Breaking Barriers: A Survey of Sign Language Translation Systems

Shijina B[1], Dr.B.Ben Sujitha[2]
[1,2] *Computer Science and Engineering Department, Noorul Islam Centre for Higher Education, Thuckalay, Tamilnadu*

***Abstract*— Real-time sign language translator systems represent a significant breakthrough in technology aimed at fostering seamless communication between the deaf community and the hearing world. Here we explores the relevance and impact of real-time sign language translator systems in bridging the communication gap for individuals who use sign language as their primary mode of communication. By leveraging cutting-edge technologies such as computer vision, machine learning, and natural language processing, these systems have the capability to interpret and translate sign language gestures into spoken language or text in real time. This capability revolutionizes communication accessibility in diverse settings including educational institutions, workplaces, healthcare facilities, legal proceedings, and public events. Our survey aimed to analyse the advancements in real-time sign language translators developed over the past years .We analysed the current literature, technical reports, and conference papers on real-time sign language translation systems.**

***Keywords*—real-time sign language translator, machine learning, Sign language Recognition, Tensor Flow Object Detection, gestures.**

1. INTRODUCTION

Sign language is a vital mode of communication for deaf and hard of hearing individuals, yet its comprehension by those outside the deaf community can pose a significant barrier. Real-time sign language translation systems aim to bridge this gap by leveraging cutting-edge technologies such as computer vision, machine learning, and natural language processing. These systems typically employ cameras to capture sign language gestures, which are then processed by algorithms capable of recognizing and interpreting the gestures into spoken or written language in real-time. The development of such systems represents a remarkable advancement in inclusive communication, empowering deaf individuals to interact more seamlessly with the hearing world. In addition to improving communication accessibility, real-time sign language translation technology holds promise in various domains, including education, healthcare, customer service, and public events. By facilitating effective communication between deaf and hearing individuals, these systems promote inclusivity and diversity while fostering greater understanding and collaboration across communities. As researchers and technologists continue to refine and enhance real-time sign language translation systems, the potential for these technologies to positively impact the lives of millions of deaf individuals worldwide grows exponentially. Through ongoing innovation and collaboration, we can strive towards a more inclusive society where communication barriers are minimized, and all individuals have equal access to information and opportunities.

1.1 Review Information and Selection Method

The papers were categorized based on the development from sign language recognition to sign language translation represents a significant advancement in assistive technology and accessibility for the deaf and hard of hearing community. This journey involves several key stages and technological innovations. The aim of this selection was to summarize the development from sign language recognition to sign language translation using fusion of computer vision, machine learning, and natural language processing technologies with profound implications for inclusivity and accessibility in our increasingly digital world. Journal articles, technical reports, and papers presented at conferences provide a wealth of useful options for selecting references. These studies helps us to gather information about (i) the various techniques in hand gesture and sign language recognition (ii) Sign Language translation using machine learning (iii) real time translation of sign language to speech and text (iv) various approaches and techniques in real time sign language

translation (v) challenges in real time sign language translation.

1.2 Outline of the paper

The structure of this paper is as follows: *Section 2* Presents an over view of sign language recognition and sign language detector using machine learning. *Section 3* highlights the sign language translation using machine learning. *Section 4* discussed real time sign language translation system. *Section 5* focuses on the applications of real time sign language translation. *Section 6* focuses on the challenges of real time sign language translation. Finally, there is a results and discussion section that analyses the performance of different systems and their implications for disabled individuals and sign language users.

2. SIGN LANGUAGE AND RECOGNITION SYSTEM

Deafness is a disability that impair their hearing and makes one unable to hear, while muteness is a disability that impair their speaking and make them unable to speak. Both are only disabled at their hearing and/or speaking. The only thing that separate them and the normal people is communication. If there is a way for normal people and deaf-mute people to communicate, the deaf-mute people can easily live like a normal person. The only way for them to communicate is through sign language.

While sign language is very important to deaf-mute people, to communicate both with normal people and with themselves, is still getting little attention from the normal people. One of the solution to communicate with the deaf-mute people is by using the services of sign language interpreter. But the usage of sign language interpreter can be costly. Therefore, researchers want to find a way for the deaf-mute people so that they can communicate easily with normal person. The breakthrough for this is the Sign Language Recognition System. The system aims to recognize the sign language, and translate it to the local language via text or speech.

However, building this system cost very much and are difficult to be applied for daily use. Early researches have known to be successful in Sign Language Recognition System by using data gloves [1-4]. But, the high cost of the gloves and wearable character make it difficult to be commercialized. Knowing that, researchers then try to develop a pure vision Sign Language Recognition Systems. However, it is also coming with difficulties, especially to precisely track hands movements.

2.1 Approaches in sign language recognition

Sign language recognition systems aim to interpret and understand sign language gestures performed by individuals, translating them into spoken or written language or executing commands. These systems are valuable for facilitating communication between individuals who use sign language and those who do not.

Sign language recognition systems can be categorized based on various criteria, including the input modality, the techniques used for recognition, and the intended application. Here are some common categories:

(a) Input Modality:

- Video-based Recognition: These systems use video input from cameras to capture and analyze the gestures and movements of sign language users [3-6].
- Glove-based Recognition: Some systems use gloves equipped with sensors that detect hand movements and gestures, translating them into corresponding signs or text [1-2].
- Wearable Devices: With advancements in wearable technology, sign language recognition systems can be integrated into devices like smart glasses or wristbands to interpret and translate sign language on-the-go [2].

(b) Techniques Used:

- Computer Vision Techniques: These systems employ computer vision algorithms to analyze video input, detect key points, track hand movements, and recognize signs based on predefined gestures and patterns [3-6].
- Machine Learning and Deep Learning: Many sign language recognition systems utilize machine learning and deep learning techniques, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), to recognize patterns and sequences in sign language gestures [7]

- Sensor Fusion: Some systems combine data from multiple sensors, such as cameras and accelerometers, to improve accuracy and robustness in sign language recognition [2].

(c) Application:

- Communication Aids: These systems facilitate communication between deaf or hard-of-hearing individuals and hearing individuals by translating sign language into spoken language or text in real-time [10].

(d) Real-time vs. Offline Recognition:

- Real-time Recognition: These systems analyze sign language gestures and movements in real-time, providing immediate feedback or translation as the user signs [9].
- Offline Recognition: In contrast, offline recognition systems analyze recorded video or sensor data after the signing session is complete, allowing for post-processing and analysis.

3. SIGN LANGUAGE TRANSLATION USING MACHINE LEARNING

Sign language translation using machine learning involves the development of algorithms and models that can interpret and translate sign language gestures and expressions into spoken or written language, and vice versa. Here's a description of the process:

Data Collection: The first step in developing a sign language translation system is collecting a large dataset of sign language videos or images along with their corresponding spoken or written translations. These datasets may include various sign languages such as American Sign Language (ASL), British Sign Language (BSL), or others depending on the target audience [11-12].

Pre-processing: The collected data needs to be pre-processed to extract meaningful features that can be used by machine learning algorithms. This may involve tasks such as image/video segmentation, hand and gesture detection, and feature extraction to represent gestures effectively [5-6].

Feature Extraction: Extracting relevant features from sign language images or videos is crucial for building accurate translation models. Features may include hand shape, hand movement, hand orientation, facial expressions, and body posture. Deep learning techniques, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), are commonly used for feature extraction from images and videos [13].

Model Training: Once the features are extracted, machine learning models are trained to recognize and interpret sign language gestures. Models can range from simple classifiers to complex deep learning architectures depending on the complexity of the gestures and the desired accuracy of the translation system. Supervised learning techniques are often used where the model learns from labelled data pairs of sign language gestures and their corresponding spoken or written translations [11-13].

Translation: After the model is trained, it can be used to translate sign language gestures into spoken or written language. The model takes sign language input (either from videos or images) and generates the corresponding spoken or written translation [11-13].

Feedback Loop and Improvement: The translation system can be further improved by collecting user feedback and continuously updating and retraining the model based on the feedback received. This iterative process helps enhance the accuracy and performance of the translation system over time [11-13].

4. REAL TIME SIGN LANGUAGE TRANSLATION SYSTEM

Real-time sign language translation involves converting sign language gestures into spoken language or text in real-time. Several approaches have been developed to achieve this, leveraging technologies such as computer vision, machine learning, and natural language processing.

However, sign language recognition systems face several limitations, mainly related to the collection of gesture data. In sign language, hand movements, full-body motions, and facial expressions are all essential components of effective translation. The challenge lies capturing this information in real-time, processing it accurately, and recognizing it in a way that simple enough to support the daily needs of people with hearing loss. To meet these

requirements, the system must be powerful, which makes it less portable, and must be able to translate a wide range of signs in real-time. These limitations impact the usability and practicality of sign language recognition systems [14].

The development of a real-time sign language translator using Tensor Flow Object Detection offers significant potential for bridging communication gaps between sign language users and non-signers. By leveraging the power of object detection models and the latest version of Tensor Flow Object Detection, the translator can accurately detect and localize sign gestures in real-time, enabling efficient and effective translation into spoken or written language. The performance evaluation of such a system from an end user's perspective highlights the importance of accuracy in sign detection, speed and responsiveness, robustness to variations, translation accuracy, user-friendly interface and interaction, adaptability, usability, accessibility, and effective error handling [15].

5. CONCLUSION

Sign language translation technologies have made significant strides in recent years, offering promising solutions for bridging communication gaps between the deaf and hearing communities. These technologies utilize computer vision, machine learning, and natural language processing algorithms to recognize and translate sign language gestures into spoken or written language, and vice versa. One key conclusion is that sign language translation technologies have the potential to enhance accessibility and inclusivity for deaf individuals in various aspects of life, including education, employment, healthcare, and everyday communication. They empower deaf individuals to participate more fully in society by breaking down communication barriers.

However, it's important to note that sign language translation technologies still face several challenges and limitations. These include: *Accuracy:* Despite advancements, accuracy in recognizing and translating sign language gestures remains a challenge, especially considering the wide variation in signing styles and regional dialects. *Real-time Translation*: Achieving real-time translation in dynamic conversations can be difficult due to the complexity of sign language and the need for precise recognition and interpretation .*Hardware Dependence:* Some sign language translation systems require specialized hardware, such as gloves or cameras, which may limit their practicality and accessibility in certain contexts. *Cost and Availability:* High costs and limited availability of advanced sign language translation technologies may restrict access for individuals and organizations, particularly in resource-constrained settings. *Cultural Sensitivity:* Sign language is not only a means of communication but also a cultural and linguistic identity for deaf communities. It's crucial for sign language translation technologies to respect and preserve this cultural aspect while facilitating communication.

In conclusion, while sign language translation technologies hold great promise for improving accessibility and communication for deaf individuals, continued research and development are needed to address the existing challenges and ensure that these technologies are accurate, accessible, culturally sensitive, and widely available. With further innovation and collaboration, sign language translation technologies have the potential to significantly enhance the lives of deaf individuals and promote inclusivity in society.

6. FUTURE SCOPE

Currently, most real-time sign language translation systems focus on a limited set of sign languages. In the future, there's potential for these systems to support a wider range of sign languages from different regions and cultures, thus making communication more inclusive on a global scale. Real-time sign language translation could become more accessible through mobile applications, allowing users to communicate effectively using their smartphones or tablets. These apps could leverage the processing power of mobile devices along with cloud-based services to provide accurate translation on-the-go. Overall, the future scope of real-time sign language translation is driven by advancements in technology, increased awareness of accessibility needs, and a growing commitment to inclusivity and diversity in communication. As these systems continue to evolve, they have the potential to break down communication barriers and empower individuals with diverse linguistic and communication needs.

REFERENCES

[1] S.A. Mehdi and Y. N. Khan, "Sign language recognition using sensor gloves," *Proceedings of the 9th International Conference on Neural Information Processing, 2002. ICONIP '02.*, Singapore, 2002, pp. 2204-2206 vol.5, doi: 10.1109/ICONIP.2002.1201884.

[2] Ji, A.Wang, Y.Miao, X..Fan, T. Ru, B.Liu, L. Nie, R. Qiu, S."Dataglove for Sign Language Recognition of People with Hearing and Speech Impairment via Wearable Inertial Sensors". Sensors 2023, 23, 6693. https://doi.org/10.3390/ s23156693.

[3] Cheok, M.J., Omar, Z. & Jaward, M.H. "A review of hand gesture and sign language recognition techniques". *Int. J. Mach. Learn. & Cyber*. 10, 131–153 (2019). https://doi.org/10.1007/s13042-017-0705-5.

[4] Suharjito, Ricky Anderson, Fanny Wiryana, Meita Chandra Ariesta, Gede Putra Kusuma. "Sign Language Recognition Application Systems for Deaf-Mute People: A Review Based on Input-Process-Output ".*2nd International Conference on Computer Science and Computational Intelligence 2017*, ICCSCI 2017, 13-14 October 2017, Bali, Indonesia.

[5] Simran Malik,Yukti Kholiwal, Dr. Jayashree J." Sign Language Recognition And Detection: A Comprehensive Survey". *Journal of Data Acquisition and Processing Vol. 38 (3) 2023, ISSN: 1004-9037* , https://sjcjycl.cn/ ,DOI: 10.5281/zenodo.777632

[6] Rudresh N C, Chandana K J, Gagana D, Pallavi K G, Prashanth G V, 2023, "Sign Language Detector Using Machine Learning", *International Journal Of Engineering Research & Technology (IJERT)* Volume 11, Issue 05 (ICEI – 2023).

[7] Srivastava, Sharvani & Gangwar, Amisha & Mishra, Richa & Singh, Sudhakar. (2022). Sign Language Recognition System using TensorFlow Object Detection API. *Proceedings of International Conference on Advanced Network Technologies and Intelligent Computing (ANTIC-2021),* part of the book series 'Communications in Computer and Information Science (CCIS)', Springer. https://doi.org/10.1007/978-3-030-96040-7_48.

[8] Navasardyan, Armine & Knkoyan, Gohar. (2021). "About Sign Language Translator Application". *Armenian Journal of Special Education.* 3. 25-38. 10.24234/se.2021.3.1.267.

[9] Sanket Bankar, Tushar Kadam, Vedant Korhale, Mrs. A. A. Kulkarni." Real Time Sign Language Recognition Using Deep Learning". *International Research Journal of Engineering and Technology (IRJET)* e-ISSN: 2395-0056 Volume: 09 Issue: 04 | Apr 2022 www.irjet.net p-ISSN: 2395-0072.

[10] Sachin Tripathi, Priyanka Verma , Lakshay Malhotra, Priya Verma, Dr. Preety Verma Dhaka." Sign Language Recognition Application-Sanket". *International Research Journal of Modernization in Engineering Technology and Science e-ISSN: 2582-5208* Volume:03/Issue:01/January-2021 Impact Factor- 5.354 www.irjmets.com.

[11] Johnny, Swapna & Nirmala, Jaya. (2022). "Sign Language Translator Using Machine Learning". SN Computer Science. 3. 10.1007/s42979-021-00896-y.

[12] Dr. Jagruti Nagaonkar, Savit Nair,Akhil Mani, Reuben Dsa, Erica Mathias." Sign Language Translator". *Journal of Emerging Technologies and Innovative Research (JETIR),* 2023 JETIR May 2023, Volume 10, Issue 5, www.jetir.org (ISSN-2349-5162).

[13] Uday Patil, Saraswati Nagtilak, Sunil Rai, Swaroop Patwari, Prajay Agarwal and Rahul Sharma." Sign Language Translator using Deep Learning". EasyChair Preprint no. 2541 Date: February 4, 2020.

[14] Papatsimouli, M.,Sarigiannidis, P.Fragulis, G.F.A Survey of Advancements in Real-Time Sign Language Translators: Integration with IoT Technology. Technologies 2023, 11, 83. https://doi.org/10.3390/technologies1104008 3.

[15] John Pius Thayiparampil, Kiran k, T Binto Binu, Sreejith Viju." Real Time Sign Language Translation Using Tensor Flow Object Detection". *International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056* Volume: 10 Issue: 07 | July 2023 www.irjet.net p-ISSN: 2395-0072