Hand Gesture Based Device Control with Applications in the Medical Domain

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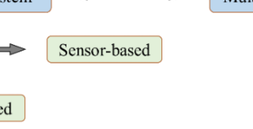
PROBLEM

While examining the relevant radiological image during the operation, the doctor has difficulty in controlling the device on which the image is projected. Touch systems or remote controls can be used to provide this control, but this can cause problems in terms of sterilization.

OBJECTIVE

The main objective of the project is developing a system that helps to control hospital devices with hand gestures. In this way, interventions at critical moments will be more effective.



INTRODUCTION

The touchless human- computer interaction HCI architecture is generally classified as unimodal and multimodal (Figure 1). Presents the gesture classifications in the literature and specifies the hand gesture subclasses such as static, dynamic and hybrid systems including both.The hand recognition is categorized into the sensor approach and computer vision approach.

Figure 1: General scheme for the HCI architecture

Thanks to hand recognition systems, people can control the device. There are many different hand gestures used here. Different hand gestures represent different commands. For example, having a fist in the hand means shutting down the system in many sources in the literature. Authentication methods should be used to separate users from each other and to ensure that only certain people can access the system. These methods, which are mentioned in the literature, are generally detected over the image, no study has been found on hand verification in real time.

METHODS

- Hand Gesture Standardization
- Dataset Manipulation
- Classification Model Development with Hybrid Ensemble Learning
- Model Evaluation and Tuning
- Authentication Based on Feature Scaling
- Device Management with Estimated Hand Gestures

RESULTS

Standardized Hand Gestures

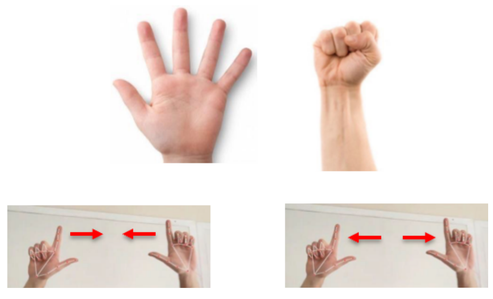


Figure 2: Selected a) Opening, b) Closing, c) Zoom in , d) Zoom out Hand Gestures

Ensemble Hybrid Model Training & Testing

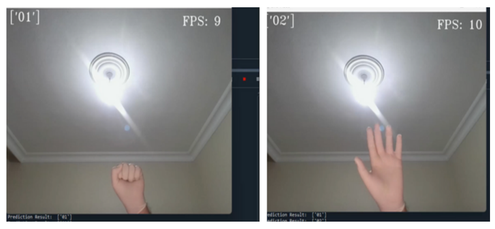


Figure 3: Hand Gesture Detection from Webcam with FPS values a) Closing , b) Opening

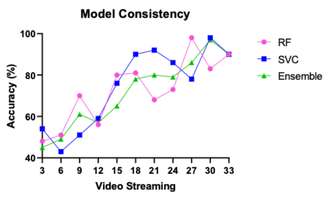
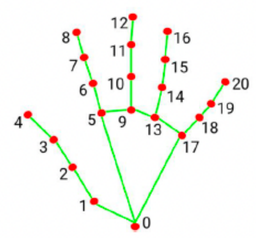


Figure 4: Ensemble Model Consistency

Training Model	Metrics			
Name	Accuracy	Precision	Recall	F1-Score
RF	0.90	0.94	0.89	0.90
MBN	0.80	0.62	0.67	0.62
DT	0.70	0.44	0.56	0.49
LR	0.80	0.78	0.82	0.79
SVC	0.90	0.92	0.93	0.92
MLPC	0.80	0.67	0.62	0.62
Ensemble	**0.90**	**0.89**	**0.89**	**0.87**

Figure 5: Ensemble Model Result

Authentication

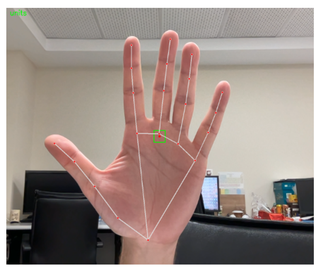


$$Ratio\ 1 = \frac{dist_{9_{10}}}{dist_{10_{11}}}$$

$$Ratio\ 2 = \frac{dist_{9_{10}}}{dist_{0_5}}$$

$$Ratio\ 3 = \frac{Ratio\ 1}{Ratio\ 2}$$

Figure 6: Representation of Feature Extraction in Authentication



Authentication Results:

Person 1: 96% Accuracy
Person 2: 94% Accuracy
Person 3: 91% Accuracy

Figure 7: Representation of authentication.

Real-time Applications & Device Management

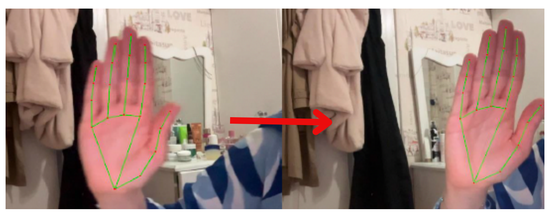


Figure 8: Obtained Result from one of the "Sliding" Hand Gesture that provide open to virtual mouse mode

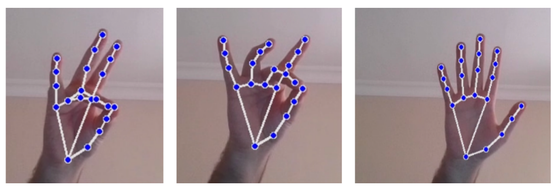


Figure 9: When the virtual mouse mode is active, it also brings three actions as well

DISCUSSION

- Function control with 3 different hand movements, mouse control with 5 different hand movements are provided.
- Hybrid ensamble model was used hand classificaiton. A new method has been introduced in the literature.
- Originally, it was planned to keep this dataset in a MySQL database. However, since there the dataset is no too large to handle, the information of hand gestures was kept only in trained model instead.
- This created a problem to take late response from the detection model for this reason the multiprocessing technique was implemented in the prediction model to increase the FPS.
- Many different methods have been tried in the authenticaiton part and finally the ratio between keypoints and reference points have been used.
- An example of the algorithm written for the authentication section has not been encountered in the literature.
- The hand gestures used in the virtual mouse mode are selected from the standardized gestures found in the literature.
- Finally, despite many difficulties in the project, the project was completed with 95% success.

ORIGINALITY

Sterile real time human – machine interface

User characterization and authorization

Standardization of hand gestures

CONCLUSION

Hand gesture based device control with applications in the medical domain is provided with 8 different movements. While 5 of these movements are used functionally, 3 of them are used in virtual mouse mode. In addition, hand authentication was made and contributed to the literature. 95% of the project completed successfully.

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