# SIGN LANGUAGE TRANSLATOR

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# ABSTRACT

This project report describes the design of a Glove based Sign Language Translator System that is capable of translating hand gestures that entail the American Sign Language(ASL) to their corresponding meanings in order to enable the hearing-impaired and the mute community to make conversations or seek help in case of emergencies effectively. This project is an Arduino based construction that interfaces three different types of sensor elements in order to process the hand gestures and the individual digit (finger) orientations to suit the alphabet wise indication. This circuitry works in tandem with a Bluetooth module that relays the translation to the user's smartphone, engaging mobility and a hassle free interface that only requires the person on the other end to have a reading ability. This project can further be enhanced by introducing phrases that are commonly used in the ASL and by attempting to make a more compact circuit. The outcome of this project is indicative of the scope for further research in terms of design excellency and innovation specific to public and market needs.

# 1. INTRODUCTION

A sign language is a language that uses visual-manual modality for conveying information and is fully fledged with its own language and lexicon. For those belonging to the hearing impaired and mute community, sign language serves as a crucial way of expressing themselves and is a means of effective communication when auditory abilities are compromised. This project attempts to model the American Sign Language(ASL), which is a commonly used sign language globally, into an interpretive language for those unfamiliar with the ASL.

## 1.1 PROBLEM DESCRIPTION

In a world where almost every human interaction results in a necessity to establish communication, the hearing-impaired and the mute communities experience a setback when it comes to effective communication, either because they are unable to convey themselves properly or the person involved in the conversation is not equipped to understand the sign language. This may lead to them being subjected to a feeling of lack of inclusivity, a fear of missing out on experiences and a vulnerability that comes with miscommunication or no communication at all during emergencies.

## 1.2 PROJECT SCOPE

There is an inherent gap that arises from communication between two people, one of them who does not understand the ASL, and the other who can converse only in ASL. This project aims to bridge that gap between any two given people by interpreting the fingerspelling of individual alphabets for the person involved in conversation. This project can also be used in workshops and training centres that aim to propagate understanding sign languages, as training kits to master the ASL.

## 1.3 DOMAIN STUDY

A brief literature review confined to the deaf-mute communities brought to light a number of discrepancies and issues that people with such impairments face on a daily basis. This involved being unable to communicate spontaneously with people arising from the uncertainty in deciphering if the person is familiar with ASL or not, being misunderstood on multiple occasions, and being unable to seek help during emergencies. Thus, this project is entirely dedicated to obliterating the boundaries that hold the deaf-mute from going about their regular day with no hiccups.

# 2.SYSTEM REQUIREMENTS

The following are the hardware, software and operating system requirements for the building of the project as well as for its working.

## 2.1 HARDWARE REQUIREMENTS

**For the project build:** Any computer that can support the software programs mentioned in 2.2, a microcontroller based board, Bluetooth module that is microcontroller compatible and sensing elements.

**Components List:**

1. Arduino Mega –(1)

2. Accelerometer[MPU6050] –(1)
3. Flex Sensors –(5)
4. LDRs –(9)
5. 10k resistors –(9)
6. 47k resistors –(5)
7. Single strand copper wires and Jumper cables.

**For the project in action:** A smartphone with a display screen that supports Android applications.

### 2.2 SOFTWARE REQUIREMENTS

**For the project build:** Arduino IDE, Android Studio, KiCad, Processing 2(optional)

**For the project in action:** Android version that is Android Studio compatible

### 2.3 OPERATING SYSTEM

**For the project build:** Windows 7 and above

**For the project in action:** Android OS version 2.0 and above

# 3.SYSTEM DESIGN

System design involves the implementation of an abstraction from the problem domain that describes the superficial functionality of the system. The Glove based Sign Language Translator system uses the Top-Down design methodology with the Specifications and Requirements constituting the initial stages and the final stages concluding with Debugging and Subsystems Integration.

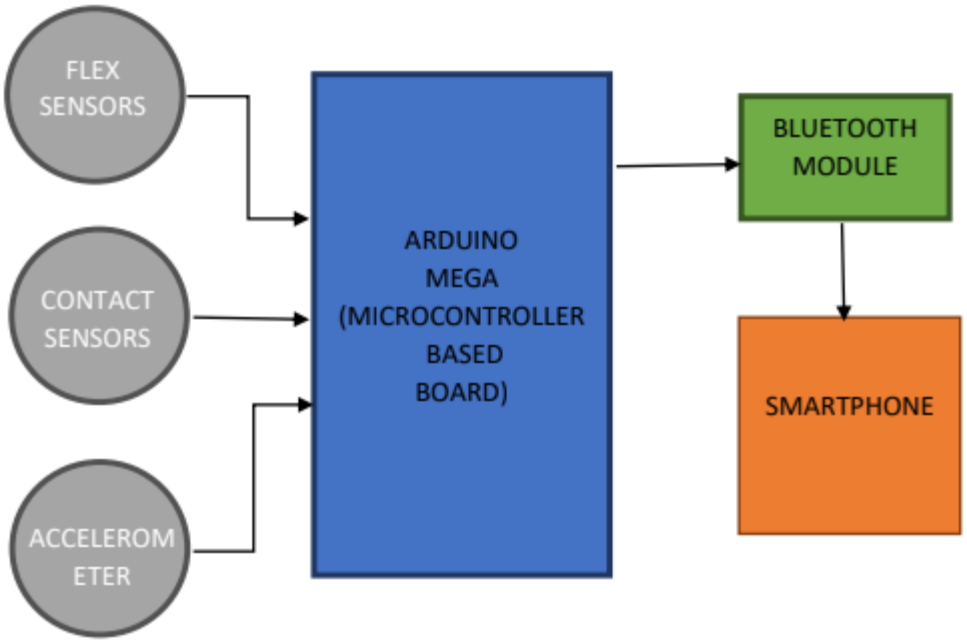
### 3.1 SYSTEM DESCRIPTION

The Glove based Sign Language Translator is an integration of multiple subsystems that consist of three different sensor elements, a Bluetooth module as well as a customized self made PCB board that houses discrete electronic component such as resistors, input/output wires and connections that run across the glove connecting all subsystems together with the Arduino Mega.

### 3.2 SYSTEM ARCHITECTURE

The architecture of the system is that of a simplistic construction which involves basic electronic components that do not require any special prerequisites or operating conditions. The system boasts of a minimalistic approach to integration of components as there is no complex circuitry involved.

#### 3.2.1 BLOCK DIAGRAM




### 3.2.2EXPLANATION OF BLOCK DIAGRAM

The block diagram consists of the Arduino Mega, a microcontroller board, at the heart of the circuit to which the rest of the components are interfaced. The flex sensing block consists of five flex sensors each dedicated to one of the five fingers. They are used to determine the extent to which each of the fingers bend for a given alphabet. Such permutations are numerous and hence enable unique five finger orientation combinations for most alphabets.

The contact sensing block consists of LDRs that are responsive to the amount of light incident on them and outputs readings accordingly. When two fingers are in contact via tips or the finger sides or are folding against the palm, there is no light incident on the LDRs as compared to when the fingers are openly stretched, and this dynamic change in value is noted and is used to characterize the number of fingers in contact with each other and the palm as well.

The accelerometer block consists of one MPU6050 module that is capable of processing the orientation of the hand by calibrating its axial readings in terms of yaw, pitch and roll. It is placed on the back of the palm to keep track of changes in the wrist movement and hence the hand position.

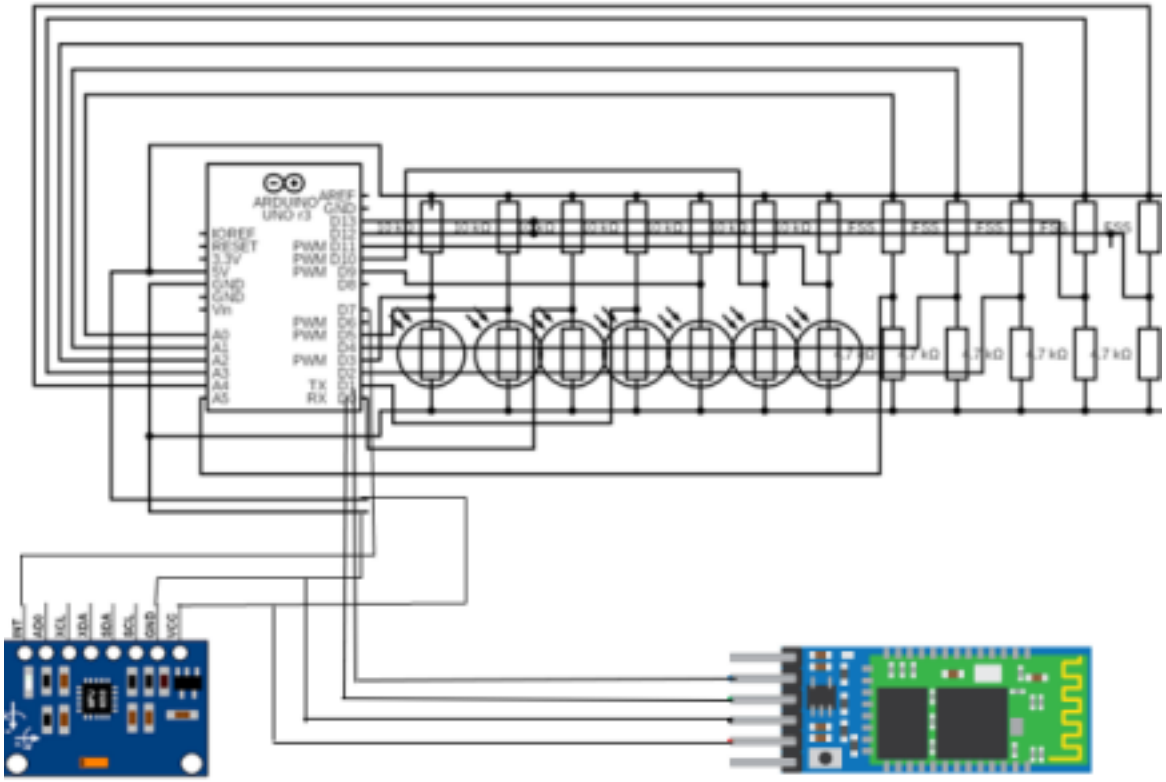
The outputs from all three sensor types are fed as input to the Mega to be read by its reception line. The Mega then processes all the sensor information via the uploaded code and produces outputs according to the code specifications and user requirements. This output from the Mega is relayed to the Bluetooth module which further modulates the output for suitable wireless transmission of data and information to the smartphone.

The app on the smartphone serves as in interface between the Bluetooth module and the phone. The connection is established via Bluetooth of the phone therefore, enabling mobility to connect to the glove from any phone that has a Bluetooth connectivity and an Android play store that has the capability to download the required app (E.g. – Bluetooth terminal). The phone is used as a display device to show the translated alphabet output from the sign gesture.

### 3.3 SYSTEM WORKING

The working of the Sign Language Translator System can be defined by the circuit diagram and its explanation.

### 3.3.1 CIRCUIT SETUP DIAGRAM



### 3.3.2 COMPONENT DESCRIPTION:

1. Arduino Board: The Arduino MEGA ADK is a microcontroller board based on the ATmega2560. It has a USB host interface to connect with Android based phones, based on the MAX3421e IC. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Mega was comsidered to be used for its functionality of operating within 16 analog inputs. The $I^2C$ connections are not multiplexed with analog pins in mega. It enables us to use analog pins for other purposes.

2. Flex Sensors: 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. The[10] flex sensor gives the values for the bending of each finger and transmits it to the Arduino and is read by it.
3. Contact Sensors: A photoresistor (or light-dependent resistor, LDR, or photo-conductive cell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light-activated and dark-activated switching circuits. The LDRs are places between each finger to detect the contact such that when the value is high the fingers are close together. There are LDRs placed in the face of the finger too which detects the face of two fingers touching each other.
4. Accelerometer: An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is

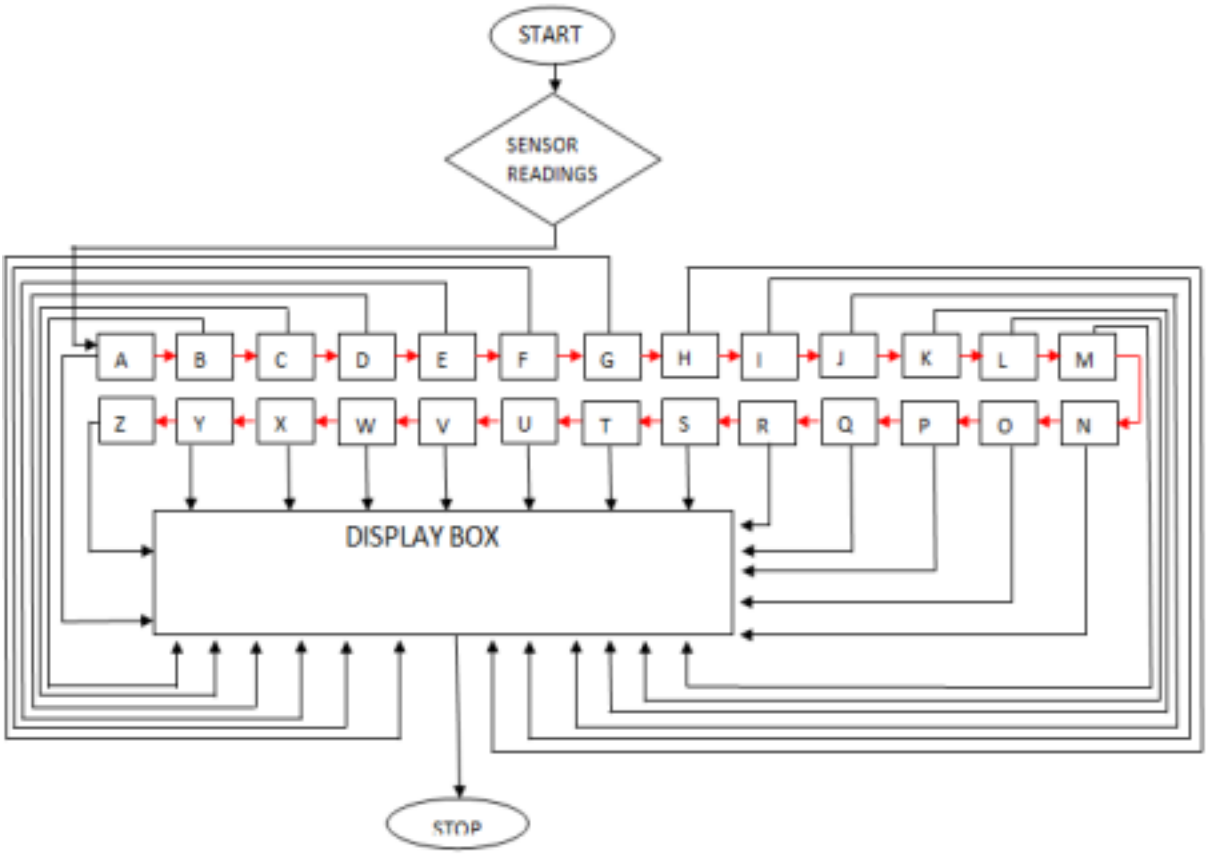
the case with many mobile devices, dynamic to sense movement or vibrations. Acceleration is the measurement of the change in velocity, or speed divided by time. It is used to detect any motion in the hand thus giving values corresponding to alphabets which require change in the orientation of the hand.

5. Bluetooth Module: HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This 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 Blue-core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

### 3.3.3 EXPLANATION OF WORKING

The circuit diagram consists of an Arduino Mega as the microcontroller with most of its Analog pins(A0-A13) interfaced with the flex(A0-A4) and contact(LDRs(A5-A13)) sensors. The accelerometer has its SDA and SCL connected to its corresponding pins in in Mega and its interrupt pin to digital pin 2. Each of the flex sensors are connected serially to one 47k resistance, this is used to impede any excess current flowing from the pins to the flex. Each of the LDRs are connected to 10k resistance for the same purpose. The entire circuit is powered by the Arduino Mega Vcc pin of 5V and accordingly, a GND connection is also given. When the hand gesture is carried out and an alphabet is indicated, the Mega takes record of the readings from each of the five flex sensors, each of the nine LDRs, and the accelerometer orientation to gauge the alphabet being indicated, as defined by the code that models the ASL.

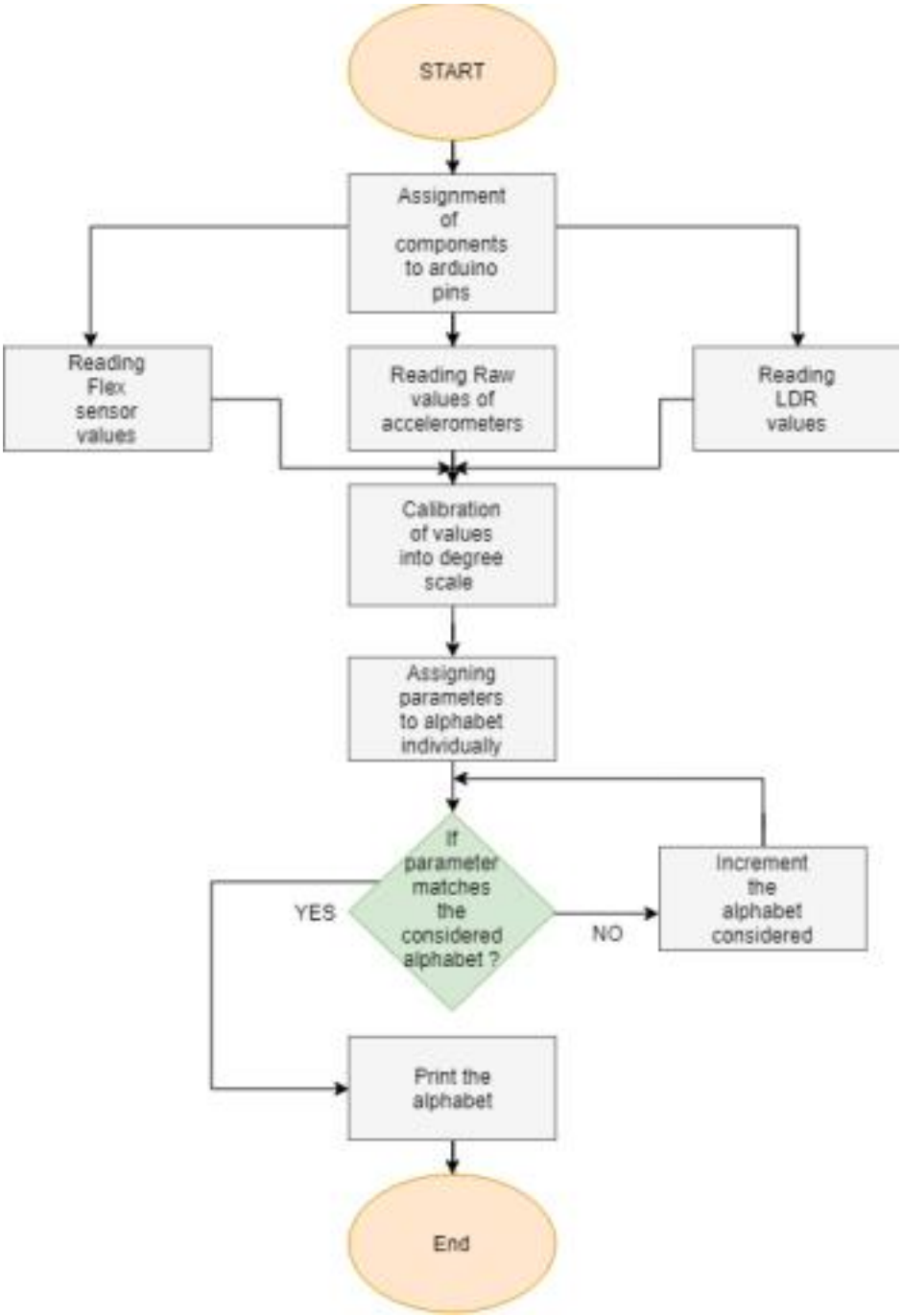
### 3.4 DATA FLOW DIAGRAM




## 4. IMPLEMENTATION

The circuitry under consideration can be modelled to work as per application requirements by defining a code that embodies what the abstraction intends for the system to do. The Arduino code for the Sign Language Translator is given in the appendix. The code and parameters can be altered according to specific conditions as there are varying factors such as light as we use LDRs. The model firstly is made on the bread board to ensure the working of the same. It is then simplified in anyway found necessary. The additional contacts and components other than that of Mega are soldered together on a PCB which is designed on a software such as Eagle or kiCad. The best attempt to explain the implementation is made using the help of data flow chart and program code algorithm. The outlook is made to look like a professional product with the help of three layers of glove to ensure the safety of the
circuit as it is a completely independent and wireless model when it is powered with batteries.

## 4.1 PROGRAM FLOW CHART



# 5. CONCLUSION

The Glove based Sign Language Translator is a system that is robust in ways that helps contribute to making communication easier for those constituting the deaf-mute communities. The visual-manual modality of the sign language can longer be a hurdle when it comes to effective communication. Though the benefits outweigh its constraints, the limitations require serious addressing via further product enhancements.

## 5.1. ADVANTAGES AND LIMITATIONS

### 5.1.1 ADVANTAGES

The Glove based Sign Language translator device offers the following pros

1. It is completely portable, with all the components fit snugly into the glove in their respective compartments.
2. It possesses wireless transmission from the Mega to the smartphone.
3. It translates all the English alphabets, thereby providing effective communication that counters the problem description, and is quick in response 4. It has skin-safe circuitry since all the wiring is carefully insulated and runs along a cloth glove that lies above the skin.
5. There is no need for assembly of the discrete parts as they're all housed on a compact PCB.

### 5.1.2 LIMITATIONS

1. It cannot translate gestures involving phrases.
2. It is highly dependent on light due to the use of LDRs.

## 5.2 FUTURE ENHANCEMENTS

1. A better way of identifying contact can be introduced to the circuit in the place of LDRs to obtain a better performance regardless of the ambience of use.
2. Phrases of ASL can be included in the system by modifying the robustness of the sensors and using versatile sensing elements as well.
3. A two-way response system i.e. sign-English and English-sign can also be established
4. Similar circuitry for those who are mute as well as visually impaired can be built and integrated to cater to the needs of a wider group of people.

# 6. REFERENCES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