background research and studying the available products on the market, it was determined that constructing an entire prosthetic arm was not necessary. The market for a prosthetic hand is substantially larger than that of complete prosthetic arms and focused first on what needs of the user would be.
The design of this prototype of prosthetic arm has been divided in to two parts. The first one will collect the data of the movement of the fingers and second will represent the movement. The block diagram below shows the flow of the design.

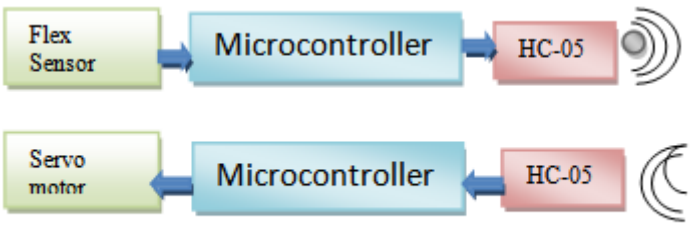


Figure 1: **Block Diagram of the prototype**

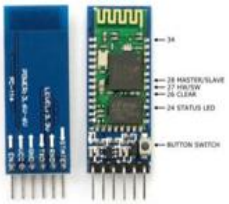
III. Sensors

1. Flex Sensors:

In this prototype flex sensor play an important role. The Flex Sensor patented technology is based on resistive carbon elements. As a variable printed resistor, the Flex Sensor achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius—the smaller the

radius, the higher the resistance value. A simple flex sensor is of length 2.2". As the sensor is flexed, the resistance across the sensor increases. The resistance of the flex sensor changes when the metal pads are on the outside of the bend (text on inside of bend). Connector is 0.1" spaced and bread board friendly.
Each flex has their own resistance to know the best resistance in series with each one selected is done by simple calculation.
Voltage in flat state= voltage ×(resistance at 0 stage/(resistance at 0 stage+ resistance in series))
Voltage at 180 state= voltage ×(resistance at 180 stage/(resistance at 180 stage+ resistance in series))
Difference = Voltage at 180 state -Voltage in flat state

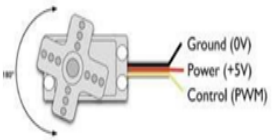
2. Bluetooth Module HC05:



HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm
(Note: write pairing way of two HC05)

IV. Actuator

1. Servo motors: Unlike dc motors, with servo motors you can position the motor shaft at a specific position (angle) using control signal. The motor shaft will hold at this position as long as the control signal not changed. This is very useful for controlling robot arms, unmanned airplanes control surface or any object that you want it to move at certain angle and stay at its new position. Servo motors may be classified according to size or torque that it can withstand into mini, standard and giant servos.



V. Microcontroller

Arduino Uno is the best board, with Atmel ATmega328P core as its heart, to start with AVR microcontroller in on board applications [4].

Features:

- 14 Digital I/O Pins (of which 6 provide PWM output)
- 6 PWM Digital I/O Pins.
- 6 Analog Input Pins
- 32 KB Flash Memory of ATmega328P of which 0.5 KB used by bootloader.
- SRAM 2 KB of ATmega328P
- EEPROM 1 KB of ATmega328P
- Clock Speed 16 MHz
- LED: 13. There is a built-in LED driven by digital pin 13.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

Power Supply:

- Operating Voltage 5V
- Input Voltage 7-12V
- output Voltage (limit) 6-20V
- DC Current per I/O Pin 20 mA
- DC Current for 3.3V Pin 50 mA

Communication:

- ICSP (In-Circuit Serial Programming)
- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

VI. Proposed Prototype

1. Paring the Bluetooth Module HC05: It is simple to pair a Bluetooth module from Android phone but bit tricky to pair it with another HC-05 module. One play as slave and another becomes master. The method of pairing 2 BT modules is as follows.

a) SLAVE Mode: To configure the SLAVE, by default all HC05 modules are SLAVEs.it can leave to defaults.But to know the ADDRESS of the slave follow this procedure.

- Before connecting the HC05 module to Arduino Uno, upload an empty sketch to Arduino. This bypasses the Boot loader of UNO & the Arduino is used as USB-UART converter.

```
void setup() {}
void loop() {}
```

- connections with HC05 Slave :

ARDUINO	HC05
Rx(pin0)	Rx
Tx (pin1)	Tx
+5v	VCC
GND	GND
+3.3V	KEY

- Now provide the USB cable power to Arduino. The HC05 module enters the Command mode with Baud Rate 38400.
- Open the Serial Monitor of Arduino .
- Ensure to select "BOTH NL & CR" & Baud Rate as 38400 at the bottom of the serial monitor.This is very important as the Bluetooth module HC05 expects both Carriage Return and Line Feed after every AT command.
- If you type in AT & click on SEND button you should get an OK confirmation from the HC05 module.
- If you get ERROR(0) try again to enter the Command mode. If there is no response then check whether correct COM port has been assigned in Arduino IDE & confirm Baud Rate is 38400 , "Both NL & CR" selected.
- Type in AT+NAME? to get the name of the module.
- AT+NAME=HC05_SLAVE You can change the name as you like with
- The password by default is 1234 .Confirm that with AT+PSWD?
- The ROLE of the module can be known by typing AT+ROLE? You can change it by AT+ROLE=0. '0' for SLAVE & '1' for Master. Leave it as 0 as we want this module to be SLAVE.
- You should know the Address of this module to make it PAIR with another.Type in AT+ADDR? Note the Address here, it is 14:2:110007.
- While using this address in AT commands you should replace the colon with a comma , like 14,2,110007
- Now remove the KEY connection from the HC05 module & disconnect the power.
- Again provide the power to see STATUS LED on the module blinking fast indicating that it is looking for a PAIR.

b) MASTER Module setup:

- do the same connection as before
- If you type in AT you should get an OK response.
- Reset the module by issuing AT+ORGL which restores the module to original state.
- You can change the name to user friendly one by typing AT+NAME=usergivenname
- AT+RMAAD will release the module from any previous PAIR.
- AT+PSWD=1234 to set the password as 1234
- AT+ROLE=1 changes the ROLE of the module to MASTER
- AT+CMODE=1 Allows connecting to any address.
- Default is CMODE = 0 which allows connection to only bound address & will set the connect mode to "fixed address".
- using the AT+BIND= 14,2,110007 command we will set the address of the slave device that we previously wrote down.
- You can watch the status LEDs of both slave & master.The fast blinking Status LED starts flickering slowly & the Pairing LED goes steady.
- Now you can remove the KEY connection from master & Reset the module by removing the power & connecting back.

2. Glove Module:

- According to the calculation proper resistance are connected in series with flex sensors
- Set the Bluetooth connection between Two HC05.
- Read the flex sensors data for Thumb, Index, and Annular fingers.
- Map the reading from the flex sensor with the servo motor angle.
- Write the data on Bluetooth communication line.

3. Hand Module:

- Read the data received from the Bluetooth connection.
- According to the received data, give the command to three servo motors.

VII. Conclusion

Study of this prototype gives understanding of control as a skill acquired through practice, appropriate modifications in the training protocol might be expected to facilitate learning and improve final performance. Study shows that high signal resolution is not essential for complex movement control and suggests that other factors are more important. Author hypothesizes that combinations of signals from multiple cortical areas might produce more consistent performance. With further development, it may eventually become possible for people with severe neuromuscular disorders to operate devices such as a robotic arm, a motorized wheelchair, or a neuro-prosthesis with brain signals recorded from the scalp.

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