SMART GLOVES TO CONVERT SIGN LANGUAGES TO VOCAL OUTPUT

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Abstract – The Objective of this paper is to design a SMART GLOVE for conversion of sign languages to vocal output . This could be of importance to a Mute person who needs an interpreter for communication. The glove consists of a Micro-controller, speaker, flex Sensors, gyroscope, battery, resistors. The sensors are calibrated in a manner that for each combination of the fingers, points to a voice note that is preinstalled in the program. A gyroscope or simply gyro that assists in incorporating more no of signs when a same sign with a different orientation would be considered distinct. The principle is also being used in the development of animatronics hand and various other robotics application.

Key Words: Communication, Sensors, Calibration, Voice-Note, Gyroscope, Animatronics Hand.

1. INTRODUCTION

Sign language is a complete, natural language that has the same linguistic properties as spoken languages, with grammar that differs from English. It is used as a means of communication by Mute people who are unable to speak. It is expressed by movements of the hands and face. Facial expressions plays a very essential role in order to communicate in Sign Language. A mute person uses this language to talk to normal people. As a normal person being unaware of the language, bridges a communication gap between the two personnel. There requires an intermediate person who is aware of the language and assists in the process. Also the Sign Language is very dynamic and differs from place to place so it might be a very difficult task to communicate with a normal person.

Fig 1: Example of sign languages

From the figure it is observed that the sign language can be of the form letters or complete words. It can also be made to form complete sentences making proper meaning.

2. HARDWARE COMPONENTS

Arduino Nano: It is a Micro-Controller board based on Atmega 328P developed by Arduino.cc. It can operate on 5v and 3.3v and has a maximum current rating of 40mA. It has a 32kb of flash memory to store the program and another 2kb for SROM. It uses a crystal of clocking frequency of 16 MHZ. Arduino Nano when compared to other Arduino controllers is very compact. It has a total of 8 Analog Pins and a total of 14 digital pins. The pins 3,5,6,9,11 are used for pulse width modulation applications. It uses SPI and I2C Protocol for communication. The Digital pins 2,3 can also be used as external interrupt pins.

Fig 2 : Arduino Nano

Flex Sensors: A flex sensor is a type of sensor that measures the amount of deflection. The sensor is Stuck on a flexible surface and the resistance is being made to vary by bending it. It is also called as flexible potentiometer. A flex sensor can either be made by conductive ink, capacitive or fibre optic. It has two pins one for the input and the other for output. The same input pin is used for receiving data. The bend resistance ranges between 45k and 125k ohms with a tolerance of 30%. It is usually available in two sizes 2.2 inches and 4.5 inches.

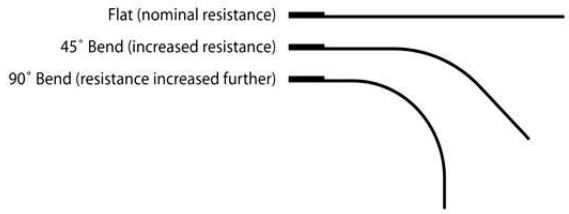

Fig 3 : Bending of a flex sensor

The resistance is directly proportional to the bending so when the bend angle increases, its resistance also increases. These bend values can be stored with the help of analog pins of the Microcontroller.

Gyroscope: A gyroscope is a device that measures position and orientation of the device to which it is fastened. One of the most popular gyro is the MPU6050. It is a Micro electronics mechanical bases system or simply MEMS. It also has a accelerometer integrated with it. It uses the I2C protocol for communication. It gives the values in the form of roll pitch and yawn or x,y,z axis. In order to read the values each axis needs to be connected to analog pin.

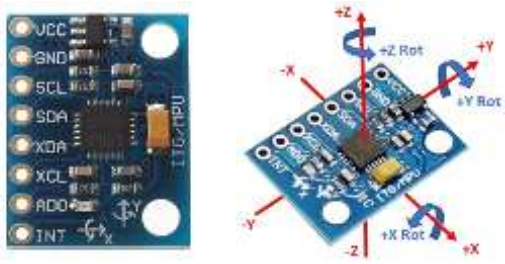

Fig 4: Gyroscope

Storage Module: An SD card module is an SPI communication based device that allows communication with the memory card and enables to read or write data on the memory card. The memory available on the EPROM is very less and so a memory is to be required in order to store large amount of data. The module is also being used for data logging. The data from the sensors can be stored in more readable form and can be used for further applications. In order to communicate it requires an SD library which provides few special functions.

Fig 5 : SD Card Module

Speaker and Amplifier: A Speaker in an electrical transducer that converts electrical audio signals to a sound. It is used to play the audio files stored in the memory chip. The output produced by this module is very low and hence there is a need to use an audio amplifier that takes the power from the battery and is used to amplify low power electronic audio signals from radio receivers or other devices.

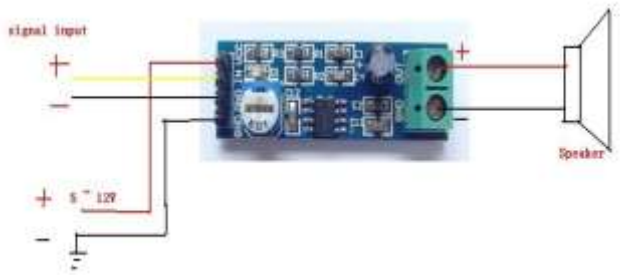

Fig 6 : Sound Amplifier Module

3. SOFTWARE PERIPHERALS:

3.1 Arduino IDE: Arduino Integrated Development Environment or simply Arduino IDE is used to write, compile and upload programs on Arduino compatible boards. It is based on C and C++ languages. In this the program code is divided into two sections, one is the setup part and the other is the loop part. The setup part is where all the variables are declared and the loop part is where the logic of the program resides and needs to be repeated. It also has an option to add various libraries created by various authors. Few of the commands that are commonly used are digitalWrite, digital Read, analogRead and analogWrite. The same syntax must be followed in order to use the function else it wont be identified. These are used to make the pins high and to get the data from sensors.

3.2 Audacity: It is a free open source digital audio editor and recording application software. It can also be used for post processing of various audio files. It is considered as one of the most popular application. The free and open nature of audacity has allowed it to become very popular in education, encouraging its developers to make the user interface easier for students and teachers. It is used to convert the mp3 files to wav files and reduce it to 8 bit as Arduino supports maximum of 8 bits.

3.3 Libraries: The Arduino environment can be extended through the use of libraries, just like most programming platforms. Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from Sketch>Import Library. A number of libraries come installed with the IDE, but you can download or create your own as its an open source platform.

All the libraries that are used in the program are depicted below along with their application:

- Wire.h - Allows communication with I2C devices. It is used to interface the gyroscope to the Arduino.
- SD.h – Allows reading from files and writing to files in the memory chip.
- SPI.h – Allows communication with SPI device as the master device. It is used to interface the Sd card module to Arduino.
- TMRpcm.h – Allows asynchronous playback of PCM or WAV files directly from SD card through a Speaker. It directly plays the audio files without actually loading it into the board.

4. INTEGRATION OF COMPONENTS:

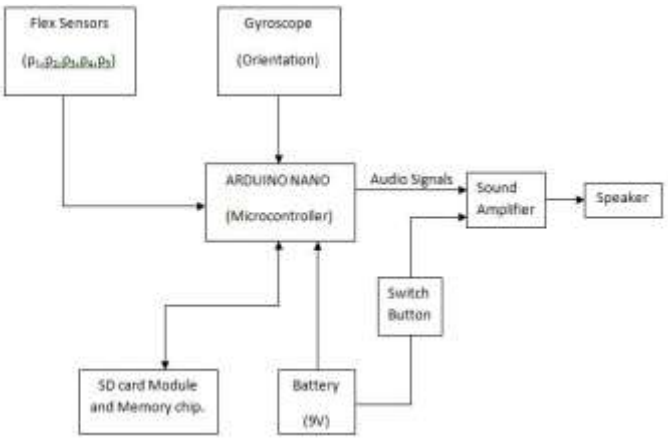

Fig 7: Block Diagram of Components

All the Hardware components are connected to the Arduino with the help of wires. The major components of the system are : Arduino Nano, Flex sensors, Battery and Switch, Sd card module and memory card, an MPU6050 Gyroscope, Sound Amplifier and Speaker. The Flex Sensors are connected to the analog pins of the arduino with the help of voltage divider circuit as shown below

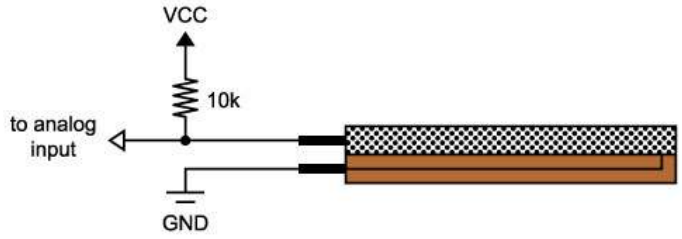

Fig 8 : Sensor connectivity to Arduino pins

All the five sensors are connected to analog pins in the same manner. This is the input to the microcontroller. Now the SD card module is connected to the SPI pins of the Arduino and the memory card is interfaced using the SD.h library. Here all the voice notes are stored. The voice notes are converted to wav 8 bit file using audacity software. The files are then ready to use. A gyroscope is connected to the arduino using I2C pins of arduino nano. Using the library wire.h it is interfaced and the output pins of gyro are connected to the analog pins to receive the orientation values of the device. The Speaker is connected to the arduino to play the audio files through it. It is connected through sound amplifier in order to amplify the signals so as to be loud and clear. A battery is connected through the switch so as to control the power supply to the components and use when ever required.

A program is dumped into the board so as to play a particular audio file for the combination of various sensor values. This can be done with the help of conditional loops and the functions within the audio library. These are tmrpcm.setVolume( ), tmrpcm.play("audio file name")

5. VOLTAGE DIVIDER CIRCUIT:

It is also called as potential divider circuit. In this circuit the voltage across the output is at fraction when compared to its input. This circuit divides the input voltage among the components of divider. As we know that flex sensors use the same pin as the input and output, it is connected to the pins with the help of this circuit. In the circuit, one of the resistor is fixed while the other resistor is variable that is the flex sensor. The resistance value of the fixed resistor decides the range of the readings obtained from the sensor. Mathematically the circuit is given as

$$V_{R(x)} = V_S \left(\frac{R_X}{R_T} \right)$$

Fig 8 : Mathematical Equation for voltage divider circuit.

In the above formula $V_{R(x)}$ is the output voltage, V_S is the input voltage, R_x is the fixed voltage, R_T is the total voltage i.e fixed voltage as well as variable voltage. In the Arduino the 5V is converted into 8 bits ie the value ranges between 0-1024. The value of fixed resistance is choosen so as to obtain maximum sensor range at the output terminal.

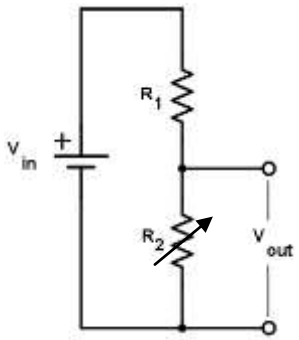

Fig 9 : Voltage divider circuit

As shown above the V_{out} is the output voltage and the flex sensor is connected at this position. The output values are received by the analog pins of Arduino Nano and the other end of the flex sensor is used as a ground pin. The resistance R1 is fixed and a constant voltage of 5V is supplied by the battery at junction $V_{in,}$ This way the same pin can be used to supply power to sensor as well as read the data from the sensor.

6. ADVANTAGES AND CHALLENGES:

6.1 ADVANTAGES:

- The cost of the device would be very less so affordability is not a concern.
- Easy to operate and consumes less power.

6.2 CHALLENGES:

- The chances of error is more due to the sensitivity of the flex sensor.
- Does not consider facial expressions for sign languages.
- Might be an issue for some individuals to carry everywhere.

7. CONCLUSIONS AND FUTURE IMPLEMENTATIONS

7.1 CONCLUSIONS

The glove is helpful to mute people who have the disability to speak. Traditionally the sign languages are translated by another person who has a knowledge about it. In the absence of that person it becomes a difficulty to communicate. The sensors that are placed on the fingers are calibrated in such a way that each combination of values picks a specific audio file. Also the gyroscope would be useful to add more signs as the same set of values with a different orientation would be considered different. This way actual sign languages can be used for communication. People can also store their preferred audio languages into the memory card with the same name so the program can identify them. A lot of signs can be stored with the various combinations and thus would reduce the communication problem to a certain level.

7.2 FUTURE IMPLEMENTATIONS

In the future, another set of sensors and gyroscope can be used for another pair of fingers so that it would accommodate place for more sign languages and a lot of real sign languages can be used. In the actual sign languages it requires use of both the hands and hence would be beneficial. The values from both the hands can be collected in a controller and a sophisticated program can be made so that the error can be reduced and with the help of logical AND these can be used to select more audio files.

Another way to implement the same objective but with a much efficient way is by the use of machine vision technology. Using a camera it can observe various hand movements and facial expressions which was a challenge in the previous method. The camera can be taught using machine learning and Artificial intelligence methods. Almost all signs can be added by this method and also the person would not require to carry the glove anywhere he moves. This way the error also can be reduced to negligible amounts. One would also have the facility to add their own signs with a friendly user interface.

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