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SIGNLANGUAGETRANSLATOR

[1]Mable Sebastian, [2]Maya M, [3]Mohammed Sabiq, [4]Yadhu Krishnan U, [5]Rakesh

[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor (CSE)

[1]Computer Science and Engineering Department,

[1]Nehru College of Engineering and Research Center (NCERC), Thrissur, India

Abstract: In a world where communication barriers often isolate individuals with hearing impairments, bridging the gap between spoken language and sign language becomes imperative. This project proposes a novel solution aimed at facilitating seamless communication between the deaf and hearing communities through a multimodal interface. The project focuses on developing two key functionalities: converting audio inputs into sign language and translating sign language gestures into audio and text outputs. To achieve this, the system integrates advanced machine learning algorithms, computer vision techniques, and natural language processing models. For the audio to sign language conversion, the system utilizes speech recognition to transcribe spoken language into text, which is then translated into sign language gestures using a deep learning-based sign language generation model. The generated sign language animations are displayed in real-time through an avatar or a robotic interface. Conversely, for sign language to audio and text translation, the system employs computer vision algorithms to detect and recognize sign language gestures from video inputs. These gestures are then interpreted into text using machine learning classifiers trained on sign language datasets. Finally, the text is converted into spoken language using text-to-speech synthesis for audio output and displayed alongside the animations for text output. The proposed system offers a comprehensive solution for bidirectional communication between the deaf and hearing communities, facilitating real-time interaction without language barriers. It has the potential to enhance accessibility in various settings, including education, healthcare, and public services, ultimately fostering inclusivity and equality for individuals with hearing impairments.

I. INTRODUCTION

In a world where communication serves as the cornerstone of human interaction, the barriers posed by language differences can often isolate individuals with hearing impairments from mainstream society. Sign language, a visual-gestural language used by deaf and hard-of-hearing individuals, offers a rich medium for communication. However, the divide between sign language and spoken language remains a significant challenge, hindering seamless communication between the deaf and hearing communities.

The project titled "Audio to Sign Language and Sign Language to Audio and Text" aims to bridge this gap by proposing a comprehensive solution that enables bidirectional communication between spoken language and sign language. Through the integration of cutting-edge technologies such as machine learning, computer vision, and natural language processing, the project seeks to create a multimodal interface that facilitates real-time translation between audio inputs and sign language gestures, as well as vice versa. By developing functionalities for both audio to sign language conversion and sign language to audio and text translation, the project endeavors to empower individuals with hearing impairments to engage in fluid communication across

diverse settings. From educational environments and healthcare facilities to everyday social interactions, the proposed system holds the potential to revolutionize accessibility and inclusivity for the deaf and hard-of-hearing population. This introduction sets the stage for exploring the intricacies of the project, highlighting its significance in addressing the communication barriers faced by individuals with hearing impairments and underscoring the transformative impact it aims to achieve in fostering a more inclusive society.

II. LITERATURE SURVEY

A literature review is an overview of the works that recognized academics and researchers have published on a certain subject. It comprises the state of the art, encompassing significant discoveries as well as theoretical and methodological advancements on a given subject. Reviews of the literature do not present newly conducted experiments; instead, they rely on secondary sources. A literature review enables us to improve and showcase our abilities in two primary domains: locating knowledge and evaluating it critically.

2.1 REAL TIME SIGN LANGUAGE TRANSLATION SYSTEM

There are people who cannot communicate in the same way with others. Deaf and hard-of-hearing people use sign languages for their communication with other people. Sign languages are also used for the communication between deaf and non-deaf people, including different types of hand gestures and facial expressions for communication and emotional expression. Sign language recognition and gesture-based controls are applications that are used by gesture recognition technologies, and it is a fact that this technology has reduced the communication gap, while these systems are used for converting gestures to text or speech. The focus of our research is to analyse real-time sign language translators that are used for language translation. Sign Language Translation Systems that were developed from 2017 to2021 are analysed in this paper. Index Terms—Sign Language, Sign Language Recognition, Handicapped aids, Application Program Interfaces, IoT.

2.2 TECHNICAL APPROACHES TO CHINESE SIGN LANGUAGE PROCESSING

As with the huge number of deaf-mute people in China is of concern, there is a growing need to integrate them into mainstream society through the use of efficient sign language processing technologies. Sign language processing entails the systematic recognition and translation of sign language images/videos to text or speech. This survey provides an overview of the most important work on Chinese sign language recognition and translation, discussed its classification, highlights the features explored in sign language recognition research, presents the datasets available, and provides trends for the future research.

2.3 AN EFFICIENT TWO-STREAM NETWORK FOR ISOLATED SIGN LANGUAGERECOGNITIONUSING ACCUMULATIVE VIDEO MOTION

Sign language is the primary communication medium for persons with hearing impairments. This language depends mainly on hand articulations accompanied by nonmanual gestures. Recently, there has been a growing interest in sign language recognition. In this paper, we propose a trainable deep learning network for isolated sign language recognition, which can effectively capture the spatiotemporal information using a small number of signs frames. We propose a hierarchical sign learning module that comprises three networks: dynamic motion network (DMN), accumulative motion network (AMN), and sign recognition network (SRN). Additionally, we propose a technique to extract key postures for handling the variations in the sign samples performed by different signers. The DMN stream uses these key postures to learn the spatiotemporal information pertaining to the signs. We also propose a novel technique to represent the statical and dynamic information of sign gestures into a single frame. This approach preserves the spatial and temporal information of the sign by fusing the signs key postures in the forward and backward directions to generate an accumulative video motion frame. This frame was used as an input to the AMN stream, and the extracted features were fused with the DMN features to be fed into the SRN for the learning and classification of signs. The proposed approach is efficient for isolated sign language recognition, especially for recognizing static signs. We evaluated this approach on the KArSL-190 and KArSL-502 Arabic sign language datasets, and the obtained

results on KArSL-190 outperformed other techniques by 15% in the signer-independent mode. Additionally, the proposed approach outperformed the state-of-the-art techniques on the Argentinian sign language dataset LSA64.

2.4 IDF-SIGN: ADDRESSING INCONSISTENT DEPTH FEATURES OF DYNAMIC SIGN WORD RECOGNITION

Inconsistent hand and body features pose barriers to sign language recognition and translation leading to unsatisfactory models. Existing recognition models are built up on the spatial-temporal depth Sp features. Finding suitable expert features for the Sp model is challenging especially for dynamic sign words because many inconsistent features exist across hand motions and shapes. In this article, we propose IDF-Sign: an efficient and consistent Sp model from a spatial-temporal multivariate pairwise consistency feature ranking (PairCFR) approach. The temporal features are obtained by computing the 3D position vector of skeletal hand joint coordinates, while the spatial features were obtained by taking every ten spatial coordinates in the 3D video frames and averaging it and doing so until the end of the frames. The PairCFR was used to rank and select the best Sp model features at different feature thresholds. We employed a threshold selection to compute a mid-point value of each ranked feature according to its weight. The receiver operating characteristics (ROC) scheme was employed to identify the relationship between the sensitive parameters and the Sp features, and the obtained values were utilized as modeling inputs. To verify the IDF Sign, we design a real-life experiment with a leap motion sensor (LMS) consisting of ten signers with a total of ninety dynamic sign words. LMS provides the depth videos, since depth videos are too dense for the Sp model to treat directly, we read the depth videos in comma-separated files in real time. Extensive IDF-Sign evaluations using machine learning on ASL, GSL, DSG, and ASL-similar datasets prove the Optimized Forest achieved an average recognition performance of 95%, 78%, 65.07%, and 95%ofthetop-1, respectively.

2.5 HAND GESTURE RECOGNITION FOR MULTI-CULTURE SIGN LANGUAGE USING GRAPH AND GENERAL DEEP LEARNING NETWORK

Hand gesture-based Sign Language Recognition (SLR) serves as a crucial communication bridge between hard of hearing and non-deaf individuals. The absence of a universal sign language (SL) leads to diverse nationalities having various cultural SLs, such as Korean, American, and Japanese sign language. Existing SLR systems perform well for their cultural SL but may struggle with other or multi-cultural sign languages (McSL). To address these challenges, this paper introduces a novel end-to-end SLR system called GmTC, designed to translate McSL into equivalent text for enhanced understanding. Here, we employed a Graph and General deep-learning network as two stream modules to extract effective features. In the first stream, produce a graph-based feature by taking advantage of the super pixel values and the graph convolutional network (GCN), aiming to extract distance-based complex relationship features among the super pixel. In the second stream, we extracted long-range and short-range dependency features using attention-based contextual information that passes through multi-stage, multi-head self-attention (MHSA), and CNN modules. Combining these features generates final features that feed into the classification module. Extensive experiments with five culture SL datasets with high-performance accuracy compared to existing state-of-the-art models in individual domains affirming superiority and generalizability.

2.6 DEEP LEARNING FOR SIGN LANGUAGE RECOGNITION: CURRENT TECHNIQUES, BENCHMARKS, AND OPEN ISSUES

People with hearing impairments are found worldwide; therefore, the development of effective local level sign language recognition (SLR) tools is essential. We conducted a comprehensive review of automated sign language recognition based on machine/deep learning methods and techniques published between 2014 and 2021 and concluded that the current methods require conceptual classification to interpret all available data correctly. Thus, we turned our attention to elements that are common to almost all sign language recognition methodologies. This paper discusses their relative strengths and weaknesses, and we propose a general framework for researchers. This study also indicates that input modalities bear great significance in this eld; it

appears that recognition based on a combination of data sources, including vision-based and sensor-based channels, is superior to a unimodal analysis. In addition, recent advances have allowed researchers to move from simple recognition of sign language characters and words towards the capacity to translate continuous sign language communication with minimal delay. Many of the presented models are relatively effective for a range of tasks, but none currently possess the necessary generalization potential for commercial deployment. However, the pace of research is encouraging, and further progress is expected if specific difficulties are resolved

2.7 ENABLING TWO-WAY COMMUNICATION OF DEAF USING SAUDI SIGN LANGUAGE

Disabled people are facing many difficulties communicating with others and involving in society. Modern societies have dedicated significant efforts to promote the integration of disabled individuals into their societies and services. Currently, smart healthcare systems are used to facilitate disabled people. The objective of this paper is to enable two-way communication of deaf individuals with the rest of society, thus enabling their migration from marginal elements of society to mainstream contributing elements. In the proposed system, we developed three modules; the sign recognition module (SRM) that recognizes the signs of a deaf individual, the speech recognition and synthesis module (SRSM) that processes the speech of a non-deaf individual and converts it to text, and an Avatar module (AM) to generate and perform the corresponding sign of the non-deaf speech, which were integrated into the sign translation companion system called Saudi deaf companion system (SDCS) to facilitate the communication from the deaf to the hearing and vice versa. This paper also contributes to the literature by utilizing our self-developed database, the largest Saudi Sign Language (SSL) database—the King Saud University Saudi-SSL (KSU-SSL). The proposed SDCS system performs 293 Saudi sign that are recommended by the Saudi Association for Hearing Impairment (SAHI) from 10 domains. The 10 domains are (healthcare, common, alphabets, verbs, pronouns and adverbs, numbers, days, kings, family, and regions).

2.8 DEEP LEARNING-BASED STANDARD SIGN LANGUAGE DISCRIMINATION

General sign language recognition models are only designed for recognizing categories, i.e., such models do not discriminate standard and nonstandard sign language actions made by learners. It is inadequate to use in a sign language education software. To address this issue, this paper proposed a sign language category and standardization correctness discrimination model for sign language education. The proposed model is implemented with a hand detection and standard sign language discrimination method. For hand detection, the proposed method utilizes flow-guided features and acquires relevant proposals using stable and flow key frame detections. This model can resolve the inconsistency between the forward optical flow and the box center point offset. In addition, the proposed method employs an encoder-decoder model structure for sign language correctness discrimination. The encoder model combines 3D convolution and 2D deformable convolution results with residual structures, and it implements a sequence attention mechanism. A Sign Language Correctness Discrimination dataset (SLCD dataset) was also constructed in this study. In this dataset, each sign language video has two recognition labels, i.e., sign language category and standardization category. The semi-supervised learning method was employed to generate pseudo hand position labels. The hand detection model was getting sufficiently high hand detection result. The sign language correctness discrimination model was tested with hand patches or full images.

2.9 A REVIEW OF HAND GESTURE RECOGNITION SYSTEM: CURRENT PROGRESS AND FUTURE DIRECTION

This paper reviewed the sign language research in the vision-based hand gesture recognition system from 2014 to 2020. Its objective is to identify the progress and what needs more attention. We have extracted a total of 98 articles from well-known online databases using selected keywords. The review shows that the vision-based hand gesture recognition research is an active eld of research, with many studies conducted, resulting in dozens of articles published annually in journals and conference proceedings. Most of the articles focus on three critical aspects of the vision-based hand gesture recognition system, namely: data acquisition, data environment, and hand gesture representation. We have also reviewed the performance of the vision-based

hand gesture recognition system in terms of recognition accuracy. For the signer dependent, the recognition accuracy ranges from 69% to 98%, with an average of 88.8% among the selected studies. On the other hand, the signer independents recognition accuracy reported in the selected studies ranges from 48%to97%, with an average recognition accuracy of 78.2%. The lack in the progress of continuous gesture recognition could indicate that more work is needed towards a practical vision-based gesture recognition system.

2.10 SIGNFORMER: DEEPVISION TRANSFORMER FOR SIGN LANGUAGE RECOGNITION

Signlanguageisthemostcommonformofcommunicationforthehearingimpaired. To bridge the communication gap with such impaired people, a normal people should be able to recognize the signs. Therefore, it is necessary to introduce a sign language recognition system to assist such impaired people. This paper proposes the Transformer Encoder as a useful tool for sign language recognition. For the recognition of static Indian signs, the authors have implemented a vision transformer. To recognize static Indian sign language, proposed methodology archives noticeable performance over other state-of-the-art convolution architecture. The suggested methodology divides the sign into a series of positional embedding patches, which are then sent to a transformer block with four self-attention layers and a multilayer perceptron network. Experimental results show satisfactory identification of gestures under various augmentation methods. Moreover, the proposed approach only requires a very small number of training epochs to achieve 99.29 percent accuracy.

III. EXISTING SYSTEM

The landscape of sign language translation is marked by three pivotal components, each presenting distinct challenges and opportunities. At its core lies manual sign language interpretation, a practice reliant on skilled individuals proficient in both sign language and spoken language. While invaluable, this method often encounters constraints in scalability, real-time communication, and accessibility. Furthermore, the digital sphere, despite its vast potential for inclusivity, frequently overlooks the needs of the deaf and hard of hearing community, resulting in a pervasive lack of accessibility in digital media. This deficit perpetuates disparities in education, employment, and social participation. Additionally, automated solutions have emerged as a promising avenue for bridging these gaps, yet their development remains in its nascent stages. Limited by factors such as accuracy, cultural nuances, and adaptability to diverse signing styles, these technologies have yet to achieve widespread adoption and efficacy comparable to human interpretation. Nevertheless, ongoing advancements in machine learning, computer vision, and natural language processing hold promise for enhancing the capabilities of automated sign language translation systems. By addressing these three critical components—manual interpretation, digital accessibility, and automated solutions—the field of sign language translation stands poised for transformative progress. Through interdisciplinary collaboration, innovation, and a steadfast commitment to inclusivity, stakeholders can work towards a future where sign language users seamlessly navigate a world enriched by accessible communication and equitable opportunities.

IV. LIMITATIONS IN EXISTING SYSTEM

- **Reliance on Human Interpreters:** The dependence on manual sign language interpretation results in limitations such as availability constraints, potential errors in interpretation, and challenges in meeting the demand for interpreters in various settings.
- **Inadequate Digital Accessibility:** The lack of accessibility features in digital media hampers the ability of deaf and hard of hearing individuals to fully participate in online activities, access information, and communicate effectively through digital platforms.
- **Limited Language Coverage:** Existing systems may not encompass all sign languages and dialects, leaving users of less common sign languages without suitable translation solutions.

- **Complexity of Cultural Nuances:** Automated systems may overlook or misinterpret the cultural nuances inherent in sign languages, impacting the richness and accuracy of communication, particularly in contexts requiring subtle or context-specific expressions.

- **Technical Limitations:** Automated sign language translation solutions may face technical constraints such as limited processing power, data storage, or bandwidth, which can affect their performance and usability, especially in resource-constrained environments.

- **One way communication:** Existing system lacks bidirectional communication, inhibiting interactive and inclusive exchanges between sign language users and non-users.

- **Adaptability to Regional Differences:** The limitations in adaptability, sustainability, and safety may contribute to reduced user satisfaction as residents miss out on the enhanced living experiences provided by the proposed AI-Enhanced Smart Living system.

V. PROBLEM STATEMENT

The abstract outlines a project aimed at developing a sign language translator system to facilitate seamless communication between deaf and hearing individuals. However, several challenges persist in achieving effective communication across these communities. One primary challenge lies in the accurate conversion of audio inputs into sign language gestures. Despite advancements in speech recognition technology, accurately transcribing spoken language into text, particularly in noisy or complex environments, remains a significant hurdle. Additionally, generating lifelike and expressive sign language animations that convey the nuances of spoken language presents a technical challenge that requires innovative solutions. Conversely, translating sign language gestures into audio and text outputs poses another set of challenges. Computer vision algorithms must accurately detect and recognize a wide range of sign language gestures, including variations in speed, style, and context. Furthermore, interpreting these gestures into coherent text requires robust machine learning classifiers trained on diverse sign language datasets to account for regional and individual differences. Moreover, ensuring real-time interaction and seamless integration of audio, text, and sign language animations demands efficient processing and synchronization of data streams. The system must also address accessibility concerns, such as compatibility with different devices and interfaces, to ensure usability across diverse settings. Addressing these challenges requires interdisciplinary collaboration and innovative approaches drawing from fields such as machine learning, computer vision, and natural language processing. Overcoming these obstacles will be crucial in developing a sign language translator system that truly enhances accessibility and inclusivity for individuals with hearing impairments.

VI. PROPOSED SYSTEM

The proposed sign language translator system offers a comprehensive solution for facilitating seamless communication between deaf and hearing individuals. By integrating seven specialized modules including admin, organization, disabled people, employer, teacher, audio to sign language, and sign language to text and speech, the system addresses various user needs and contexts. Through advanced technologies such as machine learning, computer vision, and natural language processing, the system enables real-time conversion of audio inputs into sign language gestures and vice versa. Additionally, it provides customizable features, accessibility options, and support services to enhance user experience and promote inclusivity in education, healthcare, employment, and other domains. Overall, the proposed system aims to bridge communication barriers and foster equality for individuals with hearing impairments.

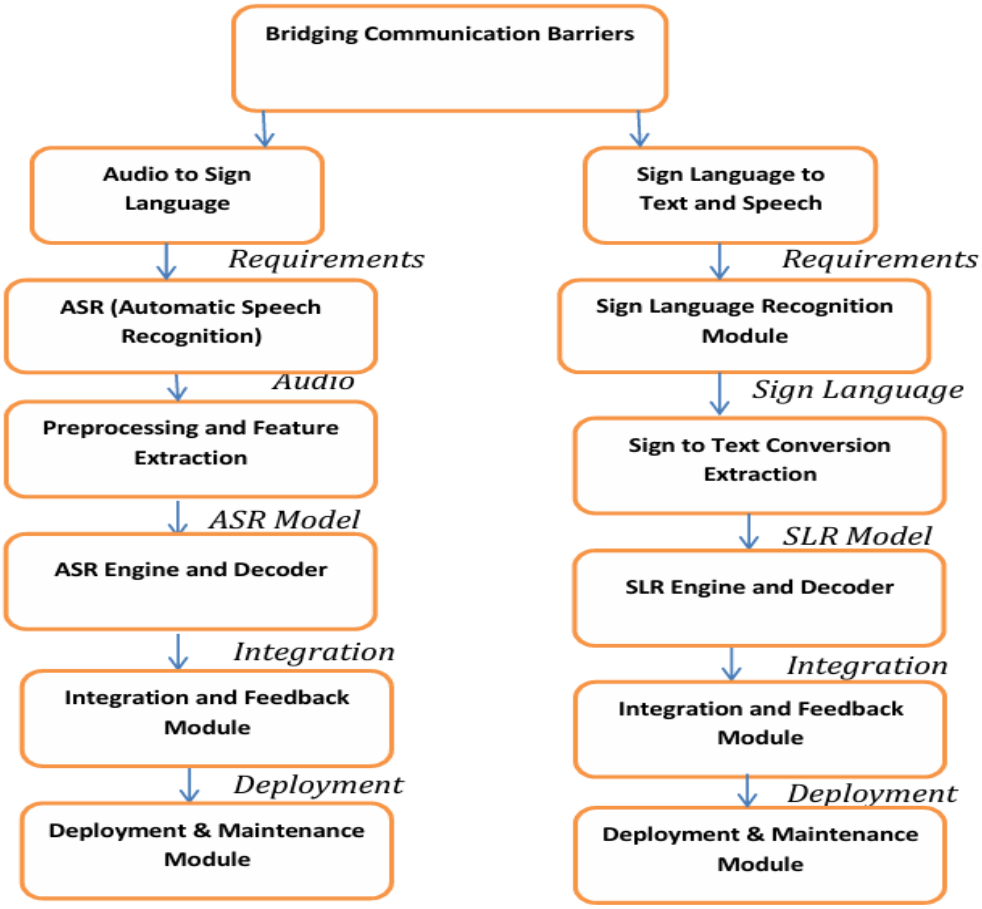

Figure 1. System Block Diagram

6.1 Admin module

The admin module serves as the backbone of the sign language translator system, overseeing user management, system configuration, and maintenance tasks. Admins have the authority to manage user accounts, access permissions, and system settings. They ensure smooth operation by monitoring system performance, resolving technical issues, and updating software as needed. Additionally, the admin module facilitates data management and security measures to safeguard user information and ensure compliance with privacy regulations. With robust administrative capabilities, this module plays a crucial role in the effective functioning and scalability of the sign language translator system.

6.2 Organization module

The organization module caters to institutions and entities utilizing the sign language translator system within their premises. It allows organizations to customize the system according to their specific needs, such as integrating with existing communication infrastructure and configuring user roles and permissions. Additionally, this module facilitates centralized management of user accounts and access rights across different departments or branches of an organization. Organizations can leverage reporting and analytics tools provided by this module to track usage metrics, monitor performance, and optimize resource allocation. By offering tailored solutions for organizational requirements, this module enhances efficiency and collaboration in diverse settings.

6.3 Disabled people module

The disabled people module focuses on providing specialized features and support tailored to the needs of individuals with hearing impairments. It offers intuitive user interfaces, customizable settings, and accessibility options to ensure a seamless and inclusive user experience. This module includes features such as personalized sign language avatars, adjustable animation speeds, and visual cues for navigation and interaction. Additionally, it provides resources and support services for users to learn and improve sign language skills, fostering empowerment and independence. By prioritizing accessibility and user-centric design, the disabled people module aims to enhance communication and participation for individuals with hearing impairments in various contexts.

6.4 Employer module

The employer module addresses the needs of businesses and employers seeking to foster an inclusive workplace environment for employees with hearing impairments. It offers tools and resources for recruiting, onboarding, and accommodating deaf or hard-of-hearing employees, including job postings with accessibility features and training materials on workplace communication etiquette. This module also facilitates real-time communication and collaboration among team members, regardless of their hearing abilities, through seamless integration with the sign language translator system. Employers can leverage reporting and analytics features to track employee engagement, satisfaction, and productivity, thereby promoting diversity and inclusion in the workplace.

6.5 Teacher module

The teacher module caters to educators and instructors seeking to enhance accessibility and inclusivity in educational settings for students with hearing impairments. It provides resources, lesson plans, and educational materials designed to support sign language learning and communication skills development. This module offers interactive tools for delivering lectures, conducting assessments, and facilitating discussions in both sign language and spoken language formats. Additionally, it enables collaboration and communication between teachers, students, and parents through messaging features and virtual classrooms. By empowering educators with specialized tools and support, the teacher module aims to create an inclusive learning environment that maximizes student engagement and success.

6.6 Audio to sign language

The audio to sign language module enables real-time conversion of spoken language inputs into sign language gestures, facilitating communication between hearing and deaf individuals. It utilizes advanced speech recognition technology to transcribe spoken language into text, which is then processed by a deep learning-based sign language generation model to produce lifelike sign language animations. These animations are displayed in real-time through an avatar or robotic interface, ensuring seamless and expressive communication for deaf users. By bridging the gap between spoken and sign languages, this module enhances accessibility and fosters meaningful interactions in various settings, including education, healthcare, and public services.

6.7 Sign language to text and speech

The sign language to text and speech module enables the translation of sign language gestures into text and audio outputs, catering to the communication needs of both deaf and hearing individuals. It employs computer vision algorithms to detect and recognize sign language gestures from video inputs, followed by machine

learning classifiers to interpret these gestures into coherent text. Additionally, the module integrates text-to-speech synthesis technology to convert the interpreted text into spoken language, providing audio output alongside text display for seamless comprehension. By offering bidirectional translation capabilities, this module facilitates effective communication and mutual understanding between users with varying hearing abilities, promoting inclusivity and equality in communication.

VII. RESULTS AND DISCUSSION

The proposed sign language translator system represents a significant advancement in bridging the communication gap between the deaf and hearing communities. By leveraging cutting-edge technologies such as machine learning, computer vision, and natural language processing, it offers a comprehensive solution for bidirectional communication in real-time. In terms of audio to sign language conversion, the system's utilization of speech recognition to transcribe spoken language into text is a pivotal step. This text is then transformed into sign language gestures through a deep learning-based model, allowing for accurate and expressive sign language animations. The real-time display of these animations through an avatar or robotic interface ensures seamless communication for deaf individuals. Conversely, the system's ability to translate sign language gestures into audio and text outputs is equally remarkable. By employing computer vision algorithms to detect and recognize sign language gestures from video inputs, followed by machine learning classifiers for interpretation, the system ensures accurate transcription into text. The integration of text-to-speech synthesis for audio output and simultaneous display of text alongside animations further enhances accessibility and comprehension for hearing individuals. Overall, the proposed system holds great promise for enhancing accessibility across various domains such as education, healthcare, and public services. Its potential to foster inclusivity and equality for individuals with hearing impairments underscores its significance in promoting a more inclusive society. However, the system's performance and usability in real-world scenarios would require thorough testing and refinement to address potential challenges and ensure optimal functionality.

REFERENCES

[1] Zhang, Y., Li, C., Song, J. (2019). Sign Language Recognition from Speech using Deep Learning Models. In Proceedings of the International Conference on Electronics, Communication and Control Engineering (ICECC), 63-67.

[2] Rana, A., Gupta, R., Dixit, A. (2020). Real-Time Sign Language Recognition using Deep Learning. In Proceedings of the International Conference on Advances in Computing, Communication, Automation (ICACCA), 133-139.

[3] Saxena, A., Reddy, K. V. (2019). Audio to Sign Language Conversion using Deep Learning and Hand Gesture Recognition. In Proceedings of the International Conference on Computing, Communication, and Intelligent Systems (ICCCIS), 98-103.

[4] Laddha, S., Mathur, S., Bhagat, P. (2020). Audio to Sign Language Translation using Deep Learning Approach. In Proceedings of the International Conference on Inventive Research in Computing Applications (ICIRCA), 829-833.

[5] Joshi, N., Gupta, V. (2019). Real-time Conversion of Speech to Sign Language using Deep Learning. In Proceedings of the International Conference on Intelligent Sustainable Systems (ICISS), 826-831.

[6] Singh, D., Bajaj, K. (2018). Audio to Sign Language Conversion using Deep Learning. In Proceedings of the International Conference on Signal Processing, Communication, Power and Embedded System (SCOPES), 1-5.

[7] Ahmed, R., Kamaruddin, N. (2021). Audio to Sign Language Conversion using Deep Learning and Hand Tracking. In Proceedings of the International Conference on Artificial Intelligence and Data Engineering (ICAIDE), 83-88

[8] Gupta, S., Verma, P. (2021). Real-Time Audio to Sign Language Conversion using Deep Learning. In Proceedings of the International Conference on Intelligent Human Machine Systems and Cybernetics (IHMSC), 68-72.

[9] Sharma, P., Singh, S. (2019). Audio to Sign Language Conversion using Deep Learning and Hand Tracking Techniques. In Proceedings of the International Conference on Intelligent Human Computer Interaction (IHCI), 1-5.

[10] Rathore, P., Singh, A., Saini, M. (2020). Real-Time Conversion of Speech to Sign Language using Deep Learning. In Proceedings of the International Conference on Artificial Intelligence, Big Data and Robotics (ICAIBDR), 201-205.