**Hand Gesture Recognition for Indian Sign Language using Deep Learning**

**PROJECT SYNOPSIS**

OF MAJOR PROJECT

**BACHELOR OF TECHNOLOGY**

Computer Science & Engineering

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**Introduction**

Communication is a fundamental aspect of human interaction, and it takes various forms, including spoken language and non-verbal gestures. For individuals with hearing impairments, sign language serves as a crucial means of expression and communication. In India, like many other countries, Indian Sign Language (ISL) is a vital mode of communication for the deaf and hard-of-hearing community. However, there exists a significant communication gap between the deaf community and those who do not understand ISL. Bridging this gap is essential to ensure inclusivity and equal participation in society for individuals with hearing impairments.

The key objectives of this project are as follows:

**1. Gesture Recognition:** Developing a comprehensive database of ISL gestures, encompassing a wide range of signs and expressions commonly used in Indian Sign Language.

**2. Data Collection and Annotation:** Collecting high-quality data of ISL gestures, which includes images or video recordings of hand signs and their corresponding meanings. This data will be meticulously annotated to create a valuable training dataset.

**3. Deep Learning Model Development:** Designing and implementing deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), to recognize and interpret ISL gestures from input images or videos.

**4. Real-time Recognition:** Developing a real-time recognition system that can interpret ISL gestures in real-world scenarios, allowing deaf individuals to communicate more effectively with others.

**5. User Interface:** Creating a user-friendly interface, such as a mobile or web application, that enables both deaf and non-deaf individuals to use the system for communication.

**6. Testing and Validation:** Rigorous testing and validation of the model's accuracy and reliability, with the involvement of the ISL community to ensure that it meets their needs and expectations.

**7. Accessibility:** Ensuring that the system is accessible and adaptable to different environments, lighting conditions, and variations in hand gestures.

**8. Education and Awareness:** Promoting awareness and educating the general public about ISL and the importance of effective communication for individuals with hearing impairments.

Ultimately, the "Hand Gesture Recognition for Indian Sign Language using Deep Learning" project aims to break down communication barriers and empower individuals with hearing impairments to participate more fully in society. By leveraging the capabilities of deep learning and technology, this project seeks to promote inclusivity, understanding, and equality for all, regardless of their ability to hear.

**Rationale**

The project "Hand Gesture Recognition for Indian Sign Language using Deep Learning" is imperative due to the pressing need to overcome significant challenges faced by the deaf and hard-of-hearing community in India. The foremost necessity is to address the formidable communication barrier that exists between deaf individuals, who rely on Indian Sign Language (ISL), and the broader society, where ISL understanding is limited. This barrier leads to social isolation, restricts access to education and employment, and hinders participation in various social activities. By bridging this communication gap, the project promotes inclusivity, fosters equality, and offers a technological solution to empower the deaf community.

Furthermore, the project's significance lies in its potential to leverage technological advancements in deep learning and computer vision. These cutting-edge technologies enable the development of accurate and reliable ISL recognition systems, which can substantially improve the quality of life for deaf individuals. Enhanced access to education, increased employment opportunities, and preservation of the cultural richness embedded in ISL are among the key benefits. Ultimately, this project exemplifies the use of technology for social good, demonstrating how AI can be harnessed to address real-world challenges and create a more inclusive and equitable society where all individuals, regardless of their abilities, can participate fully.

**Objectives**

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**Literature Review**

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| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Journals** | **Year** | **Authors** | **Techniques** | **Findings** | **Shortcomings** |
| **1.** | Continuous Sign Language Recognition and Its Translation into Intonation-Colored Speech | 2023 | Nurzada Amangeldy, Aru Ukenova, Gulmira Bekmanov, Bibigul Razakhova, Marek Milosz and Saule Kudubayeva | sign language recognition, natural language processing, intonational speech synthesis, long short-term memory, spatiotemporal features | **Integrated Approach for Sign Language Recognition:** The research presents an integrated approach that combines morphological, syntactic, and semantic analysis, as well as intonation modeling for translating continuous sign language into natural language. This integrated approach has practical and social significance.  **Scientific Novelty in Sign Language Recognition:** The study introduces a novel method of continuous sign language recognition by combining multiple modalities, resulting in a high recognition accuracy of 0.95, particularly for the Kazakh language.  **Integration with NLP Processor:** The work successfully integrates a sign language recognizer with an NLP processor to translate recognized sign language sentences into coherent natural language sentences.  **Intonation Study**: The research provides a unique study of the intonation of the Kazakh language based on changes in the frequency of the main tone and sentence members, which can contribute to the synthesis of intonation-colored speech. | **Quality of Gesture Recording:** The study acknowledges limitations related to the quality of gesture recording, where low camera resolution, incorrect camera positioning, low lighting, interference, or noise can negatively impact gesture recognition accuracy.  **Minimum Frame Requirement:** The model's limitation, requiring a sample to contain at least 60 frames, might be restrictive for certain applications or scenarios with shorter gestures.  **Specificity to Kazakh Language:** While the research is valuable for the Kazakh language, it may not be immediately applicable to other sign languages without further adaptation.  **Commercialization Potential:** While the study mentions the potential for commercialization, it does not provide a detailed plan or discussion of how this will be achieved. |
| **2.** | Vision-based Hand Gesture Recognition for Indian Sign Language Using Convolution Neural Network | 2023 | Boinpally Ashwanth, Sri Bhargav Ventrapragada, Shradha Reddy Prodduturi , Jeshwanth Reddy Depa, K. Venkatesh Sharma | Indian sign language Recognition, Convolution Neural Network, Image Processing, Edge Detection, Hand Gesture Recognition | **Effectiveness of CNNs for Hand Gesture Recognition:** The study demonstrates that Convolutional Neural Networks (CNNs) are highly effective in recognizing and classifying hand gestures in Indian Sign Language, indicating the potential of deep learning for this task.  **Method Choice Depends on Requirements:** The research highlights that the choice of the recognition method for vision-based hand gesture recognition should be based on specific problem requirements and data characteristics. While CNNs generally perform well, other methods like Support Vector Machines (SVM) may be suitable for specific scenarios.  **Importance of Large and Diverse Datasets:** The study underscores the significance of using large and diverse datasets for training and evaluating hand gesture recognition systems. The performance of CNNs is closely related to the quality and size of training data. | **Recognition Accuracy Improvement:** The study suggests that there is room for improvement in recognition accuracy, particularly for complex and nuanced hand gestures. Future research can focus on developing advanced CNN architectures and incorporating additional modalities to enhance accuracy.  **Real-time Implementation Challenge:** Real-time implementation of hand gesture recognition remains a challenge, especially for resource-constrained devices. The study points to the need for future research to develop efficient and scalable implementations for real-time applications.  **Specific to Indian Sign Language:** The findings of the study are specific to Indian Sign Language, which limits their direct applicability to other sign languages. However, the methods and techniques developed can potentially be extended to improve accessibility for other sign languages. |
| **3.** | Survey on sign language recognition in context of vision-based and deep learning | 2022 | S. Subburaj, S. Murugavalli | SLR Sign language Recognition Computer vision Neural networks Deep learning HMM CNN | **SLR Evolution:** SLR has evolved from static signs to effectively capturing dynamic actions in continuous image sequences.  **Vision-Based Superiority:** Vision-based approaches generally outperform appearance-based ones, driven by deep learning techniques.  **Vocabulary Expansion:** Researchers prioritize creating larger sign language vocabularies, indicating the desire for more comprehensive SLR systems.  **Dataset Access and Speed:** Improved dataset availability and computing speed enhance training opportunities for SLR models.  **Small Dataset Challenge:** Some researchers rely on small, self-made datasets due to the lack of large datasets, especially for specific languages and regions.  **Language Variation:** Sign language variations exist based on grammar and presentation style, affecting SLR systems.  **Diverse Classification Techniques:** Researchers use varied classification methods, making method comparisons subjective.  **Deep Learning Effectiveness:** Deep learning methods, including CNN, RNN, LSTM, and Bi-Directional LSTM, perform well in processing image and video sequences. | **Subjective Comparisons:** Method comparisons lack standard evaluation criteria, introducing subjectivity.  **Small Datasets:** Self-made small datasets pose limitations, potentially affecting generalization.  **Language Variations:** Addressing sign language variations is not explored in detail.  **Lack of Methodology Details:** The paper lacks specifics about the methodologies used in the analyzed publications.  **Publication Timeframe:** Limited to publications from 2010 to 2021, possibly missing recent SLR developments. |
| **4.** | Sign language recognition system for communicating to people with disabilities | 2022 | Yulius Obia, Kent Samuel Claudioa, Vetri Marvel Budimana, Said Achmada, Aditya Kurniawana | Computer Vision, Convolutional Neural Networks, American Sign Language (ASL), Sign Language Recognition | **Dataset Use:** The study utilized a Kaggle dataset to develop a hand gesture recognition application.  **CNN Model:** A two-layer Convolutional Neural Network (CNN) model was created and trained for real-time hand gesture recognition.  **GUI Development:** A user-friendly graphical interface was developed for the application.  **High Accuracy:** The application achieved an impressive accuracy rate of 96.3% for recognizing and combining hand gestures into words. | **Gestures Require Stability:** To form letters into words, gestures need to remain stable for a few seconds, leading to potential delays.  **Background Sensitivity:** The model may be sensitive to background, suggesting a need for background removal methods for robust performance.  **Speed Optimization:** There is a need to speed up the process of forming letters into words to reduce wait times, indicating potential inefficiencies.  **Model Accuracy:** Enhancing accuracy is recommended through the addition of more CNN layers, suggesting the current model may not be fully optimized.  **Exploration of Alternatives:** Considering alternative methods beyond CNN is suggested, implying that alternative techniques might yield better results. |
| **5.** | Hand Gesture Recognition for Sign Language Using 3DCNN | 2020 | MUNEER AL-HAMMADI(Member, IEEE), GHULAM MUHAMMAD(Senior Member, IEEE), WADOOD ABDUL(Member, IEEE), MANSOUR ALSULAIMAN, MOHAMED A. BENCHERIF, AND MOHAMED AMINE MEKHTICHE | 3DCNN, computer vision, deep learning | **3DCNN for Hand Gesture Recognition:** The study explores the use of 3D Convolutional Neural Networks (3DCNN) for recognizing hand gestures.  **Preprocessing:** Preprocessing techniques involve temporal normalization using linear sampling and spatial normalization using face and body ratios.  **Two Feature Learning Approaches:** Two approaches are used for feature learning. The first employs a single 3DCNN instance to extract features from the entire video. The second uses three 3DCNN instances to capture features from different video regions, followed by fusion.  **Feature Fusion:** Multi-Layer Perceptrons (MLP), Long Short-Term Memory (LSTM), and an autoencoder are employed for feature fusion.  **Classification with SoftMax:** SoftMax activation layers are used for classification in both approaches | **Hyperparameter Optimization:** The study aims to improve performance through future hyperparameter optimization, indicating potential suboptimal current performance.  **Online Testing:** Testing the approach with live video feeds is mentioned but lacks results or details, limiting the assessment of real-time applicability.  **Edge-Cloud Computing:** Future use of edge-cloud computing is suggested but not explored, leaving its benefits and feasibility uncertain.  **Lack of Computational Resource Details:** The study does not specify the computational resources required for training and testing 3DCNN models, crucial for assessing practicality in real-world applications. |

**Feasibility Study**

**1. Technical Feasibility:**

- Data Availability: Assess the availability of a diverse and representative dataset of Indian Sign Language (ISL) gestures. The feasibility of collecting and curating such data should be considered.

- Technology Stack: Evaluate the technical capabilities of deep learning models for gesture recognition and whether they can be effectively applied to ISL.

- Hardware and Software: Determine the computational resources and software tools required for model training and real-time recognition.

**2. Operational Feasibility:**

- Skills and Expertise: Assess whether the project team possesses the necessary skills and expertise in deep learning, computer vision, and ISL.

- Scalability: Consider whether the project can scale up to accommodate a larger user base and more ISL gestures in the future.

**Need of the Project: Hand Gesture Recognition for Indian Sign Language using Deep Learning**

**1. Communication Barrier:** Deaf individuals face a communication gap with the hearing population due to limited understanding of Indian Sign Language (ISL).

**2. Equality:** Providing equal opportunities and access to essential services for deaf individuals is a fundamental goal.

**3. Educational Access:** Improving communication in educational settings enhances learning outcomes for deaf students.

**4. Employment Opportunities:** Effective communication is crucial for gaining employment and career advancement.

**Significance of the Project: Hand Gesture Recognition for Indian Sign Language using Deep Learning**

**1. Improved Quality of Life:** The project empowers deaf individuals to access information and participate more fully in society.

**2. Inclusivity and Equal Opportunities**: It fosters an inclusive society where individuals, regardless of abilities, can engage equally in various activities.

**3. Cultural Preservation:** Recognition of ISL helps preserve the cultural heritage of the deaf community.

**4. Technological Advancement:** Demonstrates the positive impact of AI and computer vision in addressing social challenges.

**5. Awareness and Sensitization:** Raises awareness about deaf community challenges and promotes inclusivity and accessibility.

**Facilities required for proposed work**

The successful development of the "Prediction of Cardiac Disease using Heart Shape" project requires a combination of software tools and hardware resources to ensure accurate data analysis, model development, and testing.

**1. Deep Learning Frameworks:**

- TensorFlow: A popular open-source deep learning framework developed by Google.

**2. Computer Vision Libraries:**

-OpenCV: An open-source computer vision library for image and video processing.

**3. Python:**

- Python is the primary programming language for developing deep learning models and conducting data analysis. Ensure you have Python installed along with necessary packages.

**4. IDEs (Integrated Development Environments):**

- Jupyter Notebook: A popular interactive development environment for data analysis and model prototyping.

- Visual Studio Code: A versatile code editor with extensions for deep learning and Python development.

**5. Data Annotation Tools:**

- Annotation software (e.g., LabelImg, RectLabel) for labeling and annotating ISL gesture data.

**6. Version Control:**

- Git: A distributed version control system for tracking code changes and collaboration among team members.

**7. Database Management:**

- Database systems (e.g., MySQL, PostgreSQL) for managing project-related data, if applicable.

**8. Web Development Tools (for User Interface Development):**

- HTML, CSS, JavaScript: Core web technologies for designing and developing user interfaces.

- Front-end Frameworks: Libraries like React, Angular, or Vue.js for building interactive web applications.

- Back-end Frameworks: Technologies such as Django, Flask, or Node.js for server-side development, if required.

- Database Management Systems: If the project includes a database, you might need tools like MongoDB, SQLite, or MySQL.

**9. Testing and Validation Tools:**

- Tools for evaluating model accuracy and performance, including metrics calculation.

**10. Virtual Environment Management:**

- Virtual environment management tools like Anaconda or virtualenv to create isolated Python environments for project dependencies.

**11. Data Analysis and Visualization:**

- Data analysis and visualization libraries like Pandas, Matplotlib, and Seaborn for exploring and presenting data.

**12. Security and Privacy Tools:**

- Security and privacy tools and practices to ensure the protection of sensitive data, especially when dealing with user data

**13. User Interface Design Tools:**

- Graphic design software (e.g., Adobe XD, Sketch) for designing user interfaces.

**14. Cloud Services :**

- Cloud platforms (e.g., AWS, Azure, Google Cloud) for hosting web applications or deploying machine learning models.

**15. Operating System:**

- A compatible operating system (e.g., Windows, Linux, macOS) based on the project's development and deployment environment.

**Expected Outcome**

This project aims to resolve the significant communication challenges faced by deaf individuals who rely on Indian Sign Language (ISL) to interact with the world around them.

**Gesture Recognition Accuracy:**

High accuracy in recognizing ISL gestures is crucial to ensure effective communication between deaf or hard-of-hearing individuals and others. The system should aim for near-perfect accuracy to minimize misunderstandings.

**Real-time Recognition:**

The system should provide real-time recognition of ISL gestures to facilitate natural communication.

**Multimodal Input:**

Recognizing not only hand gestures but also facial expressions and other non-manual components of ISL can enhance the system's comprehensiveness and effectiveness.

**Extensive Gesture Vocabulary:**

The system should support a wide range of ISL gestures to cover the diversity of signs used in different regions and for various purposes.

**Adaptability:**

The system should adapt to variations in lighting conditions, hand shapes, and sizes to work in a variety of real-world settings.

**User-Friendly Interface:**

Develop a user-friendly interface that is intuitive for both deaf individuals who use ISL and those who may not be familiar with it.

**Noise Tolerance:**

The system should be robust against background noise and irrelevant hand movements to avoid false positives in recognition.

**Accessibility:**

Ensure that the system is accessible and usable for individuals with varying levels of sign language proficiency.

**Training Data and Machine Learning:**

Collect and maintain a diverse dataset of ISL gestures to train machine learning models effectively. Regular updates and expansion of the dataset are essential to improve recognition accuracy.

**Integration:**

Make it possible to integrate the ISL gesture recognition system with other communication tools, such as video conferencing software or text-to-speech applications, to enhance accessibility.

**REFRENCES**

[1] Amangeldy, N., Ukenova, A., Bekmanova, G., Razakhova, B., Milosz, M., & Kudubayeva, S. (2023). Continuous Sign Language Recognition and Its Translation into Intonation-Colored Speech. *Sensors*, *23*(14), 6383. Aurelijus Vaitkevicius, Mantas Taroza, Tomas Blažauskas, Robertas Damaševiˇcius, Rytis Maskeliunas and Marcin Wo´zniak

[2] Gangrade, J., & Bharti, J. (2023). Vision-based hand gesture recognition for Indian sign language using convolution neural network. *IETE Journal of Research*, *69*(2), 723-732.

[3] Subburaj, S., & Murugavalli, S. (2022). Survey on sign language recognition in context of vision-based and deep learning. *Measurement: Sensors*, *23*, 100385.

[4] Obi, Y., Claudio, K. S., Budiman, V. M., Achmad, S., & Kurniawan, A. (2023). Sign language recognition system for communicating to people with disabilities. *Procedia Computer Science*, *216*, 13-20.

[5] Al-Hammadi, M., Muhammad, G., Abdul, W., Alsulaiman, M., Bencherif, M. A., & Mekhtiche, M. A. (2020). Hand gesture recognition for sign language using 3DCNN. *IEEE access*, *8*, 79491-79509.