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Research Title

Speech Recognition System Using Deep Learning Techniques for Arabic
Sign Language

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1. Chapter one: introduction

1.1 Overview:

Even though communication is a basic human need, millions of deaf and hard-of-hearing people around the world continue to encounter obstacles in their everyday lives because of accessibility issues. Although machine translation between sign language and spoken language is still a major technical issue, sign language is an essential form of communication among deaf communities. In the Arab world, Arabic Sign Language remains underrepresented in research and development, creating a pressing need for intelligent systems specifically designed for these linguistic contexts.

Natural language processing, speech recognition, and computer vision have all been transformed by recent developments in deep learning. Long-term memory networks, transformer-based designs, convolutional neural networks, and recurrent neural networks have all shown exceptional performance in identifying intricate visual and sequential patterns. In sign language recognition, where precise capture and interpretation of hand movements, face expressions, and movement dynamics are required, these models are especially well-suited.

By converting spoken signs into spoken language, a deep learning-based speech recognition system for Arabic Sign Language seeks to close the communication gap. Typically, this system combines speech synthesis, sequence modeling, gesture detection, feature extraction, and video capture. Deep learning allows the system to automatically extract temporal and geographical information from gesture data with little need for human guidelines.

This system's development represents both a technological and a social contribution. It helps preserve and digitize regional sign languages, encourages diversity, and supports assistive communication devices. Additionally, creating a dataset and model for Arabic Sign Language

recognition establishes the groundwork for upcoming studies in resource-constrained language technology (Kagalkar, 2025).

To achieve high accuracy, instant performance, and usability in real-world communication scenarios, this work focuses on the design and implementation of an intelligent voice recognition system based on deep learning that is specifically tailored for Arabic Sign Language.

1.2 Problem Definition

Most current systems concentrate on widely used languages like American or British Sign Language, despite notable breakthroughs in sign language recognition technologies. There is currently little technological assistance for Arabic Sign Language, and it is still mainly underdeveloped.

Deaf people in the Arab region face communication challenges due to the lack of automated Arabic Sign Language recognition systems, which restrict their access to public services, work, and education. Thus, an intelligent, effective, and real-time system that uses deep learning techniques to convert Arabic sign movements into speech is required.

1.3 Thesis Objectives

- Main Objective

To design and develop a deep learning-based speech recognition system for Arabic Sign Language.

- Specific Objectives

1. To collect and preprocess a dataset of Arabic sign gestures.
2. To develop a deep learning model for sign gesture recognition.
3. To implement sequence modeling for dynamic sign interpretation.
4. To integrate a speech synthesis module for real-time audio output.
5. To evaluate system performance using standard metrics (accuracy, precision, recall, F1-score).

1.4 Thesis Questions

- How can Arabic Sign Language identification accuracy be increased using deep learning techniques?
- Which neural network design works best for recognizing dynamic gestures?
- Is it possible for the system to translate in real time?
- What difficulties arise when using local sign language with limited resources?

1.5 Thesis Contribution

Significant technological, scholarly, and social contributions to assistive technology and sign language recognition are made by this thesis, especially for regional languages like Arabic Sign Language that have few resources:

- **Creation of a New Dataset for Arabic Sign Language:** The development of an organized and indexed dataset for Arabic Sign Language is a significant contribution to this study. Because there aren't many publicly accessible datasets for Arabic Sign Language, this work helps create a foundational resource that will aid in further study and advancement in the area.
- **Developing a Framework for Deep Learning-Based Recognition:** In this thesis, a deep learning architecture that combines long-term memory networks (LSTMs) for chronological modeling and convolutional neural networks (CNNs) for spatial feature extraction is proposed and implemented. The accuracy of dynamic gesture detection is increased by this hybrid approach, which makes it possible to capture hand shape and movement dynamics efficiently.
- **Real-Time Sign-to-Speech Conversion System:** In contrast to numerous theoretical models, this research creates a working prototype that can instantly translate recognized Arabic Sign Language signs into spoken Arabic. Combining speech synthesis with sign recognition offers a complete assistive communication solution.
- **Technology Support for Languages with Limited Resources:** Most sign language recognition systems in use today concentrate on languages that are widely spoken. By

extending the use of deep learning to resource-constrained regional sign language, this thesis advances inclusive artificial intelligence and lessens technological inequality.

- **Comparative analysis and performance evaluation:** Using common indicators including accuracy, precision, recall, and the F1 score, the study offers a thorough performance evaluation. To identify the most effective architecture for Arabic Sign Language identification, it also contrasts several model configurations.
- **Accessibility and Social Impact:** Apart from its technical achievements, this initiative fosters social inclusion by offering a tool that helps the hearing and deaf populations in the Arab region communicate with one another. The system promotes accessibility in public services, employment, and education.

1.6 Thesis Organization

The study challenge, research methodology, application, and findings of the suggested deep learning-based speech recognition system for Arabic Sign Language are presented in many chapters of this thesis.

- Chapter 1: Introduction

The study's background is given in this chapter, along with the difficulties the deaf community faces in communicating and the significance of creating an automated system for Arabic Sign Language recognition. The study's organization, scope, constraints, problem statement, research aims, and research questions are also described.

- Chapter 2: Literature Review

This chapter reviews current research in sign language recognition, speech recognition systems, and deep learning techniques such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), long-term memory networks (LSTMs), and transformer-based models. It highlights research gaps, talks about recent advancements, and argues for the necessity of an Arabic Sign Language-specific system.

- **Chapter 3: Methodology**

The general system design and research technique are covered in this chapter. The methods for gathering data, preparing the dataset, preprocessing, feature extraction, model design, training, and text-to-speech module integration are all covered in this chapter. The workflow and system architecture are also presented.

- **Chapter 4: Execution and Experimental Outcomes**

This chapter describes how the suggested system is implemented using TensorFlow/ByTorch, and Python. It presents training settings, hyperparameter settings, and evaluation metrics. To evaluate system performance, experimental findings are assessed using the accuracy measure, the fine-tuning metric, the recall metric, the F1 metric, and confusion matrices.

- **Chapter 5: Analysis and Discussion**

The experimental data are interpreted, model performance is compared, and the system's advantages and disadvantages are discussed in this chapter. It also discusses the difficulties encountered during development and assesses the efficacy of the suggested technique in practical implementations.

- **Chapter 6: Final Thoughts and Upcoming Projects**

This chapter provides an overview of the research results, highlights the main contributions of this thesis, and makes recommendations for future developments, including database enlargement, mobile deployment, and continuous sentence recognition.