# Machine Learning for Gesture Recognition to Reduce COVID-19 Transmission

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## Abstract

In the age of COVID-19, "don't touch your face" is easier said than done. Our research transforms everyday wired earbuds and smartphones into a sonar system to alert people when they touch their faces. We work to develop signal processing and machine learning approaches to (1) detect face touches and (2) ensure compatibility with off-the-shelf earbuds and smartphones. Preliminary results and user studies (N=10 participants) demonstrate that the Saving Face system is able to detect face touch gestures with 94.2% accuracy. We thus expect our system to serve as a scalable, effective approach to help reduce the transmission of surface-based pathogens and combat the COVID-19 pandemic.

**Fig. 1** Operating principle of the Saving Face system

## Introduction

With an estimated 10% of COVID-19 cases resulting from hand-to-face transmission, the CDC and WHO advise us to avoid hand-to-face contact.

The Saving Face mobile app has been motivated by three main objectives:

1. **Effectiveness**: Accurate reporting of face touches
2. **Scalability**: Minimize barriers for users (e.g. expense and custom hardware)
3. **Convenience**: Integrates easily into everyday activities (e.g. intuitive interface and inaudible)

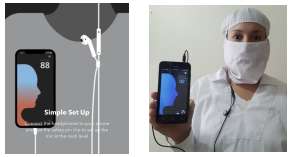


**Fig. 2** Earphone wearing positions

## Methodology

### Designing The System

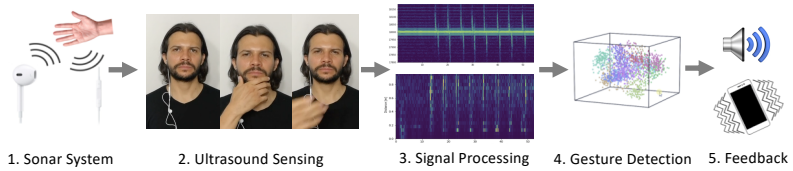



**Fig. 3** Design and implementation of the Saving Face system

**Step 1** An ultrasound signal is played through the left earphone and received by the microphone, transforming wired earphones into a sonar system.

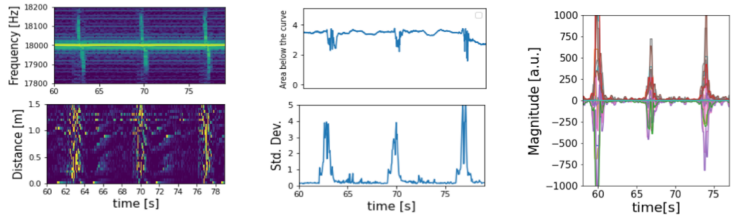
**Step 2** As a user reaches to touch their face, the ultrasound signal is reflected off the hand, creating unique distortions in the signal received by the microphone.

**Step 3** The received signal is processed to obtain information about the speed, position, and trajectory of the user's hand.

**Step 4** The Saving Face gesture recognition machine learning algorithms determine whether patterns in the received signal are characteristic of a face touch.

**Step 5** If a face touch is detected, the user is alerted by an audio beep or vibration.

### Processing and Analyzing the Data




(1) Generating Spectrograms (2) Extracting Features (3) Convolutional Filters

**Fig. 4** Characteristic patterns of a face touch gesture at three main stages of processing

### Building the Dataset


**Fig. 5** Data collection: nine different activities across three use cases (office, manufacturing, supermarket) used to train and evaluate the machine learning model

## Results

### 1. Machine Learning Model

- Trained and optimized a logistic regression model with leave-one-user-out cross validation.
- The model has an accuracy of 94.2% and F1-score of 94.1% when evaluated on the held-out test set.

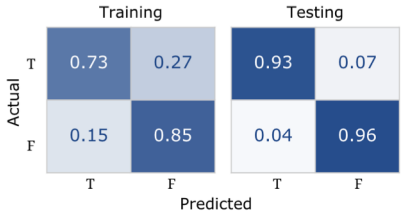



**Fig. 6** Performance of the Machine Learning Model

### 2. User Studies

- Preliminary user studies (N = 10 participants) occurred on Zoom. The results validated those of the machine learning model.

## Conclusion

The Saving Face system:

- Effectively detects face touches with 94.2% accuracy.
- Is expected to be a scalable and convenient approach to help reduce hand-to-face transmission of diseases like COVID-19.

Future directions:

- Detect face touches in more challenging scenarios and explore additional gestures.
- Study other applications of our gesture recognition technologies (e.g. behavior-reversal therapy, safety, health monitoring).

## Acknowledgements

Thanks to The Saving Face Team and MIT Media Lab

**References:** Rojas, C., Van Tuyl, M., et al., 2021. "A Scalable Solution for Signaling Face Touches to Reduce the Spread of Surface-based Pathogens" *IMWUT* 5, 1 (forthcoming March 2021).