Sign Language Recognition in Virtual Reality

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***Abstract*— A real-time system for signal language recognition in virtual reality (VR) is presented in this paper. The system makes use of an egocentric view with the Vive HTC VR headset along with a Leap Motion controller. In this demo, a random forest is used to classify the 26 letters of the alphabet, in American Sign Language, from hand-crafted features extracted from the Leap Motion controller. We detail offline classification results showing the expressive power of the features used for recognition.**

I. INTRODUCTION

We present a real-time demo for the alphabet, in American Sign Language, in virtual reality (VR) using the HTC Vive [1] and the Leap Motion controller (LEAP) [2]. We are motivated by the success of using the LEAP for sign language recognition in languages such as American [6], Arabic [7], and Indian [8]. Along with the success of the LEAP, gesture recognition has also been shown to be viable in VR [3], [9].

II. SIGN LANGUAGE RECOGNITION IN VR

A. System Overview

In this system, the 26 letters of the American Sign Language (ASL) can be recognized. This is facilitated by hand-crafted features that are extracted from the LEAP. More specifically, we use the extended binary feature representation [5], the max range of the fingers in the hand, total area of all fingers, and the ratio between the max width and length (i.e. longest finger). These features are created from the skeleton information that is extracted from the LEAP. The LEAP also gives the grab and pinch strength of the gesture, as well as the velocity of the fingertips, which we use. More details on these features can be found in our previous work [10]. All of these features (7 in total) are used to train a random forest [4] for recognition.

In VR, the user is placed in an environment that is similar to a schoolroom. In front of the user a green chalk board is shown, along with a poster showing how to do each letter, and a menu where the user can select a letter to recognize. See Fig. 1 for an example of the user's view. We chose this type of setup to facilitate a more learning-centric environment, where the user can practice one letter at a time. This type of environment is geared towards users that do not have previous experience in sign language. Once the user selects a letter to recognize, they then sign the letter and the system will let them know if it is correct (i.e. recognized). This system generalizes well to unseen users, as additional training is not needed to demo the system. One small (780 instances) pre-trained model is used for all users of the system.

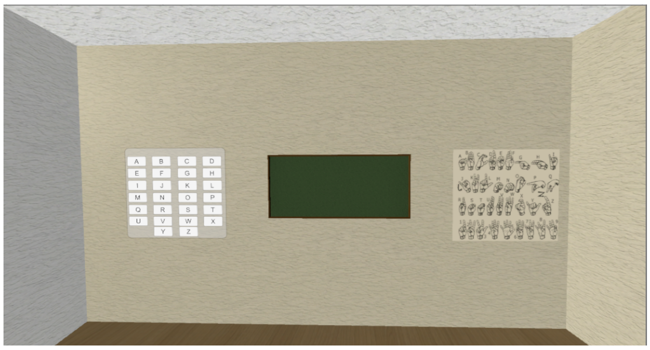

Fig. 1: User's view of the virtual environment.

TABLE I: Confusion matrix of 26 letters of ASL.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	30																									
B		30																								
C			30																							
D				30																						
E					30																					
F						30																				
G							30																			
H								30																		
I									30																	
J	1								4	23					1											1
K											30															
L												30														
M													29							1						
N														30												
O															30											
P															1	29										
Q																	30									
R																		30								
S																			30							
T													2						1	27						
U																					30					
V																						30				
W																							30			
X																								30		
Y																									30	
Z				1																						29

B. Experimental Validation

To validate using the selected features and random forest for sign language recognition, we conducted 10-fold cross-validation on 30 instances of each of the 26 letters, of the alphabet, achieving an accuracy of 98.33%. See Table I for the corresponding confusion matrix.

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