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Sign Language Interpreter Using Leap Motion Sensor

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Abstract

This project will recognize the gestures performed by hearing impaired or verbally challenged persons and convert it into natural audio. Here set of words are converted into whole sentence using NLTK library. And this words are mapped with pre-recorded audio files stored in MP3 module and this sentence is interpreted in audio through Galileo board and MP3 module.
And another is Robotic Hand followed by real Hand's motion. Here real Hand's motion is captured from Leap Motion Sensor and that data is mapped with servos' angle through Galileo Board Robotic Hand is controlled

Completion status

Both part of project is almost completed. But still, in Sign Language Interpreter, making of compact and portable version is left. And in Robotic Hand making of power supply is left. Currently it is working on LAB DC power supply

1.1 Hardware parts

- Galileo Board Datasheet, Vendor link
- FN-M16P MP3 module Datasheet, Vendor link
- Leap Motion Sensor Documentation, Vendor link
- GS-5515MG Servo Datasheet,Vendor link
- Any Speaker

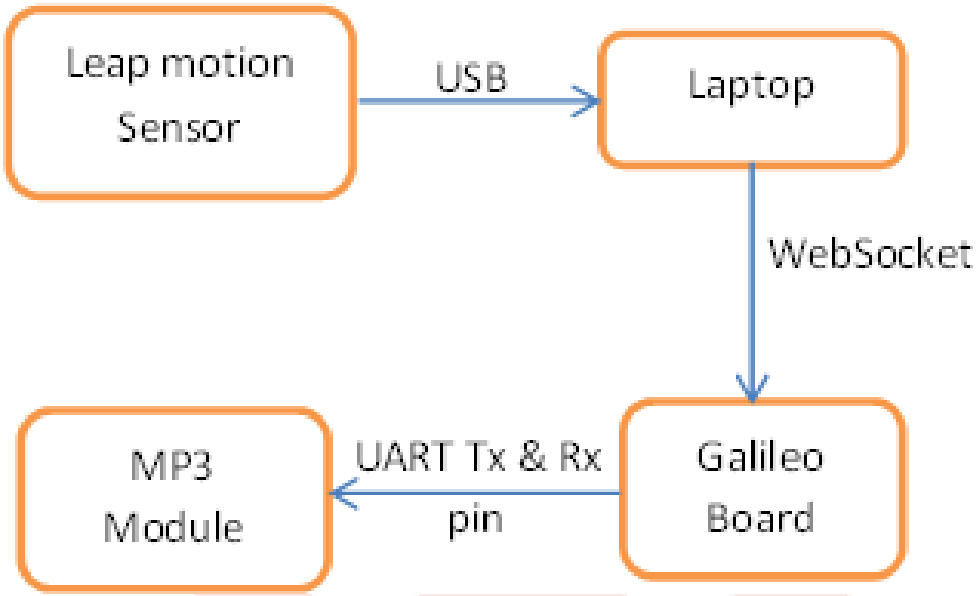

Figure 1.1: Block diagram for sign language interpreter hardware system

- 3D Printed parts of Robotic Hand(STL files given in GitHUb Repository)

1.2 Software used

- Leap SDK, download link,
- BitVise SSH Client: version, download link,
- Linux For Galileo download link, For installation read Galileo Tutorial
- Python Programming Language 2.7 download link

1.3 Assembly of hardware

For Sign Language Interpreter,

Circuit Diagram

See Figure: 1

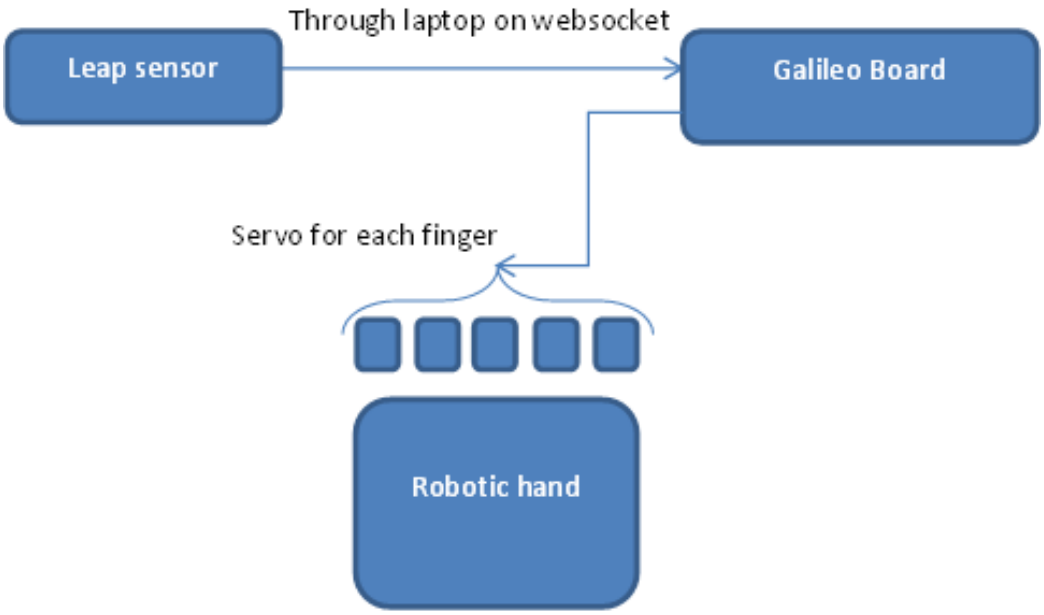

Figure 1.2: Block diagram for Robotic hand system

Step 1

Connect Leap Motion Sensor with PC with USB connection

Step 2

Connect Galileo Board with PC through WIFI or LAN

Step 3

Connect MP3 Module With Board.(Just give VCC and GND to module and board's Rx pin to Module's Tx pin and board's Tx pin to module's Rx pin.)(Refer data sheet of MP3 module for pin diagram)
.1cm
For Robotic Hand,

Circuit Diagram

See Figure: 2

Step 1

Assemble all 3D printed parts of Hand. Refer this

Step 2

Connect Leap with PC with USB

Step 3

Connect PC with Galileo using LAN or WIFI

Step 4

Connect PWM pin of servo to Board's PWM output pin(For Connection refer Galileo_board_tutorial)
Provide 5V DC power supply to each servo. Make sure, 700mA current is provided to each servo.

1.4 Software and Code

Github link for the repository of code

For Sign Language Interpreter:

There is two programs one for laptop and another for board. One script will be running on board to catch massages sent through PC. And this one will also handle the task related to interfacing with MP3 Module to play any audio file through UART communication. And One script will be running on PC to recognizing Gestures and interpret them in words. And task related to making natural sentence from words and making grammar for set of words will also done by this program. This thing will be done through NLTK library.
Task Achieved with each program:
on_laptop.py

- Recognizing Gesture:
  For Gesture Recognizing two parameters each figures position and direction of all three axis are counted. And also relate them with palm

center to make independent of palm position from sensor. And 300 samples are captured and stored in JSON file. And for recognizing new gesture, new captured samples are then compared with that samples of all words. For making this system faster, all data is converted into matrix and all processes are done through numpy.

- Making of sentence:
  After Recognizing single words, set of word is generated. Then this set become sentence here. Like, if set is ['What', 'name', 'you'], then here some words are added to make proper sentence and also it corrects the places of word. So, here output or above set is ['what', 'is', 'you', 'name']. Then grammar will be corrected in next module.

- Correcting Grammar
  Here Grammar of sentence is correct. For that, I have used online API of Ginger grammar. So this will make ['what', 'is', 'you', 'name'] to ['what', 'is', 'your', 'name'].

- Sending sentence to board
  Then this sentence is sent to board through websocket here this code become client and board become server.

on_board.py

- Receiving sentence
  Receive the sentence through websocket.

- Differentiate each word from sentence and map with file number.

- Generate hex code for MP3 module
  MP3 module needs hex code to perform specific task. So here proper hex code is generated. hex code also includes check bits counting.

- Sending hex code to MP3 module
  then this generated hex code is sent to mp3 module through UART.

For Robotic hand:

Laptop side program
Here Leap data is mapped to angle. Here two parameters used one is tip position's y axis and palm center's y axis. and tip position's y axis is relate to palm center. So, it become independent from hand position. and send data of all five angle of each finger to board through websocket **Board side**

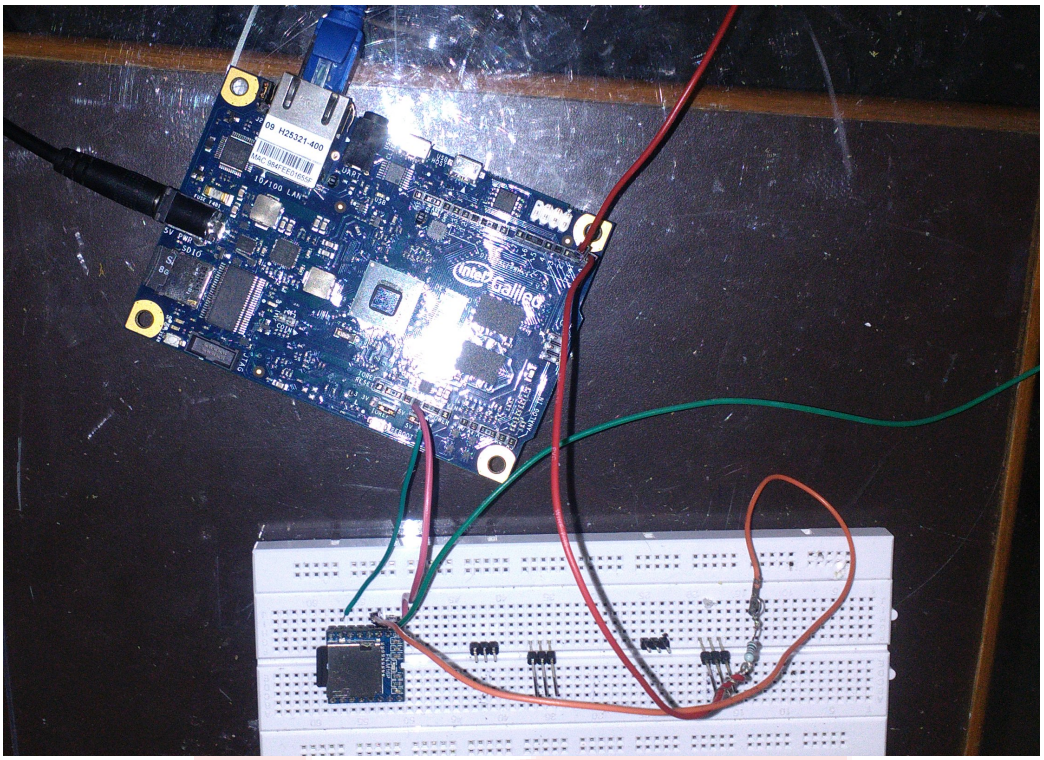

Figure 1.3: Connection between MP3 module and Galileo

program It just receive angle and data and generate PWM signal according to that.

1.5 Use and Demo

For Sign Language Interpreter
See Figure: 3
step 1:
Make all connection with board, mp3 module, leap and pc
step 2:
connect board with SSH to pc
step 3:
Enter IP of board in on_laptop.py
step 4:
run on_board.py on Galileo board.
step 5:
run on_laptop.py on laptop

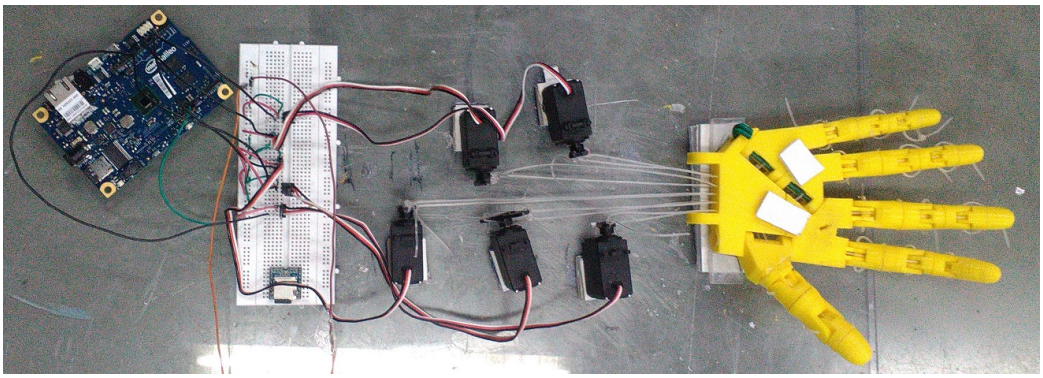

Figure 1.4: Connection for robotic hand

For better recognizance seat on chair and put leap on table. And before performing any new gesture show whole palm first.

For Robotic Hand
See Figure: 4
step 1:
Make all connection with board, servos, leap and pc
step 2:
connect board with SSH to pc
step 3:
Enter IP of board in follow_hand_client.py
step 4:
run follow_hand_server.py on Galileo board.
step 5:
run follow_hand_client.py on laptop

Now perform pose on leap at least 15CM above the sensor.

1.6 Future Work

For Sign language Recognizing system,
Make whole system potable and compact like an Tablet. And make it more accurate.
For robotic hand,

Make more joints accessible.

1.7 Bug report and Challenges

Bug report:
Sometimes, another person's (who have not loaded data) gestures is not recognized.
Challenges:
Initially, Recognizance was not accurate. Error rate was almost 50%. that was some LeapTrainer.js library. So I've decided to make my own thing. So I made algorithm, Now challenge is to make it faster. Because it was too slow. It take 18-21 seconds to recognize single word. So, I converted all data in form of matrix and all process of I have done is through numpy. so it become more faster, Now it takes only 0.3 second to recognize word.
In robotic hand there was a problem of power supply because I need 5V with 5A power supply. It was quit hard to build such supply. So, currently I am using LAB DC power supply.

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