Advancing Filipino Sign Language Literacy: Development of an Interactive Sign Language Recognition-Based Educational Application

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Abstract

Communication is essential for societal development, yet individuals with hearing impairments face significant challenges. In the Philippines, Filipino Sign Language (FSL) is the official language of the Deaf community, but most Filipinos do not understand it. This study explores recent advances in Sign Language Recognition (SLR) for the development of a Filipino Sign Language recognition system. The primary goal is to develop an educational application that incorporates real-time FSL recognition to support Deaf learners and promote FSL literacy among the general population. This project aims to foster inclusivity and enhance social integration of the Filipino Deaf community.

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Communication is fundamental to the growth of an emerging nation, as it fosters understanding and drives development across all sectors of society. However, individuals with hearing or speech impairments face significant barriers due to their inability to engage in conventional verbal communication (Levy, 2023). To overcome this challenge, these individuals rely on sign language, a visual system of communication that utilizes hand gestures, facial expressions, body movements, and spatial orientation to convey meaning. Different sign languages have developed globally, each shaped by the culture and language of its users (Britannica, n.d.).

In the Philippines, approximately 1.23% of the population is either deaf, mute, or hearing-impaired (Philippine Senate, 2015). To support accessibility and inclusion, the country officially recognizes Filipino Sign Language (FSL) as the national sign language. It is mandated for use in educational institutions, legal proceedings, broadcast media, and other public services involving the Deaf community to ensure equal access to communication (Supreme Court of the Philippines, 2018).

However, despite the enactment of the FSL Law, most Filipinos still do not understand Filipino Sign Language. This lack of awareness has created a significant communication gap between the Deaf and hearing populations (Lozada, 2015).

With the continuous advancement of technology and research, accessibility tools for the Deaf have improved significantly (Mairona-Basas & Pagliario, 2014). One such development is automated Sign Language Recognition (SLR), an interdisciplinary field focused on creating algorithms and systems that can visually detect and interpret sign language. These technologies can be embedded into digital applications, allowing for real-time interpretation and interaction, thus reducing communication gaps.

Despite global progress in SLR, research specific to Filipino Sign Language remains limited. Developing a robust and accurate FSL recognition system requires extensive datasets and

expertise in fields such as computer vision, natural language processing, human-computer interaction, linguistics, and a deep understanding of Filipino Deaf culture. The scarcity of localized data and research has constrained the creation of interactive learning tools tailored to FSL.(Bragg et al., 2019)

This study aims to investigate recent advancements in Sign Language Recognition (SLR) and evaluate their application in an interactive educational tool designed to teach Filipino Sign Language (FSL). While the system development will be based on existing research, it acknowledges that the limited number of studies specifically on FSL may leave some aspects underexplored. The primary objective is to support Deaf learners and promote FSL literacy among the wider population. By creating an engaging and user-friendly platform that incorporates real-time recognition technology, this study strives to foster inclusivity, bridge communication barriers, and enhance the social integration of the Deaf community in the Philippines.

Review of Related Literature

A deaf person is an individual who has a partial or complete inability to hear and process sound. This condition can be present at birth or acquired later in life due to illness, injury, or age. The inability to hear poses significant challenges in communication, learning, and social interaction.

To bridge communication gaps, the Deaf community uses sign language, a visual language expressed through hand shapes, facial expressions, and body movements (Britannica, n.d.). Sign languages are not universal; each country, and often regions within it, have their own with distinct vocabulary and grammar shaped by local culture. American Sign Language (ASL), widely used in the U.S. and parts of Canada, has influenced other sign languages. However, each sign language is a complete language, and using ASL outside its context can overlook local Deaf communities' cultural and linguistic identities.

Sign languages are often taught in specialized schools for the deaf, where they serve as the main medium of instruction from an early age. Beyond schools, community workshops, language

courses, and digital platforms offer learning opportunities for both deaf and hearing individuals. Teachers, interpreters, and family members also support learning by reinforcing communication in daily life .

Sign language is especially important for children who are profoundly deaf and gain little from hearing. It often becomes their first language. Some families learn sign language to support communication, and even hearing families may teach it to babies to aid early language development, as hand-eye coordination develops before speech (National Deaf Children's Society, n.d.).

In the Philippines, the officially recognized sign language is Filipino Sign Language (FSL), which has been declared the national sign language under Republic Act No. 11106 (Supreme Court of the Philippines, 2018). It is used in various formal domains such as educational institutions, legal proceedings, broadcast media, and other public services to ensure accessibility and inclusion for the Deaf community. Filipino Sign Language (FSL) was heavily influenced by American Sign Language (ASL) due to U.S. colonial ties, especially through the 1907 founding of the School for the Deaf and Blind in Manila. While FSL shares a Latin-based manual alphabet with ASL, it has developed distinct signs such as for the letters E, T, and G to reflect Filipino culture. Beyond the alphabet, FSL differs significantly from ASL in vocabulary, grammar, and classifiers. FSL has evolved through Lexical adaptation to Filipino concepts and culture, Creation of local signs for unique foods, places, and traditions, Grammatical changes aligned with Filipino Deaf communication, and Regional variations across the country. Though rooted in ASL, FSL has become a unique, culturally rich language shaped by the Filipino Deaf community (Panahon, 2023). Figure 1 shows the Filipino Sign Language Alphabet Gestures from A TO Z left to right.

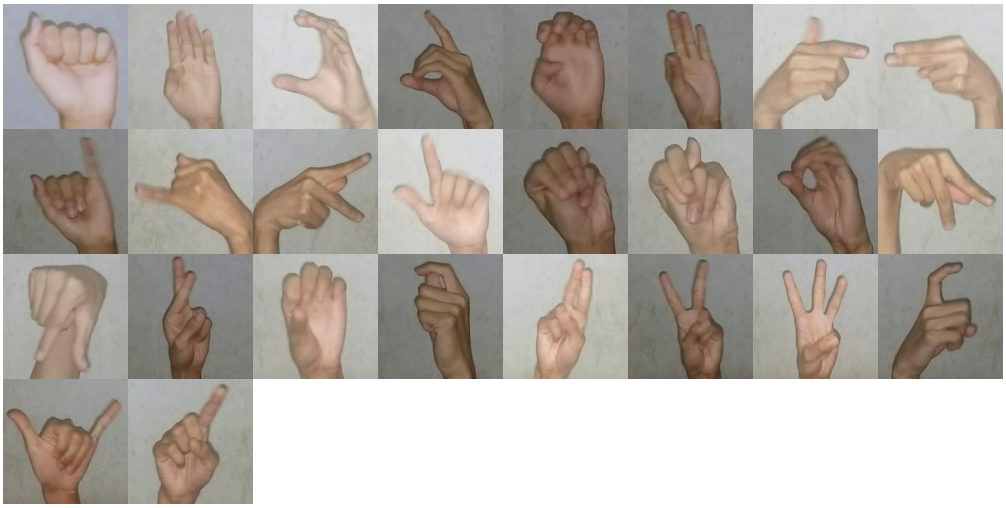

Figure 1

Filipino Sign Language Alphabet Gestures (FSL).

Experts in the most recent summit from the First Filipino Sign Language (FSL) Summit urged Filipino linguists to explore FSL's regional variations and historical roots, highlighting the importance of preserving indigenous sign languages. The summit stressed the urgency of integrating FSL into educational curricula, media, and public services to ensure equal opportunities and representation for the Deaf community (Garcia, 2021).

As Filipino Sign Language (FSL) gains recognition in education, media, and public services, There is a need for tools further is an increasing need for tools that support its further development. A notable innovation are Sign Language Recognition (SLR) systems. These systems use computer vision and machine learning to interpret visual gestures. By capturing images or video frames of signing, the system can analyze features such as hand shapes and movements, and in some cases, facial expressions and body posture. It then translates these gestures into text or speech, helping to bridge communication gaps between Deaf and hearing individuals (Madhiarasan & Roy, 2022).

There are numerous amount of research focused on Sign lanugage Recognition. The 2019 systematic literature review by Wadhawan and Kumar analyzed 117 research papers on Sign Language Recognition (SLR) published between 2007 and 2017. The study categorized these

works across 25 different sign languages and examined six key aspects: data acquisition methods, signing modes (static vs. dynamic), type of signs (isolated vs. continuous), hand usage (single vs. both hands), feature extraction techniques, and classification algorithms. The review found that the majority of research focused on static, isolated signs using camera-based systems and primarily single-handed gestures. It also highlighted challenges such as variability in signer styles, occlusions, and the need for large annotated datasets. The paper emphasized the growing role of machine learning and deep learning methods, while calling for more research on continuous sign language recognition and multi-modal approaches to better mimic natural sign communication (Wadhawan & Kumar, 2019).

Advancements in Sign Language Recognition (SLR) continue to accelerate. A 2024 review on deep learning-based Sign Language Recognition (SLR) highlights significant progress using advanced neural network architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Transformers. These models have improved both isolated and continuous sign language recognition by effectively capturing spatial and temporal features of gestures. The review emphasizes challenges including the need for larger, more diverse datasets, user-independent models, and lightweight architectures suitable for deployment on mobile devices. Additionally, it underscores the importance of multi-modal approaches that integrate hand shapes, facial expressions, and body posture to better mimic natural sign communication (Yanqiong Zhang, 2024).

Despite advancements in Sign Language Recognition (SLR) systems, there is no systematic review focused on Filipino Sign Language (FSL) recognition research. But there Notable studies. Montefalcon et al. (2021) developed a deep learning-based system recognizing FSL numeric gestures (0–9) using a fine-tuned ResNet-50 model, achieving 86.7% validation accuracy after 15 epochs. This model outperformed previous methods reliant on manual feature extraction and ideal conditions, showing better accuracy, adaptability, and reduced training time. The authors suggest future enhancements by including additional gesture indicators such as letters for service settings.

In another study, Montefalcon et al. (2022) addressed communication barriers due to limited public understanding of FSL by creating an automated system recognizing continuous FSL words using MediaPipe for feature extraction and an LSTM neural network. Trained on a proprietary dataset, it recognized 15 continuous words in real time with a test accuracy of 94%. Real-world testing with 10 participants showed 72.38% accuracy and a prediction time of 0.3 seconds per instance. The LSTM model outperformed ResNet-34 (87% accuracy), demonstrating its strength in processing sequential sign language data.

Co et al. (2021) created a lightweight identification model to recognize Filipino Sign Language (FSL) utilizing video input in their paper titled "Towards a Memory-Efficient Filipino Sign Language Recognition Model for Low-Resource Devices". Their work focuses on making sign language recognition more accessible by simplifying the system for devices with low memory and processing capacity. The model was created using the FSL-105 dataset, with four regularly used signs: bread, egg, chicken, and crab. These signs were analyzed by extracting hand landmark data using MediaPipe, a technique for detecting and tracking hand movements in video frames. The collected features were then used to train an LSTM neural network, which is a sort of recurrent neural network designed for time-series data such as video. In order to reduce the model's memory requirements, the team used post-training quantization approaches. This approach reduced the model size by almost 90% while sacrificing only a minor amount of performance. The generated model maintained a high accuracy rate of 93.29%.

For integrations within applications analyzing existing tools allows the developers to identify gaps in other applications in order to add features that can improve future FSL applications. Several FSL learning applications have been developed to support hearing individuals in learning Filipino Sign Language. One such app, FSL Buddy by students of De La Salle-College of Saint Benilde, offers a comprehensive FSL dictionary with videos of Deaf signers demonstrating signs from different angles(De La Salle-College of Saint Benilde, n.d.). It includes features like adjustable playback speed, video replay, and offline access. Another app provided animated tutorials of English words and sentences in FSL, with integrated quizzes to

assess learning(Banag, 2023). Additionally, a system with seven modules—including learning tools, games, and a sign language recognition feature was evaluated and rated highly across software quality indicators, earning a grand mean score of 4.50 ("Very Good") (De Guzman et al., 2023).

Based on the reviewed literature, Filipino Sign Language (FSL) is a complex and evolving visual language shaped by the Philippines' unique linguistic, cultural, and social contexts. While it shares some similarities with American Sign Language (ASL), particularly in fingerspelling. FSL has distinct syntax, grammar, and vocabulary that reflect Filipino culture and local concepts. This regional specificity, along with partial overlaps with ASL, has contributed to a limited body of research, making FSL a challenging area for exploration.

Recent developments in Sign Language Recognition (SLR) systems show promising progress. Early works have primarily utilized static Convolutional Neural Networks (CNNs), while more recent research explores real-time recognition using Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, and transformer-based models. A consistent challenge, however, remains: the lack of large, diverse, and high-quality datasets necessary for training robust and generalizable models.

Furthermore, studies increasingly highlight the importance of multimodal approaches that go beyond hand gesture recognition to include facial expressions, body posture, and movement dynamics. These elements are essential for accurately capturing the natural expressiveness of sign language. In the case of FSL, most existing recognition systems rely heavily on CNNs and LSTM architectures, yet they often lack real-time capabilities and comprehensive multimodal integration.

To develop an effective FSL recognition system, researchers must address three critical requirements:

1. Access to large, diverse, and annotated FSL datasets,
2. Integration of multimodal inputs such as facial expressions and body movement, and
3. Adoption of advanced deep learning models that support accurate, real-time performance.

Integrating such a recognition model into an FSL learning platform could significantly improve current educational tools. Existing FSL applications are largely limited to static content or video-based instruction, offering limited interactivity and adaptability. By embedding intelligent SLR systems, future applications can become more dynamic, responsive, and tailored to individual learning need,

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