# Smart Wearable Hand Device for Sign Language

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***Abstract—*** ***The existing smart wearable hand devices have some drawbacks such as the predefined set of values and use Bluetooth module which provides only short distance communication. Our proposed idea is to design a smart wearable hand device suitable for different users and to communicate for long distance. Our smart wearable hand device uses GSM module for long distance communication and user-defined data to suit for different users.***

***Keywords—*** ***GSM, Flex sensor, Machine learning, FSR, aPR33A***

## I. INTRODUCTION

The root word of the word communication is SICO, which is a Latin word meaning to share. Communication means to exchange or impart information by speaking, writing, actions or any other medium. The communication is said to be perfect when the message sent by the sender is received by the receiver and also is recognised by the receiver. People who are normal communicate mostly by speaking and sometimes by writing also. But the deaf and dumb people communicate with others by means of sign language. In India, about 15 million people are deaf and mute. Around 2.7 million express their thoughts through ISL (Indian Sign Language). This study focusses on the enhancement of machine learning through interpretation of the sign language by observing the finger gestures. The finger gestures are observed by using flex sensors. It's suitable for multi-users since the sign language differs from user to user.

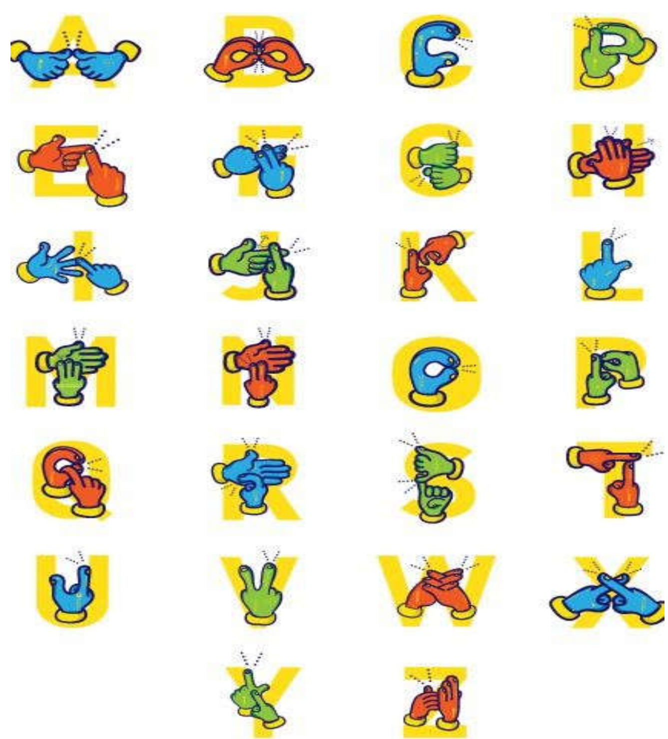

**Fig. 1 Indian sign language alphabets**

## II. SYSTEM DESIGN

*A. Hardware Design and System Flow*

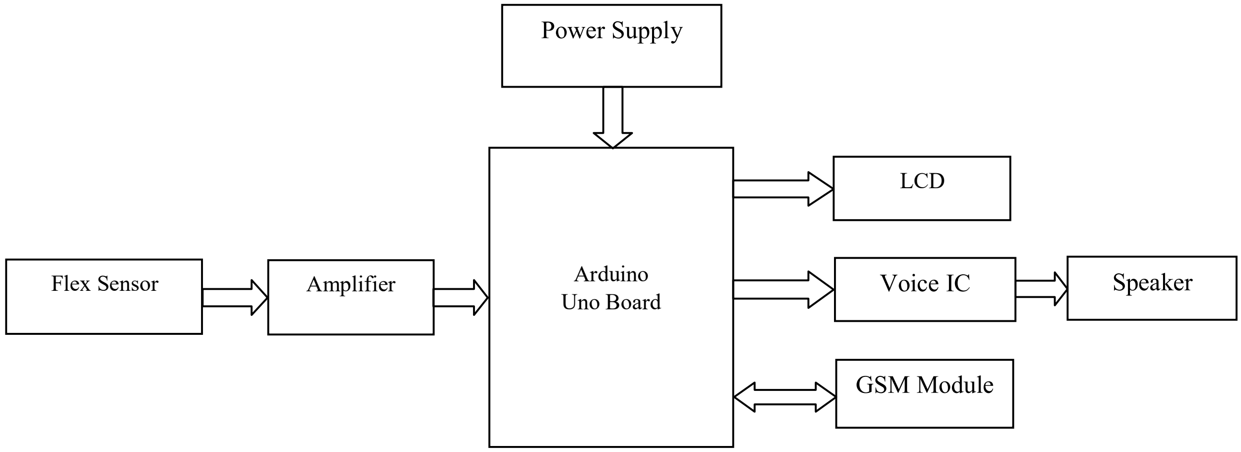


**Fig. 2 Block diagram of smart wearable hand device**

For this study, a custom-made wearable device was designed and mounted on a glove for easy access. Finger gestures are exploited through the flexion of flex sensors placed on the top of the finger. Through the flex sensors the sign input is given to the amplifier. This amplifier and an equivalent voice output is obtained.

*B. Force-Sensing Resistor*

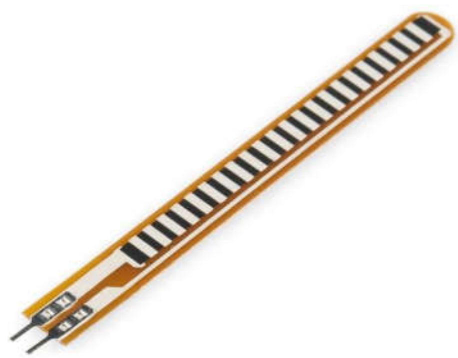

**Fig. 3 Flex Sensor**

Flex Sensor is a material whose resistance changes when a force or pressure is applied. They are also known as "Force Sensing Resistors" or "Force-Sensitive Resistor", and are sometimes referred to by the acronym "FSR". FSR has a conductive polymer, whose resistance changes with respect to the application of force to its surface. The sensing film consists of both electrically conducting and non-conducting particles suspended in a matrix. The particles are of sub-micrometre sizes. They are formulated in such a way that they have minimum temperature dependence, improved mechanical properties and increased surface durability. Application of force to the surface of the sensing film causes particles to touch the conducting electrodes, which in turn changes the resistance of the film. FSRs require a simple interface. FSRs are preferred over other sensors because of low cost and good shock resistance property.

*C. Voltage Divider*

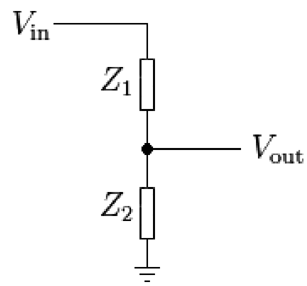


**Fig. 4 A simple voltage divider**

A voltage divider is a simple linear circuit. It produces an output voltage ($V_{out}$) that is a fraction of its input voltage ($V_{in}$). It's also known as a potential divider. Voltage division implies the partitioning of a voltage among the components of the divider. A simple voltage divider consists of two resistors in series. When an input voltage is applied across the two resistors, the output voltage is obtained from the connection between them. It's mostly used in creating a reference voltage and also as a signal attenuator at low frequencies.

*D. Arduino Uno*

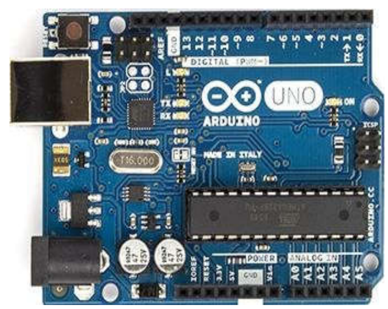


**Fig. 5 Arduino Uno R3**

Arduino Uno is a microcontroller board with ATmega328P microcontroller. It has 14 digital I/O pins. It consists of 6 pins which are used for PWM outputs, 6 pins for analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. To get started, connect it to a PC with a USB cable or you can power it with AC-to-DC adapter. "Uno" is an Italian word which means one and was selected to indicate the release of Arduino Software (IDE) 1.0.

*E. Liquid Crystal Display*

LCDs have materials which have both the properties liquids and crystals. It has two glass panels, between them is the liquid crystal material. The glass plates have the inner surface coated with transparent electrodes. They define the character, symbols or patterns that are to be displayed. Between the electrodes and the liquid crystal, are present the polymeric layers. They help the liquid crystal molecules to be in a defined orientation angle. Once a sufficient voltage is applied across the electrodes, the liquid crystal molecules will be aligned in a specific direction. LCDs have a thickness of only a few millimetres. They are compatible with low power circuits since they consume very less power. They are widely used in watches, TVs and even in small computers.

*F. GSM modem*

GSM stands for Global System for Mobile communication. It's a special type of modem that works similar to a mobile phone by taking in the SIM card and operating over a subscription to a mobile operator. It refers to a modem which supports one or more protocols, which includes GPRS and EDGE and also WCMA, UMTS, HSDPA and HSUPA. It also exposes an interface which allows applications like NowSMS for sending and receiving messages. Like a mobile phone, the mobile operator charges for sending and receiving messages. In order to send and receive messages, GSM modem must have an "extended AT command set".

To get started with SMS, GSM modems are a fast and efficient way since it doesn't require a special subscription to an SMS service provider. Since the sender is paying for message delivery, these modems are a cost-effective solution for receiving SMS messages. To start with, insert a GSM SIM card into the modem. Now connect it to the USB port on the PC.

With proper cable and a software driver to connect to a USB port on your PC, a GSM modem could also act as a standard GSM mobile phone. GSM modem is usually preferable to a GSM mobile since mobile phones have some compatibility issues. It is similar to the issue associated with MMS messaging, where if you like to receive MMS messages with the gateway, the modem interfaces present on most GSM phones will only permit to send the MMS messages. The reason is that, the mobile phones without forwarding the MMS message notifications via modem interface, processes them automatically.

One point to note here is, all the mobile phones do not support the modem interface to send and receive SMS messages. Even some of the popular mobile phones like Blackberries, iPhone and Windows mobile devices do not support this interface. Nokia mobiles which use S60 interface that is, Symbian based only supports the sending of SMS messages via modem interface and not the receiving part via modem interface.

Mind you, while installing the GSM modem or while connecting the GSM mobile phone to the computer, make sure that the appropriate Windows modem driver is installed from the device manufacturer. Even if the Windows driver is not available for your modem, you can make use of Standard or Generic 33600 bps modem driver which is built into windows. To make this configuration simpler, the gateways like NowSMS and MMS Gateways will communicate with the device through this driver.

*G. Voice IC aPR33A3*

- Has an operating voltage range from 3V to 6.5V.
- Requires no external ICs.
- Requires minimum external components.
- User-Friendly.
- Does not require Programming & Development Systems.
- Does not require battery backup.

*1) Description:*

Customers never compromise on the audio/voice. Wherever they are in whatever format they want to use, they want a clear sound. APLUS provides a technology for enhancing a listener’s audio/voice experience. The aPR33A3 series are the audio processors which are very powerful rendering high-performance audio ADCs and DACs. They are a fully integrated solution which offers high performance and unparalleled integration. It is done using analog input, digital processing and analog output functionality. They also incorporate all the functionalities required to perform the demanding audio/voice applications.

The aPR33A series C2.0 is designed mainly for a simple key trigger. The users can record and also playback the messages by a switch, averagely for about 1, 2, 4 or 8 voice message(s). It provides a power-management system. When unused, users can allow the chip to be in the power-down mode. As a result, electric current consumption will be reduced to 15uA and using time can be increased with the help of batteries.

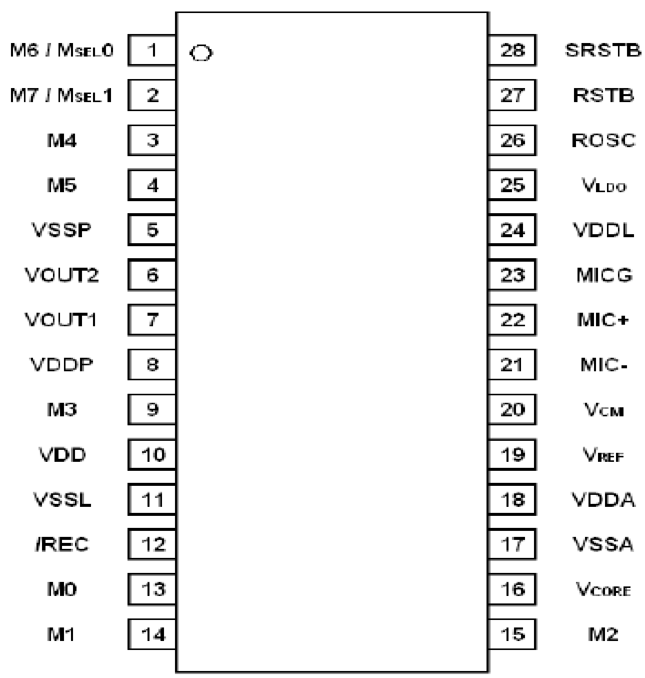


**Fig. 6 Pin diagram of aPR33A3 IC**

| Pin Names | Pin No | TYPE | Description |
|---|---|---|---|
| VDDP<br>VDD<br>VDDA<br>VDDL | 8<br>10<br>18<br>24 | | Positive power supply. |
| VSSP<br>VSSL<br>VSSA | 5<br>11<br>17 | | Power ground. |
| $V_{LDO}$ | 25 | | Internal LDO output. |
| $V_{CORE}$ | 16 | | Positive power supply for core. |
| $V_{REF}$ | 19 | | Reference voltage. |
| $V_{CM}$ | 20 | | Common mode voltage. |
| Rosc | 26 | INPUT | Oscillator resistor input. |
| RSTB | 27 | INPUT | Reset. (Low active) |
| SRSTB | 28 | INPUT | System reset, pull-down a resistor to the VSSL. |
| MIC+<br>MIC- | 21<br>22 | INPUT | Microphone differential input. |
| MICG | 23 | OUTPUT | Microphone ground. |
| VOUT1 | 7 | INPUT | PWM output to drive speaker directly.<br>DAC option. |
| VOUT2 | 6 | INPUT | PWM output to drive speaker directly.<br>DAC output. |
| /REC | 12 | INPUT | Record Mode. (Low active) |
| M0 | 13 | INPUT | Message-0. |
| M1 | 14 | INPUT | Message-1. |
| M2 | 15 | INPUT | Message-2. |
| M3 | 9 | INPUT | Message-3. |
| M4 | 3 | INPUT | Message-4. |
| M5 | 4 | INPUT | Message-5. |
| M6 / $M_{SEL}0$ | 1 | INPUT | Message-6, Message select 0. |
| M7 / $M_{SEL}1$ | 2 | INPUT | Message-7, Message select 1. |

**Fig. 7 Pin description of aPR33A3 IC**

*2) Record message*

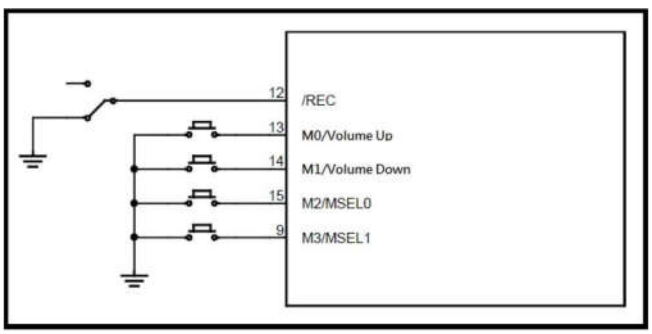


**Fig. 8 Recording circuit for a 2-message mode**

When the /REC pin drove to $V_{IL}$, the chip will be in the record mode. As soon as the message pins (M0, M1, M2,…M7) drove to $V_{IL}$ in record mode, the chip will play a beep tone and the message recording starts. To indicate the ending of the message record, the chip will play the beep sound, two times until the message pin is released. The old messages will be replaced when the user records the same message again. The Fig. 8 shows a recording circuit for a 2-message mode. We connected a slide-switch between /REC pin and $V_{SS}$ and also 8 tact-switches between pins M0 ~ M7 and $V_{SS}$. When the slide-switch is fixed in $V_{SS}$ side and tact-switch is pressed, the chip will start recording the message, until the user releases the tact-switch. After reset, /REC and M0 ~ M7 pin will act as a pull-up to $V_{DD}$ by the internal resistor.

*3) Playback message*

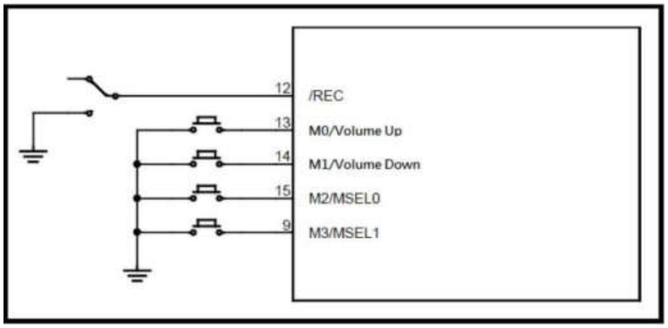


**Fig. 9 Playback circuit for a 2-message mode**

When the /REC pin drove to $V_{IH}$, the chip will be in the playback mode. As soon as the message pin (M2 or M3) drove to $V_{IL}$ in playback mode, the message playback starts. This continues until the message pin drives from $V_{IH}$ to $V_{IL}$ or at the end of the message. The Fig. shows a recording circuit for a 2-message mode. We connected a slide-switch between /REC pin and $V_{SS}$ and also 8 tact-switches between pins M2 ~ M3 and $V_{SS}$. When the slide-switch is fixed in $V_{SS}$ side and tact-switch is pressed, the chip will start recording the message, until the user releases the tact-switch. After reset, /REC and M0 ~ M3 pin will act as a pull-up to $V_{DD}$ by the internal resistor.

## III.RESULT

**TABLE I**
**OUTPUT OF THE HAND DEVICE**

| **S.No** | **Value 1** | **Value 2** | **Value 2** | **Value 3** | **Value 4** | Output |
|---|---|---|---|---|---|---|
| 1. | 205 | 354 | 354 | 464 | 412 | Project output |
| 2. | 226 | 215 | 215 | 354 | 487 | Hi all ! |
| 3. | 273 | 384 | 384 | 482 | 423 | Hello ! |
| 4. | 295 | 245 | 245 | 487 | 345 | Good day |
| 5. | 309 | 241 | 241 | 247 | 458 | How are you? |
| 6. | 332 | 454 | 454 | 216 | 246 | Doing good |
| 7. | 372 | 214 | 214 | 426 | 346 | Be happy |
| 8. | 394 | 245 | 245 | 210 | 489 | What doing ? |
| 9. | 248 | 359 | 359 | 498 | 321 | All the best |
| 10. | 420 | 347 | 347 | 249 | 215 | Good Luck |
| 11. | 446 | 267 | 267 | 371 | 465 | Need food |
| 12. | 468 | 357 | 357 | 200 | 445 | Need water |
| 13. | 494 | 247 | 247 | 302 | 258 | Call the doctor |
| 14. | 347 | 274 | 203 | 482 | 473 | Bye |

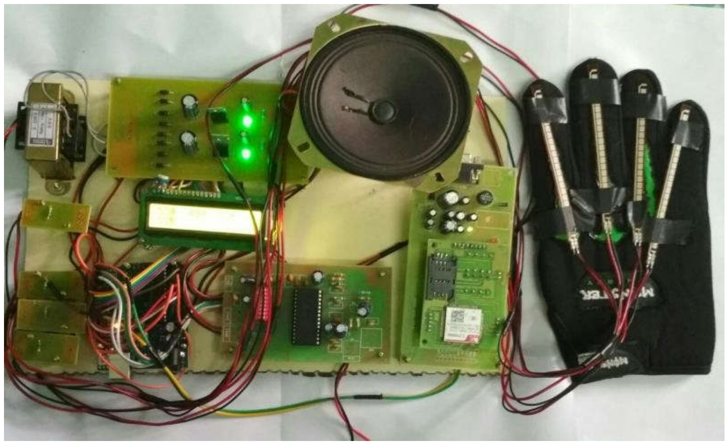

**Fig. 10 Smart wearable hand device**

*A. DESCRIPTION*

The project's main motto is to have a user defined hand device. The glove is usable for all the people. They would only have to get trained in it and also can generate new datasets if they like to have a higher prediction accuracy than the standard devices or to feed in new signs into the device. It's mainly focussed on the people with special needs who can't speak. Not only for signing, it can also be generalised to gesture recognition. As we can see from the above results, the readings from the four flex sensors which are the result of the actions made by the user, are converted to speech. Unlike the other hand devices which have only predefined values, these four sensor values can be defined by each user and the corresponding output is obtained as a speech.

## IV. CONCLUSION

A new technique based on sign language was proposed with advantage of machine learning technique. The proposed technique is suitable for multiple users with user defined signs. It also helps us to transmit sign equivalent message through GSM module.

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