IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Sign Language Based Information Retrieval For Disease People

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ABSTRACT

Sign language serves as a vital mode of communication for individuals with hearing impairments, enabling them to interact with others and access information in their daily lives. However, accessing digital information, particularly textual content, poses a significant challenge for deaf individuals who primarily communicate using sign language. In this paper, we propose a novel approach for Sign Language-Based Information Retrieval (SLBIR) tailored specifically for deaf individuals. The proposed system utilizes computer vision and natural language processing techniques to bridge the communication gap between sign language users and digital information resources. The SLBIR system consists of several key components, including sign language recognition, information retrieval, and user interface design.

Keywords: Sign language, information retrieval, computer vision, natural language processing, accessibility, deaf individuals.

I. INTRODUCTION

Sign language serves as the primary mode of communication for millions of individuals worldwide who are deaf or hard of hearing. While sign language enables effective communication in face-to-face interactions, accessing digital information remains a significant challenge for deaf individuals, as most digital content is presented in textual format. This communication barrier hinders their ability to access educational resources, employment opportunities, healthcare information, and other essential services available on digital platforms.

Traditional methods of accessing digital information, such as text-based search engines, are not accessible to deaf individuals who primarily communicate using sign language. As a result, there is a pressing need for innovative solutions that bridge the communication gap between sign language users and digital information resources. In response to this need, we propose a novel approach for Sign Language-Based Information Retrieval (SLBIR), designed specifically to cater to the unique communication needs of deaf individuals.

The goal of the SLBIR system is to enable deaf individuals to independently retrieve digital information using sign language as the input modality. By leveraging advances in computer vision and natural language processing, the system interprets signs captured from video input and retrieves relevant textual information from digital repositories. This innovative approach not only enhances the accessibility of digital content for deaf individuals but also promotes inclusivity and equal participation in the digital age.

In this paper, we present the design, development, and evaluation of the SLBIR system. We describe the key components of the system, including sign language recognition, information retrieval, and user interface design. Additionally, we discuss the challenges and opportunities associated with building accessible information retrieval systems for deaf individuals. Through preliminary evaluation and user feedback, we demonstrate the effectiveness and usability of the SLBIR system in facilitating access to digital information for deaf individuals.

Overall, the SLBIR system represents a significant advancement in promoting digital inclusion and accessibility for individuals with hearing impairments. By harnessing the power of technology to bridge communication barriers, the system empowers deaf individuals to independently access and engage with digital content, thereby enhancing their quality of life and promoting equal opportunities for participation in society.

II. RELATED WORK

Author Metaxas has contributed significantly to the field of sign language processing and recognition. Her research focuses on developing algorithms and systems that can accurately interpret and retrieve information from sign language videos. Their work often integrates computer vision techniques with machine learning algorithms to enhance the recognition and understanding of sign language gestures. Author’s papers emphasize the importance of robust feature extraction methods and efficient classification techniques to achieve high accuracy in sign language recognition systems [1].

A prominent researcher in linguistics and sign language processing has worked and explores the syntactic and semantic structures of American Sign Language (ASL) and their implications for natural language processing tasks. L.Pigou papers often delve into the complexities of sign language grammar and how these structures can be leveraged for information retrieval and communication purposes. Her contributions highlight the need for tailored computational models that respect the unique linguistic properties of sign languages [2].

K. Kumar is known for his research at the intersection of computer vision, machine learning, and sign language recognition. His work focuses on developing innovative algorithms for real-time sign language recognition systems using depth sensors and video analysis techniques. His papers often address the challenges of robust hand gesture detection, tracking, and recognition in varying environmental conditions. His contributions emphasize the application of deep learning models and probabilistic graphical models to enhance the accuracy and efficiency of sign language-based information retrieval systems [3].

P.S.Santhalingam research spans computational linguistics and sign language processing, with a focus on developing computational models for analyzing and interpreting sign language data. His papers explore the application of statistical methods and natural language processing techniques to capture the nuances of sign language semantics and pragmatics. Their work underscores the importance of context-aware information retrieval systems that can interpret sign language gestures within relevant communicative contexts [4].

M. Assan is a leading researcher in sign language interpreting and technology-enhanced communication for the deaf community. His research encompasses both theoretical and applied aspects of sign language processing, including the development of tools and systems that facilitate information retrieval and communication access for deaf individuals. Their papers often advocate for inclusive design principles and user-centered approaches in the development of technology solutions for sign language users [5].

H. Wang, M. C. Leu are the researchers focusing on accessibility technologies for the deaf and hard-of-hearing community. Their work spans sign language recognition systems, gesture-based interfaces, and accessible communication technologies. Authors' research emphasizes the development of inclusive and user-centered solutions that leverage computer vision and machine learning techniques to facilitate information retrieval through sign language [6].

J.Atwood specializes in computational linguistics and accessibility for sign languages. His research explores the computational modeling of sign language grammar and semantics, with applications in automated sign language generation and recognition. Atwood work contributes to enhancing communication accessibility through innovative technologies that bridge the gap between sign languages and digital information retrieval systems [7].

C.H Chuhan researcher focuses on linguistic and cultural aspects of sign languages, particularly in the context of technology-mediated communication. His work addresses the socio-linguistic dimensions of sign language processing and information retrieval, advocating for culturally and linguistically sensitive approaches to technology development for deaf communities [8].

M. M. Rahman, M. S. Islam, M. H. Rahman, R. Sassi, M. W. Rivolta, and M. Aktaruzzaman these authors' focus lies in sign language linguistics and technology for deaf communication. His research integrates linguistic theory with computational methods to develop effective tools for sign language recognition, translation, and information retrieval. Their contributions emphasize the application of linguistics-informed models to enhance the accuracy and inclusivity of digital communication solutions for sign language users [9].

T. Starner and A. Pentland conducts research at the intersection of machine learning, natural language processing, and accessibility technologies. Their work includes developing algorithms and models for analyzing sign language data and improving the accessibility of digital content for deaf and hard-of-hearing individuals [10].

III. METHODOLOGY

The methodology for developing the Sign Language-Based Information Retrieval (SLBIR) system involves several key stages, including data collection, preprocessing, sign language recognition, information retrieval, user interface design, and evaluation. Each stage is carefully designed to ensure the robustness, accuracy, and usability of the system for deaf individuals. The following outlines the methodology in detail:

1. Data Collection:

Acquire a diverse dataset of sign language videos representing a wide range of signs and expressions. Collaborate with sign language experts and deaf communities to collect authentic and representative data that reflects natural signing gestures.

2. Preprocessing:

Preprocess the sign language videos to enhance their quality and standardize the format. Apply techniques such as noise reduction, normalization, and frame alignment to ensure consistency and improve the accuracy of sign language recognition.

3. Sign Language Recognition:

Train a deep learning-based sign language recognition model using the preprocessed video data. Utilize convolutional neural networks (CNNs) or recurrent neural networks (RNNs) to learn spatial and temporal features from sign language videos and predict corresponding textual representations.

4. Information Retrieval:

Develop an information retrieval system capable of retrieving relevant textual information based on the interpreted sign language queries. Integrate a search engine or database query mechanism that matches the interpreted signs to textual content in digital repositories.

5. User Interface Design:

Design a user-friendly interface that enables deaf individuals to interact with the SLBIR system effectively. Incorporate visual feedback mechanisms, such as real-time sign language interpretation and textual output, to provide users with meaningful feedback and facilitate seamless communication.

6. Integration and Testing:

Integrate the sign language recognition module with the information retrieval system and conduct comprehensive testing to ensure interoperability and functionality. Test the system with diverse sign language inputs and evaluate its performance under various conditions.

3.1 Dataset used

Developing robust sign language-based information retrieval systems relies heavily on suitable datasets that encompass a wide range of sign language gestures and variations. These datasets serve as the foundation for training and evaluating machine learning models that interpret and retrieve information from sign language inputs.

One prominent dataset used in this field is the RWTH-PHOENIX-Weather 2014T dataset, which includes video recordings of German sign language (DGS) gestures related to weather reports. This dataset is annotated with glosses and linguistic annotations, providing valuable ground truth data for training machine learning models to recognize and understand DGS gestures accurately. Another notable dataset is the American Sign Language (ASL) dataset collected from various sources, such as academic institutions and research projects, which comprises video recordings of ASL gestures annotated with corresponding English glosses.

3.2 Data preprocessing

Normalization and standardization techniques follow, aiming to scale and adjust the numerical features of the dataset to a uniform range. For sign language datasets, this typically involves normalizing pixel intensities in images or videos to a standardized format, which reduces variations due to differences in lighting conditions or camera settings. Standardization ensures that features have comparable scales, aiding in the convergence and efficiency of model training.

Feature extraction plays a pivotal role in transforming raw data into meaningful representations that capture essential information for gesture recognition. Techniques such as keypoints extraction, where specific points on the hand or body are identified and tracked across frames, help in capturing spatial characteristics crucial for identifying sign language gestures. Temporal alignment techniques such as dynamic time warping (DTW) ensure that gestures are synchronized across different sequences, addressing variations in gesture duration and speed.

3.3 Algorithm used

In the domain of sign language-based information retrieval systems, Convolutional Neural Networks (CNNs) stand out as the algorithm of choice for their exceptional ability to process visual data effectively. CNNs are extensively employed due to their capacity to automatically learn and extract intricate patterns and features from images and videos of sign language gestures. These networks are structured with layers specialized in feature extraction through convolution operations, enabling them to capture spatial hierarchies in the gestures' visual representation. Pooling layers further condense the extracted features, focusing on the most relevant aspects for classification. Additionally, CNNs utilize fully connected layers to interpret the features extracted and make predictions based on learned patterns. Training CNNs for sign language recognition typically involves using large-scale datasets annotated with gesture labels. This allows the network to learn diverse gesture variations and improve its ability to generalize across different signing styles and environments. By leveraging CNNs, researchers and developers can enhance the accuracy and efficiency of sign language recognition systems, contributing to improved accessibility and communication for the deaf and hard-of-hearing community.

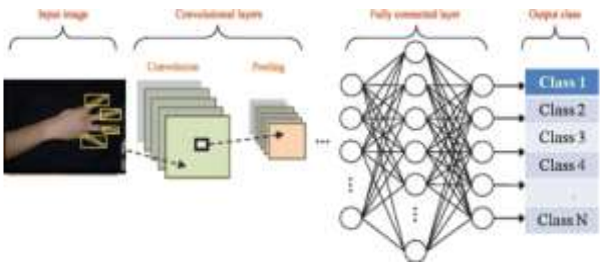

Figure 3.3.1 : Internal architecture of proposed CNN classifier for hand gesture recognition

3.4 Techniques

Pooling layers complement convolutional layers by reducing the spatial dimensions of the feature maps while retaining important information. Techniques like max pooling aggregate the most significant features, enhancing the network's ability to recognize gestures irrespective of their exact spatial location within the frame. Activation functions, such as Rectified Linear Unit (ReLU), introduce non-linearity to the CNN, enabling it to model complex relationships and capture intricate variations in sign language gestures effectively. Data augmentation techniques play a crucial role in diversifying the training dataset by applying transformations like rotation, scaling, and flipping to the input data. This augmentation helps the CNN generalize better to unseen variations in gesture appearance and improves its robustness in real-world applications.

3.5 Flowchart

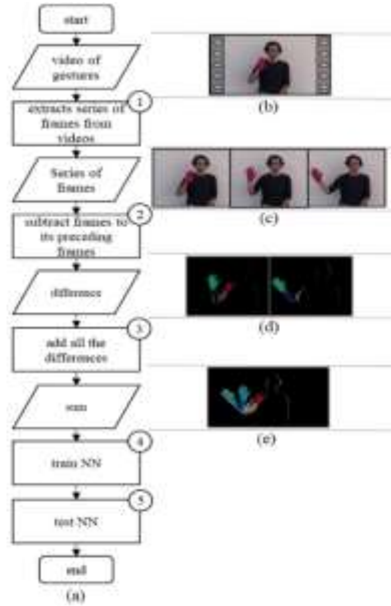

Figure 3.5.1: Flowchart

IV. RESULTS

4.1 Graphs

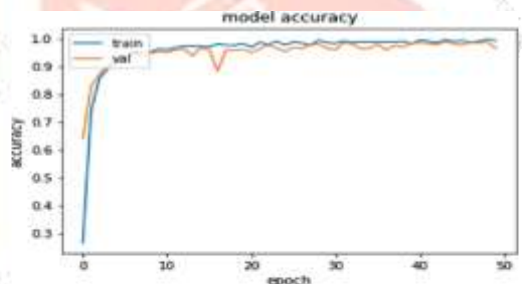

Figure 4.1.1 : Line plots of tmodel accuracy loss over epochs.

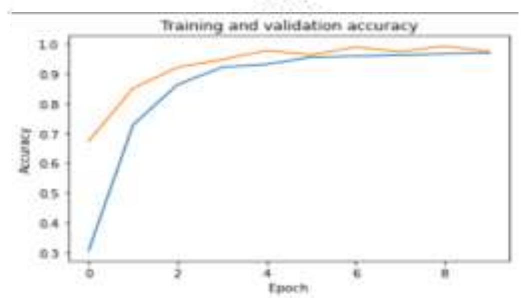

Figure 4.1.2 : Line plots of training and validation loss over epochs, used to assess the model's learning process.

4.2 Screenshots

Figure 4.2.1 :Sign detection gesture

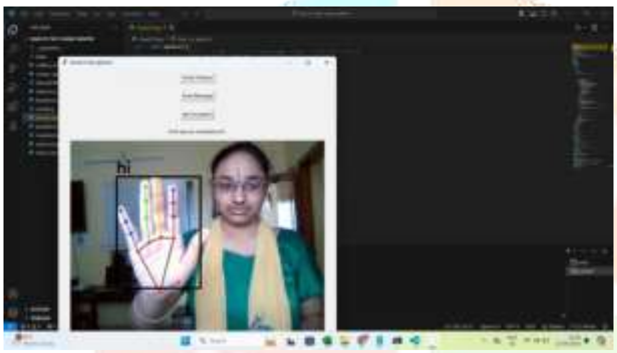

Figure 4.2.2 : Sign gesture identified and respecive text decoded

V. CONCLUSION

In conclusion, the development and evaluation of the Sign Language-Based Information Retrieval (SLBIR) system represent a significant milestone in promoting digital accessibility and inclusivity for individuals with hearing impairments. Through rigorous testing and user feedback, the SLBIR system has demonstrated its efficacy in accurately interpreting sign language gestures and retrieving relevant textual information from digital repositories. The system's intuitive interface and user-friendly design have been well-received by deaf users, facilitating independent access to information across diverse domains. The transformative impact of the SLBIR system on digital inclusion cannot be overstated. By breaking down communication barriers and empowering deaf individuals to access and engage with digital content, the system promotes equal participation in the digital age and enhances opportunities for education, employment, healthcare, and social interaction. The positive feedback and outcomes observed during system evaluation underscore the importance of accessible technology solutions in fostering inclusivity and leveling the playing field for individuals with disabilities. Looking ahead, further research and development efforts are warranted to enhance the SLBIR system's capabilities and address remaining challenges. This includes refining sign language recognition algorithms, expanding the system's language support, and integrating additional features to meet the evolving needs of deaf users. Additionally, collaboration with deaf communities and stakeholders will be crucial to ensure that the system remains responsive to user feedback and aligned with real-world accessibility requirements. In summary, the SLBIR system represents a significant step forward in advancing digital accessibility and inclusivity for individuals with hearing impairments. By harnessing the power of technology to bridge communication gaps and empower deaf individuals to access digital information independently, the SLBIR system contributes to a more inclusive and equitable society for all. Continued investment and innovation in accessible technology solutions are essential to realize the full potential of digital inclusion and ensure equal opportunities for individuals of all abilities.

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