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BRIDGING COMMUNICATION GAPS: KANNADA TEXT-TO-SIGN LANGUAGE SUBTITLE GENERATION USING AI

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Abstract: Acquiring information from digital media, particularly in indigenous languages similar as Kannada, remains problematic for people with hail difficulties. This design focuses on developing an AI- grounded frame for converting cutline textbooks in Kannada to automatic real- time Indian subscribe Language (- ISL) robustness to ameliorate availability and inclusiveness in audio – visual content. The system armature consists of modules for cutline birth and natural language processing, gesture mapping, and rendering vitality. originally, the input textbook is reused using NLT ways to enhance its clarity and ease of restatement in posterior way. Each anatomized member is counterplotted to a corresponding sign using a sign language database to insure semantic delicacy and contextual felicitousness of each sign. The vitality machine renders the signs to a 3D icon or pre-programmed sequences of the gestures. It generates mottoes alongside the videotape by catching on the timing of each gesture. With this system, content becomes accessible without mortal interveners, which streamlines universal availability across educational and instructional platforms. The vitality machine executes sign language restatement while ducking the reused audio, enabling automatic real- time interpretation of information. Through the focus on indigenous language processing blended with sign language vitality, the system positions AI as a motorist for sociolinguistic addition fostered by digital media.

***IndexTerms*- Subscribe Language Animation, Kannada Subtitles, Natural Language Processing, Availability AI, Inclusive Technology.**

I. INTRODUCTION

This study integrates language modeling along with script recognition which is a introducing trouble towards integrating Kannada into the digital world. These issues are likely to benefit indeed non-native speakers as well as researchers, and policy attorneys who strive for indifferent access to verbal tools. Above all, this work aims to unify the peak of tradition and modern technology along with one linguistically rich yet uninhabited language Kannada. Communication serves as the backbone for humans to live. Millions who are deaf or hard of hearing face innumerable walls when it comes to this essential part of quotidian life. In Karnataka and other corridor of India, Kannada is considerably spoken. still, the lack of assistive technologies, especially those relating to subscribe language paraphrase, alienates a substantial portion of society. The thing of this design is to develop an extensible assistive communication affect that engages the Deaf community more with their education, media, and more on a day- to- day base. In moment's world in which communication is pivotal, the incapacity to speak or be spoken.
to greatly limits exposure to information, education, social relations, and indeed gemütlichkeit. While sign language offers an excellent way of ISL stoners, especially in education, government services, and online media platforms. This study aims to design and develop AI- predicated Kannada text- to- sign language paraphrase system. As an Indian language with extensive use, Kannada poses certain challenges and possibilities for sign language paraphrase. In a world ruled by communication, not being suitable to be heard or understand can mean individualities come promised and cut off from information, knowledge, and others. For the millions of deaf and hard- of- hail people, this is a reality they must deal with every day.This gap creates a peak in communication between Kannada druggies and ISL druggies within education, government services, and online media outlets

II. RELATED WORKS

In [1] It contributes to the understanding of Indian subscribe Language(ISL) in India where a significant portion of the population is deaf or hard of hail. The review focuses on the significance of furnishing backing to the bloodied in developing restructuring systems of communication. The review provides a comprehensive analysis of advanced algorithms of Indian subscribe Language Recognition from deep knowledge fabrics. The primary thing is to bridge the communication divides between sign language complete individualities and learners by relating the most suitable algorithm. The highlight of the document will most presumably be the frame of sign language as an necessary system of communication in view of the deaf and hail crippled persons.
It illustrates the distinct grammatical patterns of ISL alongside its sociolinguistic connection in relation to effectiveness in commerce. Given the high frequency of hail impairment in the country, the review focuses strongly on the need for developing effective ISL

recognition systems. The literature review will also trace the elaboration of sign language recognition styles, pressing the transition from manual ways to current approaches predicated on deep knowledge. It would illuminate the excrescencies of the conventional approaches and how deep knowledge was developed to address those gaps.

In [2] This section has a Literature Review that analyzes the information regarding the Indian subscribe Language ISL recognition problems and its significance. In hail impairment, it becomes a primary means of communication and English sign language needs to be within reach by everyone. The recovery study emphasized the interpretation of sign language. streamlined technological tools are in need interpretation makes the communication easier. They remark just a small bit of individualities who are suitable of interpreting sign languages. This lack of understanding makes communication impossible and hinders the development of advanced results to give help in communication. The authors explain their work by stating that it would be less delicate for the deaf if there was a way to pierce interpretation of their sign language. With that in mind, this disquisition seeks to assess the effectiveness of different deep knowledge models for the paraphrase of Indian subscribe Language to speech for the native population. This, in turn, has taken the responsibility expounding the history of sign language recognition systems, particularly fastening on the primitive rule- predicated systems which bounded due to growth towards farther sophisticated machine knowledge and deep knowledge systems. It will also go into detail regarding the unique challenges of ISL, because of the splintered.

In [3] This work's literature review targets developing an inclusive learning platform for Indian Sign Language (ISL) recognition. The review is based on how there is a requirement to bridge communication gaps with the implementation of advanced machine learning techniques and ensuring inclusivity for the hearing-impaired group.

The review begins by highlighting the importance of Indian Sign Language (ISL) in India's multilingual environment. It refers to how the communication gap between ISL users and those who do not know sign language can hinder everyday interactions and participation. The review also mentions the high percentage of hearing impaired individuals in India and the need for accessible means of communication. The literature review then goes into discussion regarding the existing research on sign language recognition systems. It critically considers various methods and techniques, listing their limitations and advantages. Reviewing presumably are methods under machine learning, computer vision, and other artificial intelligence-based technology.

Most of the review concentrates on the topic of applying machine learning to ISL recognition. It describes multiple machine learning algorithms such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Support Vector SVMs), and how useful they are for recognizing ISL signs. The review can further refer to the utilization of hybrid models and ensemble techniques for better accuracy in recognition.

In [4] This study of the literature shows that sign language is an essential tool for bridging the communication gap between normal and hail impaired people. It shows how delicate it's to define sign language since further than 7000 modern sign languages with variations in stir position, hand shape, and body part position live and so affect automatic sign language 11 recognition(ASLR). The review acknowledges the great success of researchers probing better approaches of designing ASLR systems to search for intelligent results. Starting from the foremost trials and working toward the elaboration of machine knowledge algorithms applied in the field, the review would also give an account of the background of the recognition of sign language. The check of machine knowledge methodology would most presumably include classic approaches analogous sheltered Markov Models(HMMs) and Support Vector Machines(SVMs) to more recent deep knowledge.

In [5] subscribe language recognition and interpretation studies employing machine knowledge, image processing, artificial intelligence, and vitality software are collected in this paper. It addresses the difficulties endured by deaf-mute individualities since ultimate of the population doesn't know sign language and why good sign language interpretation systems must be created. Review of the literature is started with the idea of establishing the background of sign language as the main means of communication for deaf and mute people. It addresses the communication gap performing from non- sign language knowledge among the non- deaf-mute population, which causes sequestration and vexation in quotidian life. The study especially notes the growing interest in sign language interpretation systems and operations brought about by the formerly numerous times' developments.

In [6] This work presents a retroactive review of sign language machine translation (SLMT) algorithms together with their background and classifying Transformer architectures, a common approach applied in language translation. Starting with the growing number of Deaf and Hard of Hearing (DHH) populations and the lack of 18 certified sign language interpreters, the literature review emphasizes the need of automated translating. It clarifies the development from rule-based to neural network-based models of Machine Translation (MT) in Natural Language Processing (NLP). The review notes that although a lot of studies on MT in oral languages exist, SLMT has not drawn as much attention considering the particular difficulty in handling the dynamic and continuous character of sign language.

In [7] The literature on American subscribe Language(ASL) translators is totally reviewed in the current paper. The review acknowledges that although subscribe Language Recognition(SLR) is a extensively delved field, its use is confined 12 because of the process's complexity and resource consumption. The literature review examines the models and methodology of each study and evaluates colorful approaches for the use of automated sign language translators. It aims to talk about how ASL translators can be bettered by using Artificial Intelligence(AI) technology. Research papers published between 2015 and 2020 that give an overview of the advancements in this field in recent times are mentioned in the review. The advantages and disadvantages of different strategies are stressed. The literature review presumably covers every aspect of rephrasing ASL subscribe language recognition styles.

This can. include styles grounded on computer vision, detector- grounded styles(similar as glove- grounded styles), and mongrel styles. point representation and birth The review can address how sign language gestures. are mathematically represented, considering. the hand shape,. movement, and facial expressions.

In [8] An expansive overview of subscribe Language Machine restatement(SLMT) is handed in this check paper. The authors, Gorka Labaka, Olatz Perez-de-Viñaspre, and Adrián Núñez- Marcos, plan to give a well- structured overview of the subject, covering a wide range of SLMT motifs. The significance of SLMT in easing communication between 29non-sign language druggies and subscribe language druggies is established at the onset of the literature review. It describes the challenges of SLMT, similar as the intricacy of sign language, the lack of sizable datasets, and the need for real- time processing. The review looks at the different SLMT ways, which fall into the following general orders restatement from sign language to textbook This is the process of converting detector or videotape data input into textbook in sign language. The review would most probably go over the colorful machine restatement models used, point birth ways, and subscribe language recognition ways.

In [9]The problem of how English speakers can interact with Indian Sign Language (ISL) users is addressed in this research paper. Given that ISL is grammatically structured and governed differently than English, the authors aim to develop a system that will

translate English text into ISL. This paper's literature review would likely begin by emphasizing the importance of communication in daily life as well as the particular communication needs of the "differently abled," which refers to non-speaking, non-hearing individuals who rely on sign language. It would most likely explain why sign languages are full languages with unique grammar and vocabulary. Additionally, the review could note that different countries have different sign languages, even though nearby comparable ones. It would demonstrate the variations in vocabulary size, inflection usage, and sentence structure (English: Subject-Verb-Object; ISL: Subject-Object-Verb). The review would note that compared to English, ISL has a smaller vocabulary and simpler grammatical structures.

In keeping with ISL's use of root words, the review could also discuss the use of stemming and lemmatization, two Natural Language Processing (NLP) techniques that reduce words to their base or root form. Lastly, this document's literature review lays the groundwork for the suggested English to ISL translation system by outlining the distinctions between the two languages and how they can be reconciled.

In [10]The main goal of this work is to develop a system that will assist both deaf and hard-of-hearing people and those who can hear. The fundamental idea is to use Python and an image and video database to translate text to Indian Sign Language (ISL), or sign language. This report's literature review would likely begin by outlining the importance of sign language as a communication tool for deaf-mute people. It might clarify how body gestures, facial expressions, and hand 11 movements are used in sign language to convey meaning. The review might also suggest that sign language is not universal and varies from country to country. The literature review would most likely address the difficulties deaf-mute people have when interacting with hearing people.

III. Challenges

Erecting a Kannada textbook- to- sign language cutline generation system grounded on AI encompasses a set of intricate challenges. One of the major challenges is the absence of standardized and annotated datasets designed specifically for Kannada-to- Indian subscribe Language(ISL) restatement. Although ISL datasets are available, they're substantially limited to Hindi or English, and therefore it's challenging to train models efficiently for Kannada input. also, there's a wide verbal difference between Kannada and ISL since they've different alphabet, judgment structure, and word order. This implies that a word- for- word restatement is n't enough, and the system has to be environment-sensitive in order to save the intended meaning of the textbook. Another significant challenge is real- time processing. Cutline creation needs to do with little detention in order to be effective in live or streamed material, challenging models that optimize between performance and delicacy. In addition, the variety and nuance of sign language movements like facial expressions, hand positions, and station — make it grueling to effectively portray them through AI- controlled incorporations or robustness. This is also complicated by indigenous differences in ISL and the circumstance of several cants in spoken Kannada, both of which need to be taken into account to grease effective communication.

tackle limitations are another type of specialized hedge, especially when putting similar systems into use on mobile platforms or low- resource bias with constrained memory and processing power. likewise, without close collaboration with the Deaf community, stoner- centered design is delicate because many inventors and decision- makers are knowledgeable in sign language. Last but not least, hearing people's low position of general ISL knowledge suggests that in order to promote lesser inclusivity, the affair needs to be both pedagogically sound and technically accurate.The affective and artistic diversity of communication presents a major handicap to the development of a Kannada textbook- to- sign language system. In addition to being a language element, subscribe language is a largely suggestive form of communication that uses body language and facial expressions to convey tone, feelings, and social environment. ToAnother problem results from the imprecision and nuance of natural language, particularly in morphologically complex languages like Kannada.

Kannada boasts multiple situations of formality, emulsion words, and environment-specific meanings that vary depending on judgment structure. During processing of similar language for ISL restatement, it's necessary for the AI model not just to tokenize and classify the input meetly but also comprehend its semantic meaning. This is challenging in the absence of large, annotated corpora or high- performance language models specifically tuned for Kannada.

The lack of such corpora restricts training quality as well as real-time interpretation accuracy. Platform and environment interoperability also pose a challenge. The system must be operable on a variety of operating systems, hardware configurations, and content types—from classroom lectures and government broadcasts to social media content. This entails creating flexible architecture that can work in harmony with mobile apps, web interfaces, and even video conferencing platforms. Providing consistent performance across such diverse platforms, with real-time responsiveness In addition, the absence of standardized ISL across regions helps to cause incoherence in sign usage. Variations of ISL might slightly vary due to regional norms, instructional practice, or local customs. Fragmentation implies that the system must either standardize its output or offer customizable outputs to fit varied user communities. Crafting a model that accommodates such differences without losing uniformity and usability across a wide range of people is a technical as well as a sociolinguistic challenge.

IV. Significance and Implication

The value of this project is that it has the power to render digital communication inclusive in reality by giving deaf or hard-of-hearing people the ability to receive Kannada-language content via Indian Sign Language (ISL) subtitles. In Karnataka, where Kannada is the dominant language of education, government, and public discourse, the lack of ISL integration in digital media forms an invisible barrier that segregates the hearing-impaired population. Through automatic translation of Kannada text to ISL through the use of AI, this system makes an important step toward eliminating the gap, enabling not just accessibility but also linguistic and cultural inclusion.

Technologically, this project demonstrates the pragmatic use of artificial intelligence in addressing tangible real-world communication problems. It advances the frontier of natural language processing (NLP) and computer vision by being applied to an under-resourced linguistic pair—Kannada and ISL—which involves additional complexity based on syntax, regional dialects, and restricted training data. To successfully build this system presents the door to continuing research on low-resource language processing, multimodal translation, and gesture animation and is, therefore, a beneficial addition to AI for social good.

The implications spread to education, governmental services, medicine, and the media, where accessibility in communication can make a big difference in people's lives. Students who depend on ISL will be able to keep up with classroom material presented in Kannada, announcements over public address systems can be heard more easily, and health information can be presented inclusively. Such a system can transform the way society perceives accessibility—not as an afterthought but as an inherent right. It also encourages awareness of the significance of sign language recognition and promotes hearing individuals' empathy through exposure to visual language systems.

At the larger level, the project resonates with global and national objectives for digital accessibility and inclusion. It aligns with the United Nations Sustainable Development Goals (SDG 10: Reduced Inequalities), as well as India's Accessible India Campaign (Sugamya Bharat Abhiyan) aimed at inclusive infrastructure and technology for people with disabilities. By making the solution available for Kannada and ISL, this project serves as a model for other regional language groups in India and elsewhere to emulate.

V. Future Scope

The proposed system will offer a dynamic AI solution by converting Kannada text to Indian Sign Language (ISL) subtitles accurately and with contextual relevance. As part of the overall system, one of the primary features is real-time translation, meaning the proposed system can translate Kannada text live or through pre-recording to generate sign language subtitles in real-time. This feature is particularly useful within educational content, public service announcements, and other digital content for the Deaf and hard-of-hearing community. The proposed system will have a module to handle natural language processing, which handles tokenizing Kannada text input, converting to phrases, and finally a translation engine to map each phrase to ISL equivalent. The translation engine will also need to consider grammatical and contextual structure.

For the sake of successful communication, the avatar will be a 3D animated avatar displaying both static and dynamic ISL gestures as the visual interpreter representing signs to users in a natural and intelligible manner. It will also comprise the processing language for word recognition of commonly used phrases and contextualized vocabulary in specific domains like health, education, and public service..

In the future, the system could manifest in many different ways; for example, in mobile apps, government websites, and classroom technology to advocate for a wider scale inclusive communication experience. Supporting offline use and minimal resource capability will be in scope, supporting usage in the context of impact with zero or very minimal connectivity. More generally, the scope of features is a fully integrated and scalable tool that connects communication gaps or access, and embraces greater understanding and awareness of sign language among the people.

VI. Conclusion

The creation of an AI-based Kannada text-to-sign language subtitle generation system is a significant and long-overdue step towards accessible communication. In creating a solution to the communication issues of the Deaf and hard-of-hearing community, this project not only underscores the value of linguistic accessibility but also demonstrates the revolutionary potential of artificial intelligence in social applications. With the combination of natural language processing, deep learning models, and gesture animation, the system will produce precise, real-time ISL subtitles for Kannada text, thereby making digital content more accessible in education, media, and public services.

Although there are significant challenges, including short datasets, language variations, and real-time performance requirements, the solution presented shows that these issues can be addressed through careful use of AI methodology and user-centered design. This research provides a foundation for future exploration and extension to other regional languages and sign language variants in India.

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