Reducing Selection Bias in the Training Data of ASL Champ! to Improve the Sign Language Recognition (SLR) System

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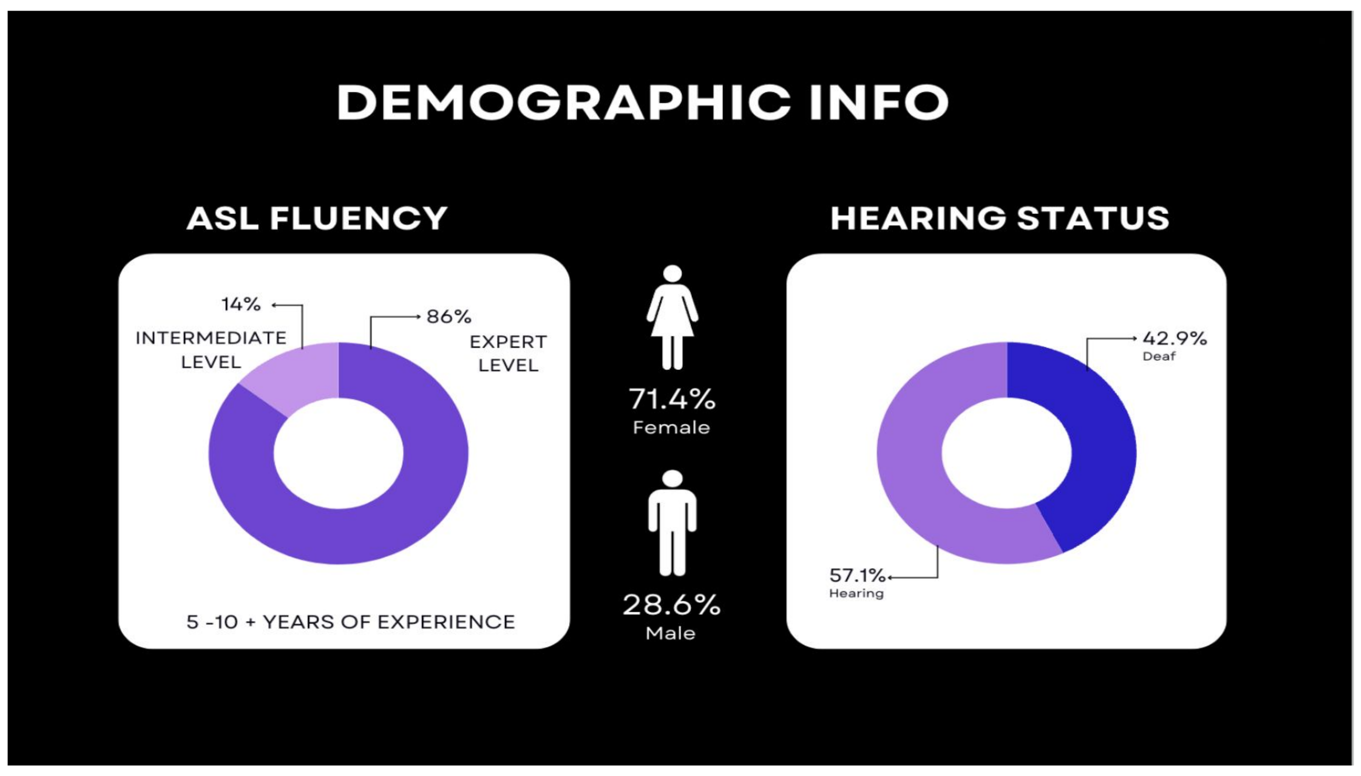
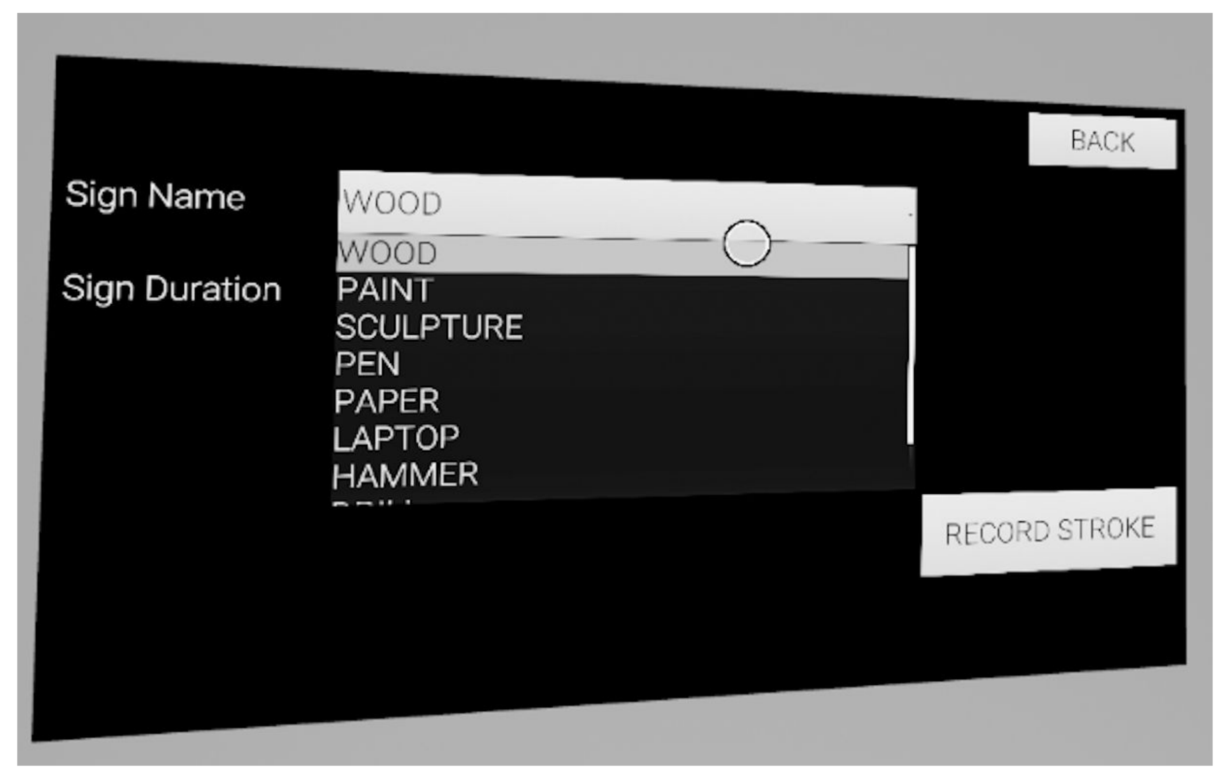




Abstract

American Sign Language (ASL) is a natural language that is critical for effective communication within the Deaf community and also to bridge the gap between hearing and Deaf or Hard-of-Hearing individuals. Conventional methods of ASL learning apart from in person classroom instruction provide foundational knowledge but often lack the immersive and interactive elements. People often opt to learn ASL through textbooks and videos due to the limited availability of proficient ASL instructors, lack of other educational resources and limited time. This creates challenges of replicating real-life conversational scenarios and lack of real time feedback. To address these limitations, Virtual Reality (VR) technology has emerged as a promising tool for ASL education by offering an immersive learning environment where users can practice ASL, a 3D language in a three dimensional space to enhance their learning as well as retain the language. The motivation behind this study is to explore the efficacy of the VR-based ASL learning platform, ASL Champ! and its potential to revolutionize the way ASL is taught and learned. Additionally, this study will also evaluate its Sign Language Recognition (SLR) system by addressing the research question: "How does reducing the selection bias in the training data of ASL Champ! affect the accuracy of its Sign Language Recognition (SLR) system?"

Methods

TECHNOLOGY USED

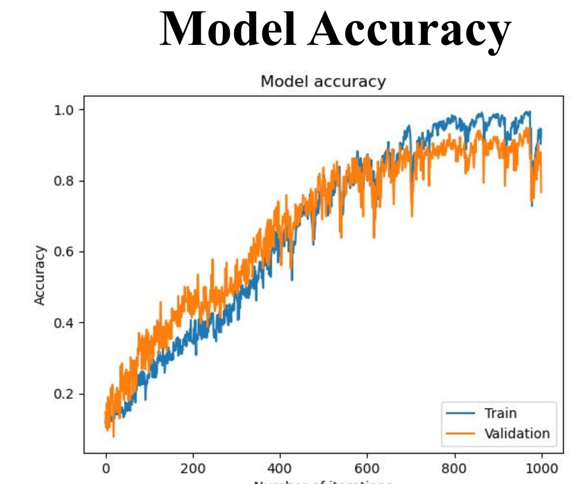
The technology that we are using is the Oculus Quest 2 VR device, MiVRy Unreal Engine plugin and a deep learning model for sign detection.

PROCEDURE

The data collection procedure involves recruiting 11 participants to train the data set within a VR environment specifically designed for this study. The VR environment, set up in the Maker Space, included nine different ASL signs. Each participant was required to produce 20 renditions of each sign using the VR headset. The data gathered from these sessions trains the sign language recognition model through deep learning.

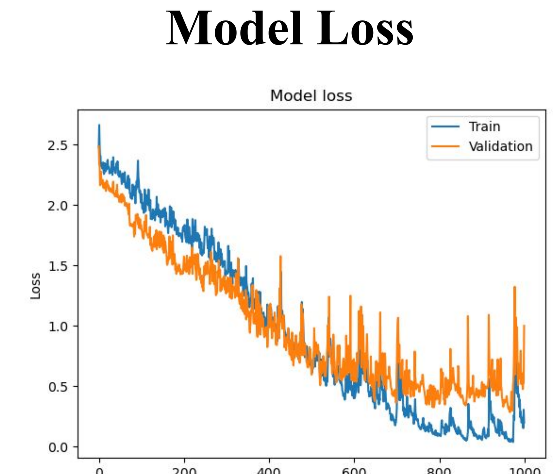
Results

Model Accuracy



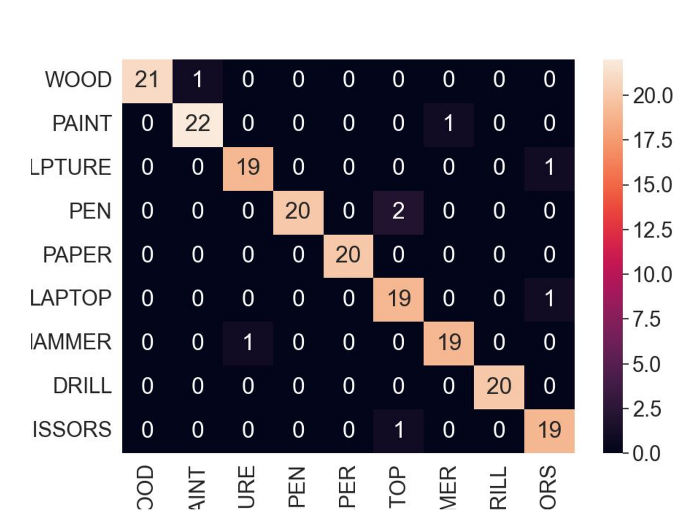
As seen here, the model was trained 1000 times. Initially, the accuracy was close to 0. But overtime, the accuracy increased. After around 700 iterations, the accuracy plateaus and won't see more improvement.

Model Loss



Model loss calculates the difference between the actual value and the predicted value. Initially, the loss is 2.5 and overtime the loss is near 0. Similar to accuracy the accuracy, the function flattens after about 700 times.

Confusion Matrix



The rows represent what's predicted by the deep learning model. The columns represent the actual value. As shown, the diagonal represents the highest accuracy. For example, out of 22 times, wood was recognized correctly 21 times. However, it was once incorrectly categorized as paint.

Discussion

The model loss function demonstrates that the validation loss is greater than the training loss indicating that the model is underfitting. This occurs when the model is unable to accurately model the training data, and consequently creating a large margin of errors.

To address these issues, it is important to consider the differences in the sample size and variability of signs as well as diversity of participants who trained the data set. Previous data sets in the coffee shop simulation did not include data from left handed signers. With 25% left handed signs in the data set, the model performance could have potentially degraded due to this change.

References

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