IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, May 2024

Sign Language Interpreter for Physically Challenged People

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Abstract*: This study introduces a novel sign language interpreter designed to improve accessibility and communication for those with physical disabilities, particularly those who experience hearing loss. Through the use of cutting-edge artificial intelligence and machine learning algorithms, the technology interprets sign language movements in real-time, removing social, professional, and educational communication barriers. By means of ongoing cooperation among researchers, technology developers, and individuals with physical disabilities, this invention hopes to make a substantial contribution towards the development of a more inclusive society. People of all physical capacities can actively interact, participate, and succeed in such a community. The fundamental ideas of a revolutionary technology that promotes acceptance, equality, and understanding at the formal, academic level are captured in this abstract.*

Keywords: TTS (Text-To-Speech), Feature Extraction

I. INTRODUCTION

It is impossible to overestimate the significance of excellent communication in a world growing increasingly multicultural and linked. Sign language is an indispensable communication tool that connects the Deaf and hard of hearing to the outside world. On the other hand, the communication gap that commonly occurs between those who are competent in sign language and those who are not is something that has long been reason for concern. The Sign Language Interpreter project is creating a sophisticated and useful system that serves as a link between spoken or written language and sign language in order to solve this issue. The goal of this project is to create a comprehensive real-time system for sign language interpretation and translation so that Deaf and hard of hearing people can communicate easily.

II. EXISTING WORK

In 2015, Anitha and Vijayakumar introduced a novel Sign Language Interpreter that combines wearable technologies and fuzzy logic. Real-time interpretation of sign language gestures is made possible by the device, which makes use of flex sensors and an IMU integrated into a glove. Its functions include text and speech translation from signs, data processing with a fuzzy logic controller, and the ability to record complex finger movements. With its capacity to address both gesture unpredictability and real-time processing limits, this technology promises seamless communication for those with hearing impairments. An important step forward in closing the communication gap between the hearing and the deaf communities is the integration of sensor technologies with fuzzy logic (Anitha & Vijayakumar, 2015).[1]

"Smart Translation for Physically Challenged People Using Machine Learning," 2022. It is highlighted how important sign language is as a communication tool for people who have trouble hearing or speaking. It highlights the challenges brought about by the communication divide between the deaf community and the general public, as well as the restricted adaptability of the current sign language systems. The initiative will use a two-part system to address this gap. The first part focuses on presenting pre-made Indian Sign Language (ISL) images or recorded sounds as text.[2]

Sign Language Interpreter Using Deep Learning (2023). Significant obstacles to communication exist for people with speech or hearing impairments. This In particular, research focuses on using deep learning models to translate and recognize signals from isolated American Sign Language (ASL) video frames. These models include Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU). Using the ASL dataset, transfer learning and data augmentation techniques are used to improve the performance of the deep learning model. The outcomes show promise, with an amazing 95% accuracy rate in identifying signs from ASL datasets. The ultimate purpose of the project is to provide a more effective and natural form of communication for those who have hearing loss, allowing meaningful interaction with non-sign language learners.[3]

The initiative aims to bridge communication gaps among voice-challenged individuals in India by introducing wearable technology for hand gesture recognition (HGR). Utilizing inertial measurement unit (IMU) and flex sensors within a glove, it records intricate finger and hand movements, mapping them to the Indian Sign Language (ISL) lexicon. Advanced machine learning techniques like Dynamic Spatio-Temporal Warping (DSTW) and Bidirectional Long-Short Term Memory (BiLSTM) ensure accurate gesture recognition. Challenges included ensuring correctness and reliability of gesture recognition, accommodating subtle differences in hand movements, and enabling real-time translation. Integrating wearable sensors with machine learning efficiently marks a significant step towards seamless communication for the voice-challenged population in India.[4]

Eleftheria et al. (2013) offers a cutting-edge gamified augmented reality learning platform that enhances cultural education and lifetime learning. In order to better understand the potential of immersive virtual reality (VR) in education, their study surveyed the literature from 2013 to 2014 using resources like Web of Knowledge, Google Scholar, and Scopus. Although the Oculus Rift's portability and low cost originally drew their attention, they discovered few outcomes that were unique to it. As such, they turned their attention to head-mounted displays and found solutions that were more in line with augmented reality (AR) than virtual reality (VR). Their findings highlight how immersive technologies are changing the face of education and opening doors to more dynamic and interesting learning opportunities.[5]

The International Journal of Human-Computer Studies' Rempel, Camilleri, and Lee investigate hand gesture design for HCI, using cues from sign language. To help create natural and instantly recognizable computer motions, their study examines the comfort levels of hand movements among

24 experienced sign language interpreters. They pinpoint uncomfortable hand postures, such bowed wrists or strange finger arrangements. The significance of designing computer gestures that strike a compromise between user comfort and machine understanding is highlighted by this research, which will help to enable smooth communication between humans and computers.[6]

Using inexpensive accelerometers, Bailador, Roggen, Tröster, and Triviño (2007) describe a novel method for real- time gesture identification. Their approach entails building specialized predictors that may anticipate future motions based on present ones and are suited to various gesture kinds. The algorithm recognizes gestures with accuracy by comparing these predictions with the actual movements. The addition of new motions can be seamlessly integrated with this adaptable technique. Their method works well for real- time applications because it uses a kind of neural network that is lightweight and well-suited for gesture recognition. This study represents a substantial development in the field of gesture recognition technology, providing a workable answer for a range of real-world scenarios.[7]

Fang, Wang, Cheng, and Lu (2007) present a technique for real-time hand gesture identification in computer interaction in their work. Their method tracks hand movements by using color and motion information, and uses a predetermined gesture for activation. It also uses an innovative method to account for hand size differences. Their approach has been successfully applied to picture navigation challenges, demonstrating its effectiveness in improving computer interface experiences. Real-time gesture recognition technology is being advanced by this research, which has potential uses for a range of interactive multimedia systems.[8]

Kahlon and Singh (2023) tackle the crucial issue of enabling direct contact between the hearing and deaf communities by means of machine translation from text to sign language and vice versa in their systematic review. They clarify the benefits and drawbacks of the current translation techniques by classifying and evaluating a variety of studies. Their objective is to improve the deaf community's comfort level and the effectiveness of sign language communication. They support the use of cutting-edge technologies, in particular deep learning, to improve the efficiency and accuracy of text to sign language translation. This study emphasizes the value of inclusivity and accessibility, aiming to close gaps in communication and enable people with hearing loss to engage fully in society.[9]

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Garg, Attry, Mittal, and Bhat (2023) emphasize in their review the significance of Indian Sign Language (ISL) as a vital communication tool for the deaf and mute population in the Indian subcontinent. ISL, which consists of hand gestures, body postures, and facial expressions, functions as a complete natural language that facilitates the conveyance of emotions and intended messages. They talk about an application designed to translate spoken words into ISL images. Speech recognition technology is used by this system to transform speech inputs into text, which is then translated into ISL. Algorithms for natural language processing help in root word extraction and word segmentation. The project's goal is to increase ISL accessibility in India, which will improve the deaf and mute population's options for communication.[10]

The important field of real-time sign language translation systems is examined by Papatsimouli, Sarigiannidis, and Fragulis (2023). These systems are vital for people who are hard of hearing or deaf. Even with advancements in assistive technologies, there is still a communication gap. Over a five- year period, their research examines contemporary developments in sign language translation, with an emphasis on integration with Internet of Things (IoT) technologies. The study clarifies the state of the art in real-time sign language translation by a thorough investigation of technical publications and literature. Machine learning, computer vision, gesture recognition, and Internet of Things integration are important research areas. The ongoing attempts to improve communication accessibility for people with hearing impairments are highlighted by this work.[11]

Bhagwat, Bhavsar, and Pawar (2023) investigate Sign Language Machine Translation Systems, focusing on Indian Sign Language, in order to investigate the crucial nexus between technology and social inclusion. While there have been many technological breakthroughs to help visually impaired people, there have been fewer innovations for those who have hearing impairments. Although sign language is a crucial means of bridging the gap between the deaf and the general public, language differences still provide difficulties to communication. The use of machine translation technologies to bridge the gap between spoken and sign languages is a possible approach. This chapter explores the complexities and difficulties of machine translation for sign language, including translation techniques, grammatical characteristics, and output interpretation. It examines current systems, points out weaknesses, and suggests fixes to deal with simultaneous morphological aspects in sign languages.[12]

Kahlon and Singh (2023) emphasize in their systematic study how important it is to give the deaf community equal chances by eliminating their reliance on human interpreters by using automated means of direct communication. After a thorough analysis of 148 papers from prestigious conferences and journals, they have divided sign language machine translation into three categories. Their work explores sign language generation techniques and their assessments, outlining the benefits and drawbacks of various categories. In order to maximize text-to-sign language translation, the study promotes efficient sign language communication and highlights the importance of utilizing cutting-edge technology like deep learning and neural networks. Through improved inclusivity and accessibility for the deaf community, they hope to promote deeper societal integration.[13]

The importance of deaf interpreters (DIs) is examined, and language ideologies pertaining to their function in sign language interpretation are examined. It offers initial survey and interview data that clarifies the characteristics and placement of DIs in the Canadian setting. The study draws attention to the complex viewpoints and experiences of DIs, especially when negotiating various linguistic and cultural nuances while interpreting circumstances. It also highlights the need for formal training and professional development opportunities for DIs, as well as the opportunities and difficulties that come with Canada's changing deaf education scene. All things considered, the study advances our knowledge of linguistic ideologies and the intricate dynamics underlying sign language interpretation techniques.[14]

The authors present a thorough overview of current developments in the field of hand gesture and sign language recognition research in their work. They divide the methods into several phases, which include gathering data, pre-processing, segmenting, extracting features, and classifying. Every step is carefully analyzed, providing comprehensive understanding of the algorithms used and their relative benefits. The authors also discuss the wider obstacles and constraints that gesture recognition research faces, with a focus on those specific to sign language recognition. In order to support further research in this emerging subject, the study intends to provide readers with a thorough grasp of automated gesture and sign language recognition.[15]

In order to improve Human-Computer Interaction (HCI), the study presents a marker-less hand/finger tracking and gesture detection system that is reasonably priced. The text discusses the drawbacks of conventional physical controllers and argues in favor of Natural User Interface (NUI). In spite of complicated backgrounds and motion blur, the suggested approach guarantees reliable hand tracking, facilitating engaging motion games and intuitive HCI. The system's capacity to convert hand gestures into useful inputs is exhibited by sample applications, which highlight its potential with low hardware needs.[16]

The study offers a computer vision system for mobile devices that can recognize hand movements and enable natural human-computer interaction. Using Support Vector Machine (SVM), the system does not require external databases to segment hands, smooth images, extract characteristics, or classify movements. It captures video frames, samples color, builds binary hand representations, recovers hand contours using convex polygons, and detects motions locally using the frontal camera of the smartphone. This stand-alone solution improves interaction and communication by allowing smartphones to recognize gestures on their own.[17]

In-depth study is done on three-dimensional hand gesture recognition, which is important for interacting with computers. Their research delves into the historical relevance of hand gestures and how they have been incorporated into speech. In addition to examining contemporary developments such as 3D hand modelling and gesture recognition methods, they also examine real-world uses, offering suggestions for improving interactive systems.[18]

The study suggests a technique for hand gesture identification to support organic human-computer interaction (HCI). Their method uses a webcam to record hand gestures, converts them to binary pictures, and then creates a three-dimensional Euclidean space. They categorize motions like pointing directions and finger counting using supervised neural network training with backpropagation. With test set accuracy of up to 89%, the study establishes a foundation for computer interfaces that are easy to use.[19]

The cited study provides an extensive analysis of vision- based methods for hand gesture detection with an emphasis on their use in HCI (human-computer interaction). The study, titled "Vision Based Hand Gesture Recognition," synthesizes several methods in this area and highlights their advantages and disadvantages. For scholars and practitioners interested in using hand gesture recognition for intuitive interface design, it is an invaluable resource. Through talks on identification algorithms, hand anatomy, and unmet issues, the article provides guidance for future HCI research endeavors.[20]

The importance of gestures in nonverbal communication and their function in sign language are covered in this study. It emphasizes the value of sign language for people who are deaf or hard of hearing and the variety of sign languages used around the world. It does, however, highlight a communication gap that exists between the general public and deaf people as a result of the latter group's inadequate sign language proficiency. The study suggests creating an automatic sign language identification system to overcome this communication gap and improve societal inclusion by facilitating communication between hearing and deaf people.[21]

III. MOTIVATION

It is essential to offer sign language interpreters to physically challenged people in order to promote inclusive communication, guarantee fair access to information, and protect fundamental rights. By facilitating efficient communication in a variety of contexts, such as social interactions, work, healthcare, and education, these interpreters help to advance equal participation and social integration. In addition to fulfilling legal requirements, providing sign language interpreters encourages social inclusion, protects linguistic and cultural legacy, and gives physically challenged people the ability to advocate for their needs. Sign language interpreters play a vital role in enhancing the independence, well-being, and general quality of life for people with disabilities by encouraging meaningful connections and creating a sense of belonging. In the end, this helps to create a more inclusive and equitable society.

IV. OBJECTIVES

- Overcome challenges related to variations in sign language gestures.
- Provide a user-friendly interface for seamless sign language communication.
- Enhance inclusivity and enable effective communication for the deaf community.
- Promote social integration and understanding among diverse communities.

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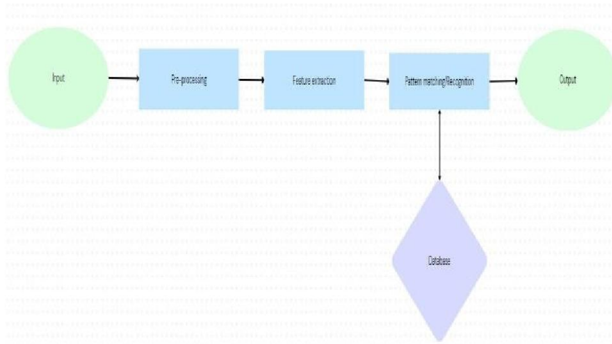
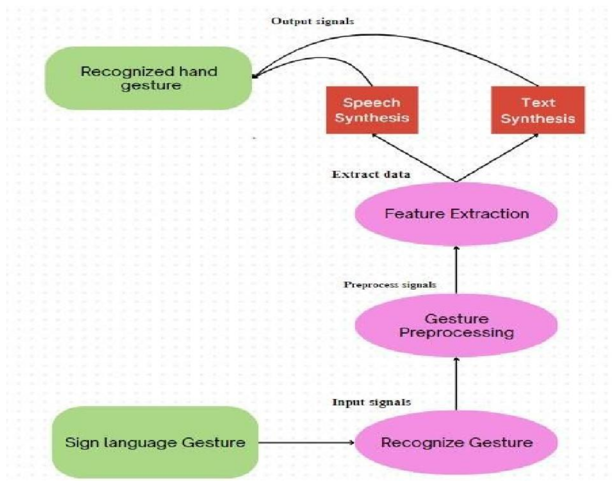
V. PROJECT ARCHITECTURE





Our Sign Language Interpreter Python project's architecture was created with scalability and modularity in mind to enable effective processing and interpretation of sign language motions. It consists of separate modules for computer vision processing, gesture recognition, user interface (UI) development, speech synthesis integration, and data gathering and preprocessing.

Live image capture and preprocessing approaches guarantee the homogeneity and optimization of the dataset during the data collection and preprocessing stage. In order to separate hand gestures from video frames, the computer vision processing module uses methods like hand detection, tracking, and segmentation. To reliably classify motions, gesture recognition uses machine learning models like SVM or CNN. Users can interact with the interpreter using a graphical interface provided by the user interface (UI), and speech synthesis integration allows the translation of spoken language from understood gestures. This architecture is modular, which makes it easy to expand and optimize as needed and promotes the smooth integration of capabilities

VI. CONCEPTS AND METHODS

- Computer vision (OpenCV)
- Gesture Recognition
- Data Collection
- Deep Learning
- User Interface
- Continuous Improvement

We start with the Data Collection and Preprocessing step when we create a Python project for a sign language interpreter. The live recording of sign language movements makes it easier to collect visual data, which is then preprocessed to guarantee consistency. The dataset is optimized for additional analysis by methods like noise reduction, normalization, and scaling.

Now let's talk about computer vision processing. To recognize hands within video frames, we use methods like deep learning models or Haar cascades. Continuous hand movement monitoring is made possible by hand tracking algorithms, while segmentation strategies use color and motion cues to distinguish the hand from the surroundings. Relevant features are taken out of the segmented hand region for Gesture Recognition. Using this data, machine learning models that classify gestures, including Support Vector Machines (SVM) and Convolutional Neural Networks (CNN), are trained. For improved accuracy, optional deep learning architectures that are well-suited for sequential gestures can be used.

Creating a graphical user interface (UI) to show video frames and interpreted outcomes is known as user interface (UI) development. The user experience is improved with interactive elements that allow for user participation and response.

Using Python tools such as pyttsx3 for text-to-speech conversion, Speech Synthesis integration enables spoken language output from interpreted sign language movements.

Because of the project's modular architecture, jobs can be divided into discrete modules for better scalability and organization. The ability to handle data in real time guarantees prompt feedback.

The focus of optimization and deployment is on improving models and algorithms for efficiency and precision, which is essential for devices with limited resources. Lastly, Testing and Feedback entails collecting user feedback for incremental changes while conducting a thorough assessment of the interpreter's performance using a variety of sign language gestures and settings.

Continuous Learning and Model Updates: These methods improve recognition accuracy over time by continuously gathering data and refining the model.

With the use of live picture capture, machine learning, and speech synthesis technologies, our Sign Language Interpreter Python project is ready to provide the deaf population with accurate and accessible communication.

VII . CONCLUSION AND FUTURE WORK

In summary, the creation of a Sign Language Interpreter for people with physical disabilities represents a crucial step towards promoting inclusivity and accessibility. Artificial intelligence and machine learning based technology, which eliminates communication barriers for those with hearing impairments, also advances education, equitable opportunities, and societal acceptance. Its real-time interpretation skills allow for seamless communication in a variety of circumstances, promoting a sense of community and comprehension. By doing so, we can build a more inclusive society in which everyone may prosper and actively participate, despite any physical limitations they may have.

Future Work:

- virtual mouse
- Mobile and wearable devices

VIII. ACKNOWLEDGEMENT

We express my profound thanks to my Guide Prof. Neha Chaube for her expert guidance, encouragement and inspiration during this project work. We would like to thank Prof. Dr. Jayesh Sarwade, Project Coordinator, Department Computer Science & Engineering for extending all support during the execution of the project work. We sincerely thank to Dr. Ganesh Pathak, Head, Department of Computer Science & Engineering, MIT School of Engineering, MIT-ADT University, Pune, for providing necessary facilities in completing the project. We also thank all the faculty members in the Department for their support and advice.

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