# ASL Recognition System:
# Bridging Gaps in Communication Accessibility

A Thesis Submitted in partial fulfillment of the Requirements of the
Renée Crown University Honors Program at Syracuse University

**Carlo F. Pisacane**

Candidate for Bachelor's of Science in Computer Science
and Renée Crown University Honors
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## Honors Thesis in Computer Science

Thesis Advisor: _____
Dr. Nadeem Ghani, Assistant Teaching Professor

Thesis Reader: _____
Dr. João Paulo Marum, Assistant Teaching Professor

Honors Director:_____
Dr. Danielle Smith, Director

# Abstract

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**Thesis Advisor:** Nadeem Ghani
**Title:** Assistant Teaching Professor, Engineering and Computer Science

# Acknowledgments

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# Preface

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# Contents

**Chapter 1** **2**

1.1 Research Problem . . . . . 2

1.2 Research Objectives . . . . . 3

1.3 Significance of the Study . . . . . 3

1.4 Thesis Structure . . . . . 4

**Chapter 2** **5**

2.1 . . . . . 5

**Chapter 3** **6**

3.1 . . . . . 6

**Chapter 4** **7**

4.1 . . . . . 7

**Chapter 5** **8**

5.1 . . . . . 8

# Chapter 1

## Introduction

Communication is a fundamental human need, and for Deaf and hard-of-hearing individuals, American Sign Language (ASL) serves as a primary mode of expression. ASL is a rich and complex visual language based on hand shape, movement, and nonmanual markers such as facial expressions. Technology has evolved from the past to make communication more accessible, including captioning services, text-based messaging, and video relay services. However, these solutions often rely on real-time interpreters or a shared written language, which can be limiting in spontaneous, in-person conversations.

In recent years, advances in computer vision and machine learning have opened new avenues for automated sign language recognition. Leveraging the power of advanced algorithms and increasingly pervasive hardware (e.g., mobile phone cameras, webcams), engineers and researchers hope to create machines that can recognize ASL hand gestures in real time. While some progress has been made in recognizing static signs or alphabets, challenges remain, especially regarding vocabulary expansion, nonmanual features, and real-world performance. The present work focuses on addressing these challenges by developing a user-centered ASL recognition tool that emphasizes accuracy, speed, and accessibility.

### 1.1 Research Problem

Current ASL recognition systems have several limitations that make them impractical. Some systems recognize only a limited set of signs, which restricts real-world applicability. Others do not account for nonmanual signs, such as facial expressions or head tilts, which are essential in ASL for the expression of tone, grammatical markers, and emotional context. Additionally, some tools also demand specialized sensors that are expensive or inconvenient, thus deterring widespread use.

There is also a broad gap in designing user interfaces that are attentive to the needs and

desires of Deaf individuals. Inaccurate calibration procedures, variability of performance under changing lighting conditions, or excessive latency can lower the reliability of a system. These barriers all compound to inhibit the real-world deployment potential of ASL recognition technology in everyday communication. This thesis fills these gaps by combining an effective machine learning pipeline with a user-friendly interface yet remains real-time.

### 1.2 Research Objectives

The overall goal of this thesis is to design a real-time ASL recognition system using computer vision and machine learning techniques. Specifically, the system must offer high recognition accuracy. The second aim is to enhance user experience by developing an accessible interface that is easy to install and requires minimal calibration or dedicated hardware. Additionally, the system needs to overcome environmental constraints by performing optimally in various lighting and backgrounds so that real environments can be utilized. Finally, the framework needs to be extensible for future additions of other signs, dynamic gestures, and nonmanual signals. By focusing on these core objectives, the system aims to be a foundation for broader applications in education, assistive technology, and inclusive communication devices.

### 1.3 Significance of the Study

This project holds the potential for shattering communication barriers among the Deaf and hard-of-hearing and making meaningful resources for hearing individuals who wish to learn ASL. An effective real-time ASL recognition system can facilitate communication more effectively in public places, schools, and workplaces, particularly where access to interpreters may not be readily available. It can also be employed as an interactive learning tool for ASL learners, offering instant feedback on handshapes to facilitate language learning. The proposed framework can further be extended to encompass the full richness of sign languages,

thereby enabling future research studies. Prioritizing usability and involving Deaf/ASL communities in the design, this research underscores the importance of user-centered solutions. Lastly, dedicated technological innovation towards ASL recognition can have the power to benefit society positively by bridging communication gaps and extending accessibility.

## 1.4 Thesis Structure

This thesis is organized into five main chapters:

1. **Chapter 1: Introduction**

   Provides the background and context of ASL recognition, defines the research problem, outlines objectives, and explains the study's significance.

2. **Chapter 2: Literature Review**

   Examines existing ASL recognition systems, machine learning techniques, and user-centered design principles. Identifies gaps in the current research and sets the stage for the proposed approach.

3. **Chapter 3: Software and Application**

   Details the methodology, including data collection, model architecture, and real-time inference pipeline. Discusses the design choices and rationale behind the system's implementation.

4. **Chapter 4: Results**

   Presents empirical findings, including model performance metrics, real-time testing results, and user feedback. Analyzes both quantitative and qualitative data.

5. **Chapter 5: Conclusion**

   Summarizes key insights, highlights contributions, and suggests avenues for future work. Reflects on the system's potential impact on accessibility and communication technologies.

# Chapter 2

## Literature Review

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### 2.1

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# Chapter 3

## Software and Application

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### 3.1

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# Chapter 4

## Results

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### 4.1

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# Chapter 5

## Conclusion

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### 5.1

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