

# American Sign Language Education in the Virtual Reality Environment for Deaf Communities

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## Abstract

The COVID-19 pandemic has changed the way we learn and receive an education. One of the unique challenges that people with hearing impairments have faced during the pandemic is communication in remote education environments. The current e-learning Virtual reality platforms do not provide user-friendly support systems such as American sign language (ASL) for hearing or speech disabilities. Our research explores how Augmented Reality (AR) or Virtual Reality (VR) can help in applying the learning methods to assist people with hearing or speech disabilities. We developed a prototype to recognize and translate English alphabet sign language letters from the real-time computer camera feed based on the ASL standards. This ASL Interpreter application can be used by deaf people to seek help for translating their thoughts or ask for medical assistance. Our prototype demonstrated that a computer camera can be used to translate hand gestures. Currently, we are integrating our ASL interpreter with the VR environment. We are also exploring ways to extract sign language hand gestures from cameras and use machine learning to translate these gestures to written or spoken words that will highly help deaf people and non-disabled people to communicate freely. In the future, we will work towards developing a mobile application prototype that uses artificial intelligence to mimic and recognize patterns specific to hand and body gestures that can translate spoken words into sign language and vice versa. The overall goal of the project is to enhance the communication process for deaf people on e-learning VR platforms.

## Motivation

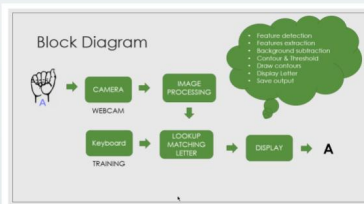
- The COVID-19 pandemic has challenged the way people with hearing impairment learn in the remote learning environment.
- Hearing impaired people can't read lips because of the face masks.
- Many people who work online don't have reliable internet.
- Video calls with glitching or lagging pictures make signing impossible.
- Closed captioning can be unreliable and can be delayed during zoom calls also sometimes not provided.
- VR can help in applying the learning methods of sign language.
- Is the camera or cameras on the VR headset a good device to read sign language.

## Background

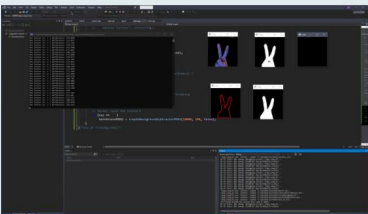
- Gesturing is a natural part of human communication and becomes more and more important in AR/VR interactions [4].
- E-learning platforms enable us to learn while using the Web as a communication channel. While it lowers many access barriers, especially geographical and time-related, by itself it does not solve the issue of enhancing inclusion for students regardless of their sensory abilities. [3]
- Virtual Reality is fast becoming another tool that can be added to the learning environments. In the area of visualization, it offers the ability to climb into environments, listen to them, perhaps even touch objects, thus providing a better sense of space than other options. [5]
- Computer/cellphone cameras can play an important role in capturing hand gestures and can also be used to interpret these gestures and translate sign language into words or text format [1].

## Approach

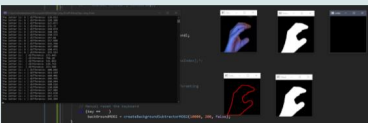
- The proposed system uses the Convolutional Neural Network (CNN) architecture to design the sign language interpreter.
- The technology can help in decoding the alphabets and translating them into words or sentences.
- The proposed system acts as a mediator between mute-deaf people and everyone else by converting sign gestures into text/speech.
- The sign language interpreter prototype will be embedded in the virtual reality environment to design an e-learning environment for remote sign language education [2].



The above diagram shows the software flow of the system.



The screenshot shows the system running and detecting ASL alphabets

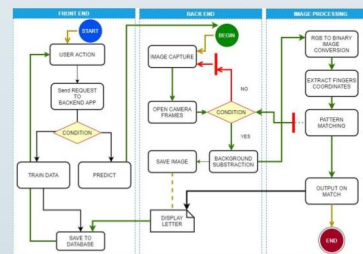


## Development

- Developed a model that can help society in a broader way by bridging the communication gap between Deaf-Muted people and everyone else.
- We propose a system, acting as an interface between the Deaf-Mute community and non-deaf people based on American Sign Language (ASL).
- The speech Conversion system helps in decoding those symbols without the need of an expert person who understands sign language.
- The feature detection is implemented using various contour analysis and feature extraction built in the OpenCV Library.
- The hand feature detection is taken through any type of camera or webcam connected to a computer which is then processed into a binary image upon which contour analysis is done and to optimize such actions using OpenCV functions.
- The extracted feature is then passed into the neural network algorithms which pass the feature through various layers and predict a single output which is then mapped to a text file.



The above image show the integration of the proposed system into the VR Game



The above image show the system architecture for the sign language interpreter.

## Conclusion

- We have designed and created a virtual world where individuals can learn ASL in a virtual environment that uses gamification methods.
- This research presents the implementation of a system that aims to translate American Sign Language gestures into text.
- The system is based on an image processing approach where a video camera is utilized to capture the hand movements.
- After the hand is detected and tracked using Hausdorff algorithm employing C++ and OpenCV library functions, frames are periodically captured and processed.
- Background subtraction is first applied, then thresholding and contouring. After contouring, the image is sent to be compared to a set of images in a reference database.
- The comparison is based on image difference. A threshold level is experimentally determined to decide between a match or mismatch.
- In case of a match, the meaning of the matched image is displayed onto the screen along with the character.
- Currently we are integrating the system to the VR E-learning game.
- Future work will include development of a mobile application prototype that uses artificial intelligence to mimic and recognize patterns specific to hand and body gestures in order to translate spoken words into sign language and vice versa.

## References

- [1]MARIABASTILLAS. 2011. Real-Time Hand Gesture Detection and Recognition Using Simple Heuristic Rules.
- [2]Helene Brashear, Valerie Henderson, Kwang-Hyun Park, Harley Hamilton, Seungyon Lee, and Thad Starner. American Sign Language Recognition in Game Development for Deaf Children. 8.
- [3]Paulo Martins, Henrique Rodrigues, Tania Rocha, Manuela Francisco, and Laetitia Morgado. 2015. Accessible Options for Deaf People in e-Learning Platforms: Technology Solutions for Sign Language Translation. Procedia Computer Science 67, (2015), 263-272. DOI:https://doi.org/10.1016/j.procs.2015.09.270
- [4]Lin Shao. Hand movement and gesture recognition using Leap Motion Controller. 5.
- [5]Aurelijus Vaitkevicius, Mantas Tarozis, Tomas Blažauskas, Robertas Damaševičius, Rytis Maskeliūnas, and Marcin Woźniak. Recognition of American Sign Language Gestures in a Virtual Reality Using Leap Motion.

## Acknowledgements

- City University of New York (CUNY)
- Borough of Manhattan Community College (BMCC)
- Computer Information Systems Department (CIS)
- CUNY Research Scholar Program (CRSP)
- Mentor: Dr. Mohammad Azhar