A Novel Sign Language Recognition System Applied in Home Appliance Remote Control

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INTRODUCTION

There are already very matured speech recognition systems in the market, such as Google. The technology is convenient for normal people but not for a small number of disadvantaged hearing or speech-impaired people. In recent years, the sign language recognition studies are gradually popular because of artificial intelligence (AI) learning algorithms[1-2]. Traditional sign language, as most people know, it is the main communication method for hearing and speech-impaired people. Currently, there is still no mature sign language recognition system similar to speech recognition system in the market. This research is based on the hope of helping a small number of hearing or speech-impaired people and other disadvantaged groups to improve their communication abilities with normal people. The novel sign language recognition system was developed based on AI image recognition technology. In this system, we use the Python programming language with Mediapipe and perform the functions of sign language training and recognition under Pytorch deep learning structure. In the preliminary study result, the system can not only translate a group of static gestures, but also a sentence composed of multiple dynamic gestures. We trained and tested 20 dynamic gestures corresponding to the home appliance control commands for this AI sign language translation system, ten subjects were invited to train and test the system, the average accuracy is about 85%.

METHOD

The main functions of the AI sign language recognition system were developed in Python programming combined with Mediapipe functions under Pytorch deep learning structure. In the beginning, a lot of static and dynamic sign language videos demonstrated by people who are familiar with sign language need to be collected for AI learning. At least, 80% sign language videos were used for AI training, the rest 20% videos were utilized to test the AI sign language recognition system. Once the AI sign language recognition system was trained well, the subjects were invited to demonstrate sign language commands related with home appliance control in front of mobile device with camera, i.e. turn on/off the fan, TV, light…etc., after the system finished AI sign language recognition, the system can output infrared remote signals and voices corresponding to home appliance control commands. The architecture of the AI sign language recognition system is shown in Fig. 1.
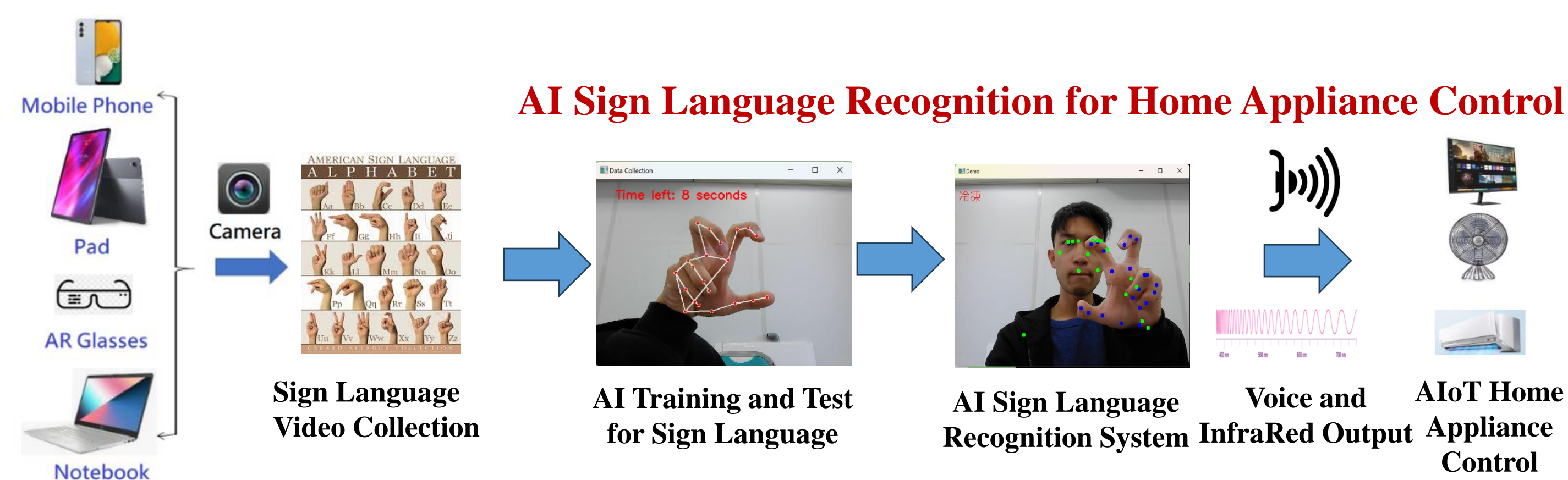

Figure 1. A Novel Sign Language Recognition System for Home Appliance Remote Control

RESULTS AND DISCUSSION

To test the performance of AI sign language recognition system, we invited 10 normal subjects (S1~S10) who are familiar with the gestures of sign language commands related to home appliance remote control to attend the test. 10 subjects were asked to demonstrate 20 different gestures of sign language commands (10 times/per gesture command) 1 meter away in front of a notebook embedded with a camera and observe the different control results of home appliances. We calculated the average accuracy of the system after performance test, the average accuracy of whole system is about 85%, the best and the worst records among 10 subjects are 93.5% and 77% respectively. The preliminary performance test results are shown respectively in Fig. 2 & Fig. 3 according to different subject and different gesture. Fig.2 shows the average recognition rate of each subject for demonstrating 20 different gesture commands. Fig. 3 shows the average recognition rate of each gesture command demonstrated by 10 subjects.
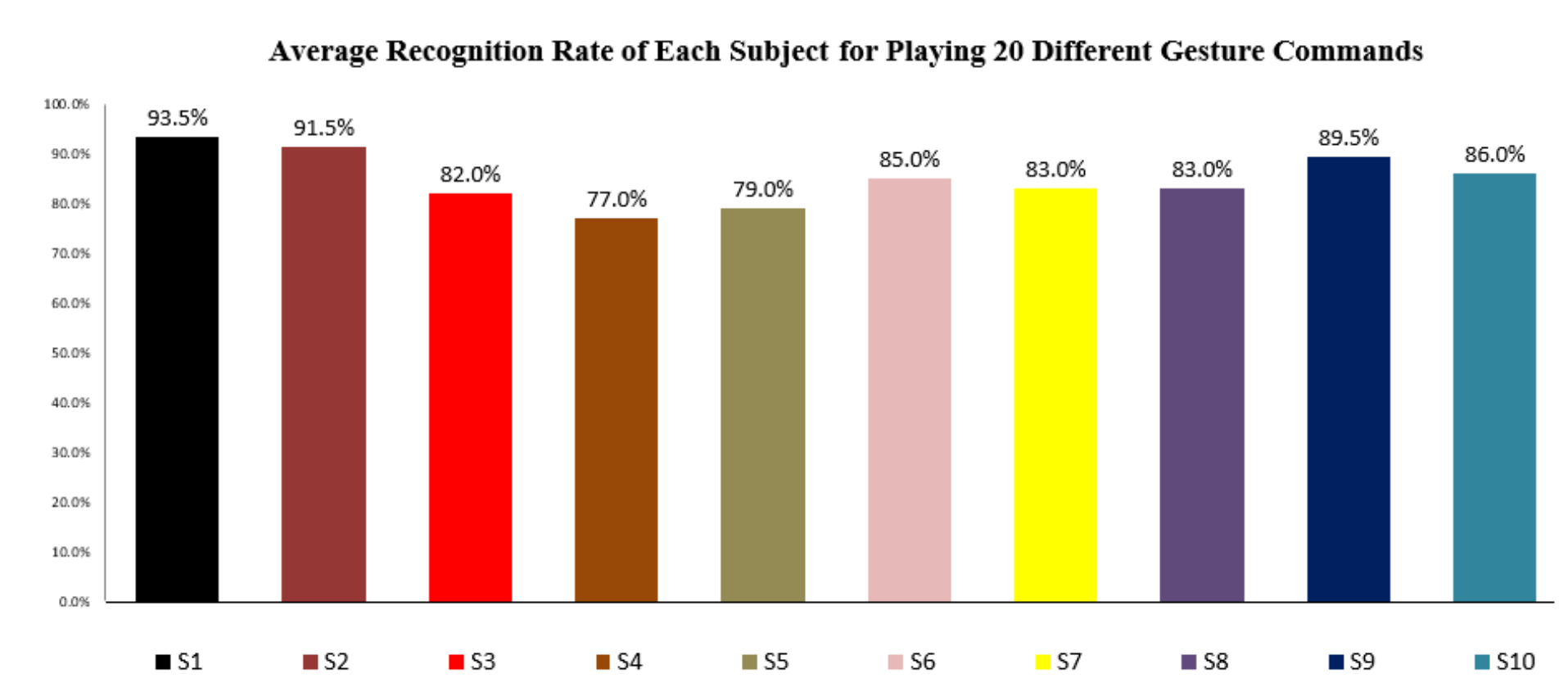

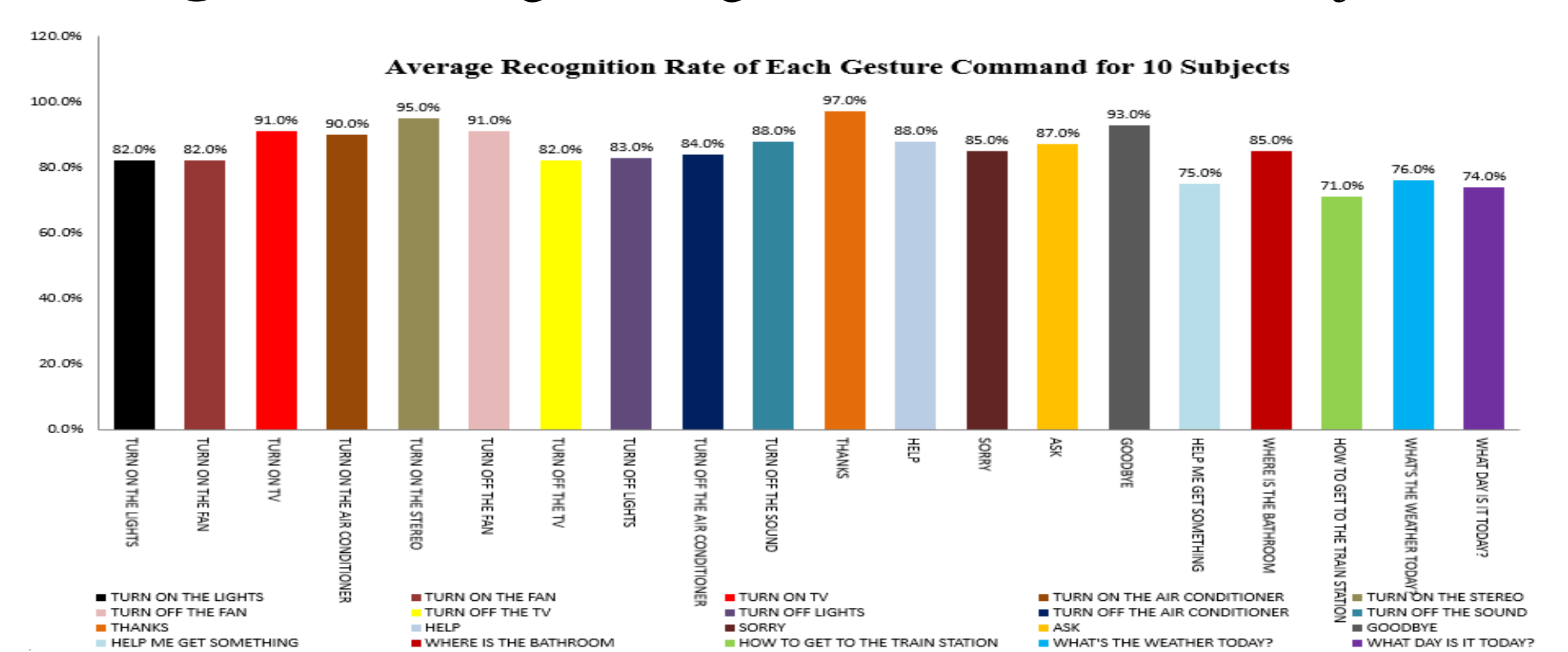**Figure 2.** Average Recognition Rate of Each Subject

Figure 3. Average Recognition Rate of Each Gesture Command

CONCLUSIONS

Fortunately, we finished the AI sign language recognition system prototype for recognizing 20 different gestures related to home appliance control commands and life dialogs. Although, the system accuracy (85%) we got now was not good enough, but we were satisfied then. It's just the new prototype not optimized so far, there are still more improvements needed. In the future, we will increase more different gestures database of sign language corresponding to life dialogs which are needed in the conversations between hearing/speech impaired and normal people. Meanwhile, the AI structure of deep learning will be revised and improved efficiently to raise the system accuracy and robustness. We believe that there will be a novel real time sign language translator developed to help the people with hearing/speech disabilities.

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