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A Survey On Signspeak: Translating English Audio To Indian Sign Language With Telugu Subtitles

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Abstract: In this survey paper, we explore the SignSpeak system, which translates audio in English and text to Indian Sign Language (ISL) and associates it with Telugu subtitles. Techniques and technologies are explored and compared for their effectiveness in increasing translation accuracy and enhancing user interaction for better engagement. The vision for this project is to break communication barriers, making life a little bit easier for the Telugu-speaking community.

Index Terms **-** Indian Sign Language (ISL), Natural Language Processing (NLP), Audio-to-Sign Conversion, Telugu Subtitles, Audio Recognition, Web Application, Language Conversion, Text Summarization

I. INTRODUCTION

The symbols and gestures used in sign language are logically organized, with each unique motion referred to as a sign. These signs consist of three main components: the handshake, hand position, and hand movement. Indian Sign Language (ISL) is utilized by millions of deaf individuals in India. It is a fully developed language capable of expressing complex concepts as effectively as languages like English or Hindi. ISL meets all the criteria of a language. In the 1960s, research conducted in the USA and the Netherlands formally recognized sign languages as complete human languages.

Deafness and mutism typically come with significant social and educational obstacles. In terms of communication, several everyday situations—including the provision of services—become more complex. If they are not given the right assistance, such as sign language interpreters or a captioning system, students with hearing impairments may find it challenging to follow lectures or engage in the free flow of class discussion. They become extremely lonely and frustrated as a result, and they may find it challenging to study and engage with others. If society assumes more awareness and access, things might alter significantly for them.

This overview study examines several current methods in speech recognition, sign language translation, and the processing of natural language (NLP) that aid in the creation of such systems. Based on their effectiveness in real-time applications, we examine several models and algorithms utilized in subtitle creation, summarization strategies, and speech-to-sign language conversion. We also assess the difficulties in combining Telugu subtitles with ISL in order to meet the various needs of India's multilingual populace.
This research aims to present a comparative review of the existing approaches, highlighting their benefits, drawbacks, and areas for improvement. By providing insights through tables and graphical representations, we hope to support future research and the creation of additional inclusive, practical, and accessible interactive tools for the deaf and hard of hearing community in India.

II.METHODOLOGY

The SignSpeak project employs a structured approach to develop a robust system capable of translating English text and speech into Indian Sign Language (ISL) animations, accompanied by Telugu subtitles. The methodology is divided into distinct phases to ensure a systematic and efficient implementation process.

A. User Input (Audio/Text)
The user provides input in either spoken form (audio) or as typed text. This flexibility allows diverse users to interact with the system efficiently.

B. Speech-to-Text Conversion
For audio input, the system uses speech recognition to convert spoken words into written text, enabling further processing and translation.

C. Text Processing (NLP)
NLP helps in analyzing the text's structure and meaning, breaking it down for easier translation and ISL gesture mapping.

D. Telugu Translation and Subtitles Generation
The system translates English text to Telugu offline using MarianMT. Subtitles are time-synchronized using Aeneas, ensuring they align with ISL animations.

E. Sign Language Translator
Processed text is mapped to ISL gestures via a database lookup, providing visual sign language cues for effective communication.

F. Output Display (ISL Animated Clips with Telugu Subtitles)
The final output integrates ISL animations and Telugu subtitles, offering an accessible format that supports both understanding and learning.

2.1 RESULTS

The SignSpeak system aims to accurately translate English text and speech into Indian Sign Language (ISL) gestures, utilizing real-time speech-to-text and NLP processing. It will also generate synchronized Telugu subtitles, enhancing the user experience. This combination of ISL animations and subtitles is designed to improve communication accessibility for the deaf and hard-of-hearing community. Preliminary evaluations suggest that the system will operate efficiently and provide a user-friendly interface, facilitating better communication between English and Telugu speakers.

III.LITERATURE REVIEW

This paper [1] covers a wide range of approaches that span traditional ones like Hidden Markov Models and Pattern Trees to advanced machine learning techniques, such as Latent Dirichlet Allocation (LDA) and K-Nearest Neighbors (KNN). Even deep learning, especially Convolutional Neural Networks (CNNs), significantly improved the accuracy; in some datasets, accuracy reached as high as 99%. Transfer learning also addresses multicultural sign language issues by utilizing models like VGGNet and ResNet. Hybrid models and Vision Transformers are relatively new developments. Graph Convolutional Networks (GCN) and Multi-Head Self-Attention (MHSA) are combined in the GmTC model to provide robust multicultural Sign Language Recognition(SLR).

Fatima and M. Sridevi [2] discuss the scope of sign language for the deaf and hard-of-hearing community. It addresses communication barriers faced by the hearing-impaired by providing American Sign Language (ASL) translations from audio input in multiple languages. Utilizing state-of-the-art algorithms such as Convolutional Neural Networks (CNNs), it generates ASL animations with impressive accuracy rates ranging from 98% to 100% for real-time hand gesture recognition. The iterative process implemented in this system enhances user-centricity and significantly boosts the accessibility of communication.

The study [3] explores the core methodologies of explainable AI and deep learning. It includes Concept Activation Vectors, Testing with CAVs, and contrastive explanations about the classification outcome. Here, the authors present an ensemble approach to learn the two widely used Indian and American Sign Languages and gain substantial improvements in accuracy over the standard models.

This review focuses on [4] and elaborates on the concept of Sign Language Recognition with deep learning, specifically translating Panamanian Sign Language into text in Spanish, by integrating CNNs and LSTMs for better sequential data handling, with an emphasis on holistic gesture, facial expression, and body posture, and was successfully achieved at 98.8%.

This paper [5] on Sign Language Translation divides approaches under hardware solutions and visual/audio cues, with the latter being more natural. It further categorizes machine translation systems into direct, transfer,and interlingual systems. Modern neural methods appear to work more effectively. In fact, the paper addresses challenges like dataset limitations and proposes future research directions.

Discussing the challenges of expressing spoken words into sign languages, the paper [6] underscored the differences in sign languages' natures and the critical call for inclusivity in communication due to the COVID-19 pandemic. It conducts a review of the fusion of non-manual elements with translation systems, thereby making an evaluation on the prototype for Dutch Sign Language's current limitations and descriptions.

This review [7] focuses on the recognition of Arabic Sign Language (ArSL) , reviews the problems related to variation in sign language,the research gaps available, and technological approaches, including CNNs to recognize hand gestures. The recent progress has been towards models that effectively reached a 90% accuracy in recognizing Arabic hand signs .

The paper [8] is a review of the progress and challenges in sign language recognition and translation,underlining the complexities of sign languages and the impossibility of traditional approaches to capture them. Huge progress has been realized using deep learning techniques such as CNN+SVM for static signs and LSTM with KNN for ASL recognition, many others that highlight the need for large datasets and advanced evaluation metrics

This survey [9] focuses on new progress recently achieved in the area of Augmented Reality and Audio Visual Speech Recognition to support supportive technologies for deaf and hard-of-hearing people. Some notable applications are AR-Books and multi-modal interfaces integrating speech recognition and object identification. The experimental analysis demonstrated that AVSR systems perform quite well with strong functionality in noisy environments and a user-centered design converting spoken language into readable text within the AR, thus upgrading the communication accessibility.

This paper [10] investigates tendencies in Sign Language Recognition and Translation. It specializes in using convolutional neural networks (CNN) and recurrent neural networks (RNN) to convert speech to signal language, even though there are some troubles with historical past noise affecting accuracy to overcome those demanding situations. To overcome those demanding situations, the paper discusses novel fashions together with multi-layer convolutional neural networks (ML-CNN) and reversible CNN, which show stepped-forward performance with the aid of editing long-term short-time period reminiscence (LSTM) by breaking up the pattern into smaller manual processes.

This paper [11] engages in the development of a comprehensive tool aimed at improving communication and learning for individuals using sign language. It includes features like mute speech turns spotting letters and words into textual content moves, supports bilingualism, and has built-in voice output.

This study [12] explores a new AI chat system made for the Chinese Sign Language Foundation.It combines sight and sound to give better speech content to deaf people. The project wants to use the best technology by putting together Yolov5 and LSTM to recognize moving sign language in China where about 27.8 million people can't hear well. The system works like a portable "magic box" that's easy to use and handy.

This survey [13] will discuss the issues regarding sign language translation based on its researched areas and challenges. It refers to the pursuit of gloss-free methods and techniques for bridging the modality gap between

the source and target languages with the anonymization of sign language videos. It includes references to demographic biases in datasets and the need for having comprehensive data. The proposed SSVP-SLT framework indicates significant improvements while putting forth innovative approaches toward further improvement in SLT performance.

Liu, Tianyu, et al. [14] discusses the major research areas of sign language recognition, pointing out challenges in much fewer samples of data and complexity in models' structure. Several approaches are shown in the development of introducing the SwC GR-MMixer model together with its GRU and MLP architecture.Innovations of the proposed model in data augmentation are shown along with experimental validation when compared to state-of-the-art models to present clear improvements in the recognition accuracy.

The paper [15] verifies some critical gaps that SLT and SLR call for translation methods improvement. With the application of NMT along with recent techniques such as weight tying, transfer learning, and ensemble learning, the new model named STMC-Transformer presented here got state-of-the-art results.

This recent review [16] in SLT, dividing the literature into three categories-improving SL recognition,modifying architectures in neural networks, and dealing with scarcity of data. It actually outlines key methods
such as the Sign2Gloss2Text, Sign2Text, Sign2(Gloss+Text), and Gloss2Text.
San-Segundo, Ruben, et al [17] reviews state-of-the-art progress in speech-to-sign language translation for Spanish Sign Language (LSE) underlined variability and existing projects. Using the two comparative approaches of rule-based and statistical, while the former approaches achieve better precision in restricted domains, it is underlined that more parallel corpora and research need to be explored to make further improvements in performance.

This paper [18] examines improvements in sign language recognition, concentrating on deep learning and computer vision techniques. The authors used a dataset of 35,000 images for Indian Sign Language (ISL), achieving outstanding accuracy rates of 99.72% for color images and 99.90% for gray scale images. This showcases the efficiency of Convolutional Neural Networks (CNN) and their revolutionary method of bridging the conversation gap by translating sign language into multiple nearby languages.

In review [19] it presents a unique technique for hand gesture popularity and translation for International Sign Language (ISL) conversation using Convolutional Neural Networks (CNNs). The study addresses present demanding situations in gesture reputation systems, which include the need for controlled lights and versatility in spotting numerous sign languages.The high cost of accuracy of this instrument has been tested, reaching 97.85% in ISL gesture recognition, indicating that it can be a useful resource for improving communication in
the deaf community.

Using an optimized American Sign Language (ASL) gesture dataset, research indicates the development of a sturdy gesture-based signal language popularity system Although the precise length of the dataset is uncertain, the dataset carries 30 sequences for every gesture, with 30 frames according to series, for training, and presents a well sorting position. The device achieves a fantastic accuracy of 99.23% [20] .

Kumar, Saurav, et al. [21] introduce a strong algorithm for visualizing Indian Sign Language and gestures using convolutional neural networks (CNN). A customized dataset in particular designed for Indian Sign Language has evolved, which completed the paintings required to obtain a high accuracy of 98.6% at the set below check.

In paper [22] , the authors discover the recognition of Indian Sign Language (ISL) using advanced strategies like Vision Transformers. They highlight the restrictions of present datasets, noting a lack of variety in pics for ISL, which caused them to create a self-compiled dataset of 72 words. This dataset consists of pics of the complete signer, addressing challenges posed with the aid of occlusions and ranging orientations of hand gestures. The proposed model carried out an excellent accuracy of 99.56outperforming previous methods and demonstrating the effectiveness of the Vision Transformer structure, which includes simple transformer layers.

Under review [23] the authors introduce a comprehensive method for Indian Sign Language (ISL) recognition and translation using the MediaPipe library and convolutional neural network (CNN). They used the ISL-CSLRT dataset, which includes movies and reviews, about the dynamic reputation of sign language. To improve gesture recognition in the context of ISL, the device achieves an impressive accuracy of approximately 94%.

In recent study [24] , the authors discovered an improved version for translating Tamil audio into Indian Sign Language (ISL). They used two first-rate datasets: “A crowd-sourced, multi-speaker speech dataset in Tamil ” for speech recognition and a GIF video dataset for icon recognition. The accuracy of the proposed formats varies. It has 45% long-term and short-term memory (LSTM), 65% BiLSTM, and Google API providing up to 95% accuracy.

Swathi, Vaddhiraju, et al. [25] introduce a real-time system for translating audio into sign language using deep learning techniques. This study used a dataset that included a variety of spoken language samples. Even if a specific data set does not contain details in a given context. NLP and computer vision methods help improve the accuracy of the system.

In survey [26] , the author explores methods for translating audio into Indian Sign Language. It mainly focuses on speech recognition and image processing. They have used a dataset containing gesture recognition data which helps to convert gestures to text and vice versa.

A survey article [27] reveals various studies. About sign language recognition Including the importance and accuracy of the data set. Most of the research uses datasets related to Indian Sign Language (ISL) and focuses on gesture recognition systems. The ability to facilitate communication between the deaf and hearing community including the integration of natural language processing (NLP) for a better understanding of spoken language is a strong point.

This paper [28] studies sign language recognition through multi-head convolutional neural networks (CNN). The authors use the ”ASL FingerSpelling” dataset, which consists of more than 500 images, divided into 24 signal and symptom images, with background and orientation. A range and their approach carried out an excellent verification accuracy of 98.98%.

A review [29] discusses recent developments and reviews on SLR with special emphasis on Indian Sign Language. Techniques involved include hand-gesture detection with directional histograms achieving 100% accuracy. Real-time neural network architectures are another topic of discussion followed by deep learning models like LSTM and CNN. Challenges in the stream mainly include the development of the dataset, and in the current experiment, a 97% accuracy was achieved in sign identification with the custom-made IISL2020.

In this paper [30] , the authors advanced an actual-time sign language recognition system with the usage of convolutional neural networks (CNN) to apprehend hand gestures for American Sign Language (ASL) letters A-Z. The authors created their dataset of ASL signs and achieved an impressive accuracy of 98in recognizing ASL letters.

Table 3.1:Summary of Methodologies, Strengths, and Limitations

Authors	Methodology Used	Strengths	Limitations
Miah, Abu Saleh Musa, et al.	Graph and general deep learning network	Focused on enhancing graph-based learning for sign language recognition	Limited generalizability to other domains.
Fatima, Naheed, and M. Sridevi	Machine learning algorithms for linking audio, text, and gestures	Explored methods for integrating multimodal inputs for effective translation.	Performance may vary with different languages.
Kothadiya, Deep R., et al	Explainable AI and ensem-ble learning	Investigated the interpretability of AI models in sign language applications.	Complexity in model inter- pretation for end-users.
Teran-Quezada, Alvaro A., et al.	Deep neural networks for sign-to-text translation	Utilized DNNs for convert- ing sign language gestures into written text.	Requires large datasets for training.
Nun˜ez-Marcos, Adria´n, et al.	Survey on sign language machine translation	Reviewed existing method- ologies in sign language translation systems.	May not provide novel solutions but rather a synthesis
Esselink, Lyke, et al.	Automatic text-to-sign translation in healthcare	Developed a system for translating healthcare- related text into sign language.	Limited scope to healthcare applications
Kamruzzaman, M. M.	Arabic sign language recognition using CNN	Employed convolutional neural networks for recognizing Arabic sign language.	Focuses only on Arabic, limiting applicability.
Mirzaei, Mohammad Reza, et al.	Audio-visual speech recognition techniques	Integrated audio-visual data for enhancing speech recognition.	Dependency on quality of audio-visual inputs.
Natarajan, B., et al.	End-to-end deep learning for sign language recogni- tion, translation, and inter- pretation	Proposed a holistic framework integrating various deep learning methods.	High computational costs for real-time applications.
Sindhu, Kambhampati Sai, et al.	Sign language recognition and translation systems	Focused on enhancing com- munication for the hearing impaired.	Complexity in deployment across various platforms.

Priyadharshini, D. Shofia, et al.	Comprehensive application for sign language recogni- tion	Multi-language support and integrated voice output functionality.	Performance issues with di- verse sign languages.
He, Xiaoran, et al.	AI Chinese sign language recognition system	Developed an interactive system based on audio- visual integration.	May require significant user training.
Rust, Phillip, et al.	Privacy-aware sign language translation	Focused on privacy aspects in sign language translation systems.	Potential trade-offs between privacy and performance.
Liu, Tianyu, et al.	Signer-independent recogni- tion method	Proposed a method for recognizing sign language re- gardless of the signer.	May not account for regional variations in signs.
Yin, Kayo, and Jesse Read	STMC-transformer for sign language translation	Utilized transformers to en- hance sign language transla- tion accuracy.	High computational requirements for training models.
Liang, Zeyu, et al.	Survey of sign language translation approaches	Reviewed multiple approaches and techniques in sign language translation.	Does not propose new methodologies or solutions.
San-Segundo, Ruben, et al.	Speech to sign language translation system	Developed a system for translating spoken Spanish into sign language.	Limited to specific language pairs.
Antad, Sonali M., et al.	Multi-language sign language translation	Focused on translating across various sign languages.	Challenges in capturing nuances of each sign language.
Pigou, Lionel, et al.	Convolutional neural net- works for sign language recognition	Employed CNNs for recognizing signs from video in- put.	Requires extensive labeled datasets for training.
Debnath, Jeet, and Praveen Joe IR	Real-time gesture-based recognition system	Developed a system for real-time gesture recogni- tion in sign language.	Performance can be affected by environmental factors.

Kumar, Saurav, et al.	Robust sign language recognition using CNN	Proposed a robust system for recognizing sign language gestures using CNNs.	Sensitivity to variations in sign execution.
Agarwal, Agrima, et al.	Indian sign language recognition using skin segmenta- tion	Utilized skin segmentation for recognizing Indian sign language.	Limited to the Indian con- text, may not generalize well.
Deshpande, Shivani, and Rajashree Shettar	Gesture recognition using Mediapipe and CNN	Integrated Mediapipe with CNN for gesture recogni- tion.	May struggle with dynamic backgrounds.
Reddy, Bandi Rupendra, et al.	Sign language generation from live audio/text	Developed a system for gen- erating sign language from audio or text inputs.	Limited to specific contexts and languages.
Swathi, Vaddhiraju, et al.	Audio to sign language converter	Focused on converting au- dio directly to sign language.	Performance heavily reliant on audio quality.
Tiwari, Rishin, et al.	Audio to sign language con- version techniques	Developed techniques for translating audio into sign language.	Quality of translation varies with speaker accents.
Harkude, Ankita, et al.	Audio to sign language translation for the deaf	Focused on creating a comprehensive translation system for the deaf.	Challenges in accurately capturing sign language nuances.
Pathan, Refat Khan, et al.	Sign language recognition using image and hand land- marks	Employed multi-headed CNN for recognizing signs.	Performance impacted by hand occlusions or positions.
Kothadiya, Deep, et al.	Sign language detection and recognition using deep learning	Proposed a system combin- ing detection and recogni- tion tasks.	Computationally intensive; requires optimized hardware.
Chaudhari, Dr. Pallavi, et al.	Sign language detection system	Developed a system for de- tecting sign language gestures in real-time.	May face issues with back- ground noise and lighting conditions.

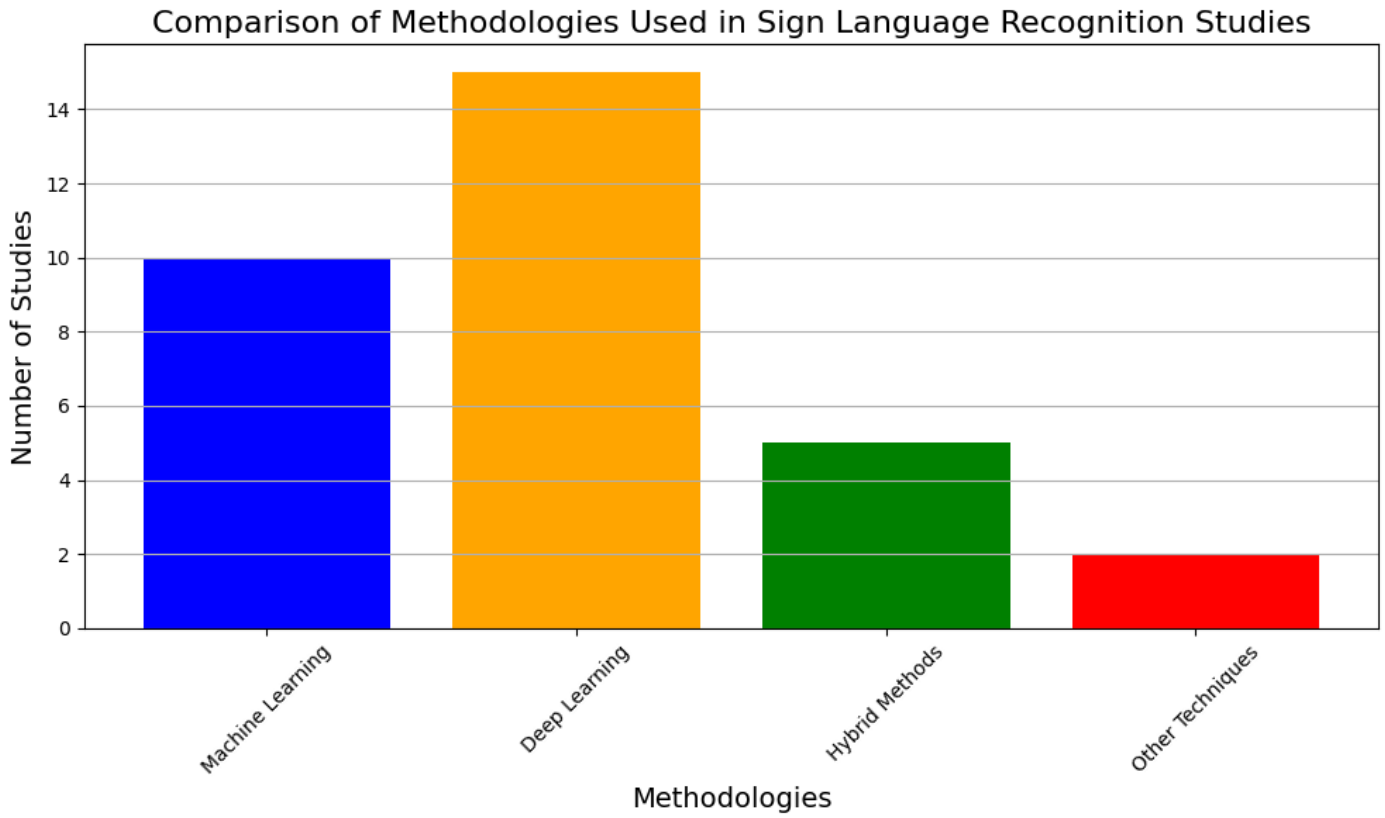

Fig. 1: Comparisons of Methodologies used in Sign Language recognition

As shown in Figure 1, the bar graph illustrates the comparisons of methodologies used in sign language recognition.

IV. CONCLUSION

The work under the SignSpeak project led to tremendous progress in bridging the communication gaps for the Telugu-speaking community through the translation of text and audio in English to Indian Sign Language with Telugu subtitles. Despite our use of highly advanced models and technologies like GPT, TensorFlow, and Flask in order to make the translation effective and perfect, literature study revealed many significant developments in technology and methodologies applied. Future research will be focused on enhancing functionality, accuracy, and adaptability to varying situations.

REFERENCES

[1] Miah, Abu Saleh Musa, et al. ”Hand gesture recognition for multi-culture sign language using graph and general deep learning
network.” IEEE Open Journal of the Computer Society, 2024.

[2] Fatima, Naheed, and M. Sridevi. ”SIGNLINK: Linking Audio, Text, and Hand Gestures Using Machine Learning Algorithms.”International Research Journal on Advanced Engineering and Management (IRJAEM), vol. 2, no. 07, pp. 2359-2364, 2024.

[3] Kothadiya, Deep R., et al. ”SignExplainer: an explainable AI-enabled framework for sign language recognition with ensemble learning.” IEEE Access, vol. 11, pp. 47410-47419, 2023.

[4] Teran-Quezada, Alvaro A., et al. ”Sign-to-Text Translation from Panamanian Sign Language to Spanish in Continuous Capture Mode with Deep Neural Networks.” Big Data and Cognitive Computing, vol. 8, no. 3, p. 25, 2024.

[5] Nunez-Marcos, Adrian, Olatz Perez-de-Vinaspre, and Gorka Labaka. ”A survey on Sign Language machine translation.” Expert Systems with Applications, vol. 213, p. 118993, 2023.

[6] Esselink, Lyke, et al. ”Exploring automatic text-to-sign translation in a healthcare setting.” Universal Access in the Information Society, vol. 23, no. 1, pp. 35-57, 2024.

[7] Kamruzzaman, M. M. ”Arabic sign language recognition and generating Arabic speech using convolutional neural network.” Wireless Communications and Mobile Computing, vol. 2020, no. 1, p. 3685614, 2020.

[8] Natarajan, B., et al. ”Development of an end-to-end deep learning framework for sign language recognition, translation, and video generation.” IEEE Access, vol. 10, pp. 104358-104374, 2022.
[9] Mirzaei, Mohammad Reza, Seyed Ghorshi, and Mohammad Mortazavi. ”Audio-visual speech recognition techniques in augmented reality environments.” The Visual Computer, vol. 30, pp. 245-257, 2014.
[10] Sindhu, Kambhampati Sai, et al. ”Sign Language Recognition and Translation Systems for Enhanced Communication for the Hearing Impaired.” 2024 1st International Conference on Cognitive, Green and Ubiquitous Computing (IC-CGU), IEEE, 2024.
[11] Priyadharshini, D. Shofia, et al. ”A Comprehensive Application for Sign Language Alphabet and World Recognition, Text-to-Action Conversion for Learners, Multi-Language Support and Integrated Voice Output Functionality.” 2024 International Conference on Science Technology Engineering and Management (ICSTEM), IEEE, 2024.
[12] He, Xiaoran, et al. ”AI Chinese sign language recognition interactive system based on audio-visual integration.” 2023 IEEE International Conference on Electrical, Automation and Computer Engineering (ICEACE), IEEE, 2023.
[13] Rust, Phillip, et al. ”Towards Privacy-Aware Sign Language Translation at Scale.” arXiv preprint, arXiv:2402.09611, 2024.
[14] Liu, Tianyu, et al. ”A signer-independent sign language recognition method for the single-frequency dataset.” Neurocomputing, vol. 582, p. 127479, 2024.
[15] Yin, Kayo, and Jesse Read. ”Better sign language translation with STMC-transformer.” arXiv preprint, arXiv:2004.00588, 2020.
[16] Liang, Zeyu, Huailing Li, and Jianping Chai. ”Sign language translation: A survey of approaches and techniques.” Electronics, vol.12, no. 12, p. 2678, 2023.
[17] San-Segundo, Ruben, et al. ”Speech to sign language translation system for Spanish.” Speech Communication, vol. 50, no. 11-12, pp.1009-1020, 2008.
[18] Antad, Sonali M., et al. ”Sign Language Translation Across Multiple Languages.” 2024 International Conference on Emerging Systems and Intelligent Computing (ESIC), IEEE, 2024.
[19] Pigou, Lionel, et al. ”Sign language recognition using convolutional neural networks.” Computer Vision-ECCV 2014 Workshops:Zurich, Switzerland, September 6-7 and 12, 2014, Proceedings, Part I, Springer International Publishing, 2015.
[20] Debnath, Jeet, and Praveen Joe IR. ”Real-Time Gesture Based Sign Language Recognition System.” 2024 International Conference on Advances in Data Engineering and Intelligent Computing Systems (ADICS), IEEE, 2024.
[21] Kumar, Saurav, et al. ”A Robust Sign Language and Hand Gesture Recognition System Using Convolutional Neural Networks.” 2023 5th International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), IEEE, 2023.
[22] Agarwal, Agrima, et al. ”Indian Sign Language Recognition using Skin Segmentation and Vision Transformer.” 2023 IEEE 20th India Council International Conference (INDICON), IEEE, 2023.
[23] Deshpande, Shivani, and Rajashree Shettar. ”Hand gesture recognition using mediapipe and CNN for Indian Sign Language and conversion to speech format for Indian regional languages.” 2023 7th International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS), IEEE, 2023.
[24] Reddy, Bandi Rupendra, et al. ”Indian sign language generation from live audio or text for Tamil.” 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Vol. 1, IEEE, 2023.
[25] Swathi, Vaddhiraju, et al. ”Audio To Sign Language Converter Using Python.” Journal of Survey in Fisheries Sciences, 2023, pp.2621-2630.
[26] Tiwari, Rishin, Saloni Birthare, and Mayank Lovanshi. ”Audio to Sign Language Converter.” IJRASET47271, 2022, pp. 11-02.
[27] Harkude, Ankita, et al. ”Audio to sign language translation for deaf people.” International Journal of Engineering and Innovative Technology (IJEIT), Vol. 9, No. 10, 2020, pp. 30-31.
[28] Pathan, Refat Khan, et al. ”Sign language recognition using the fusion of image and hand landmarks through multi-headed
convolutional neural network.” Scientific Reports, Vol. 13, No. 1, 2023, p. 16975.
[29] Kothadiya, Deep, et al. ”Deepsign: Sign language detection and recognition using deep learning.” Electronics, Vol. 11, No. 11, 2022,p. 1780.
[30] Chaudhari, Dr. Pallavi, et al. ”Sign Language Detection System.” International Journal of Engineering Technology and Management Science, 2020.