Detecting Face Touching with Dynamic Time Warping on Smartwatches: A Preliminary Study

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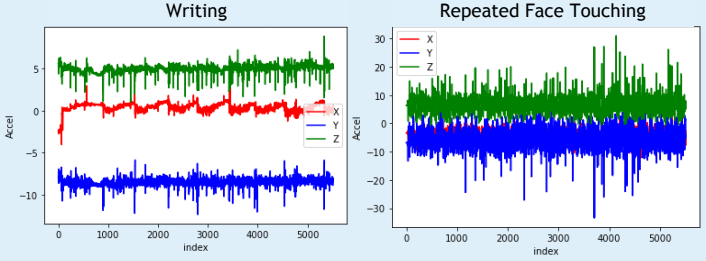
Motivation

- COVID-19 has been a global challenge in many ways [1].
- One of the CDC recommendations is to avoid touching eyes, nose, or mouth with unwashed hands [2].
- We explored a possible approach to help users avoid touching their face by alerting them through a smartwatch application.

Method

- Selected 10 everyday activities including 6 non-face-touching activities and 4 face-touching activities.
- Asked 10 participants to perform each activity repeatedly for 3 minutes while wearing a smartwatch.
- $DTW(A,B) = \sqrt{DTW(A_x,B_x)^2 + DTW(A_y,B_y)^2 + DTW(A_z,B_z)^2}$



Group	Activity
Non-face-touching	Using a mobile phone
	Lying flat on the back
	Computer tasks
	Writing
	Leisurely walk
	Moving items from one location to another
Face-touching	Repeated face touching
	Eating and drinking
	Simulated smoking
	Adjusting eyeglasses

Results

	User-Dependent Accuracy	User-Independent Accuracy
Binary Classification	99.07% (Figure 1)	85.13% (Figure 2)
Multiclass Classification	92.48% (Table 1)	55.1%

Table 1: We formulated the problem in two ways: binary classification and multiclass classification

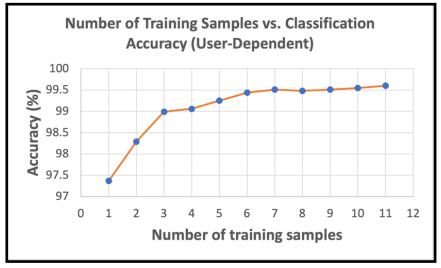


Figure 1: For each activity type, a single template was selected from each training participant.

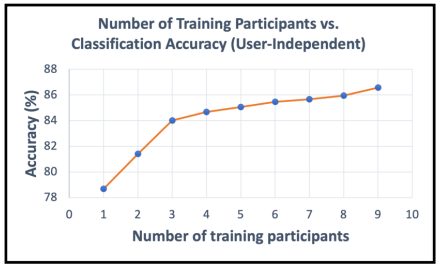


Figure 2: For each activity type, *T* (e.g., 1 to 11) samples were selected as the training data.

Actual Class \ Predicted Class	Mobile Phone	Lying Flat	Computer Tasks	Writing	Leisurely Walk	Moving Items	Repeated Face Touching	Eating and Drinking	Simulated Smoking	Adjusting Eyeglasses
Mobile Phone	99.09%	0.00%	0.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.36%	0.00%
Lying Flat	0.00%	98.64%	0.27%	0.00%	0.00%	0.00%	0.18%	0.00%	0.73%	0.18%
Computer Tasks	2.00%	0.00%	96.45%	1.45%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%
Writing	0.00%	0.00%	0.18%	99.82%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Leisurely Walk	0.82%	0.00%	0.00%	0.09%	94.36%	4.00%	0.64%	0.09%	0.00%	0.00%
Moving Items	0.18%	0.00%	0.45%	3.45%	0.00%	94.18%	0.00%	1.45%	0.27%	0.00%
Repeated Face Touching	0.00%	0.27%	0.00%	0.00%	0.00%	0.55%	83.91%	3.27%	3.45%	8.55%
Eating and Drinking	0.00%	0.00%	0.00%	0.09%	0.00%	1.55%	2.18%	90.91%	2.73%	2.55%
Simulated Smoking	0.45%	0.09%	0.55%	0.18%	0.00%	0.64%	2.91%	1.45%	89.09%	4.64%
Adjusting Eyeglasses	0.18%	0.55%	0.00%	0.00%	0.00%	0.09%	10.91%	3.45%	6.45%	78.36%

Table 2: Confusion matrix of individual activity recognition in the user-dependent scenario. There were more within-category confusions than between-category confusions, where category means face-touching activities versus non-face-touching activities.

Limitations and Future Work

- Participants wore the smartwatch on their dominant wrist, but people prefer wearing watches on their non-dominant hand.
- Data were only collected in a laboratory setting and gyroscope data were not collected.
- We did not compare the quantitative results of DTW and ML-based methods regarding classification accuracy and required resources.
- Our classification experiments were conducted offline. Real-time face-touching detection on smartwatches is the eventual goal.

Takeaways

- Smartwatches have the potential for detecting face touching using the DTW algorithm.
- Formulating the multiclass classification problem as a binary classification problem significantly increases the recognition accuracy.
- DTW has the potential to provide a personalized face-touching detection service on resource-constrained devices such as smartwatches.

[1] Maria Nicola, Zaid Alsafi, Catrin Sohrabi, Ahmed Kerwan, Ahmed Al-Jabir, Christos Iosifidis, Maliha Agha, and Riaz Agha. 2020. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International journal of surgery (London, England) 78: 185-193. https://doi.org/10.1016/j.ijsu.2020.04.018

[2] Centers for Disease Control and Prevention. 2020. Prevent Getting Sick. Retrieved March 8, 2021 from https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/index.html

Acknowledgments

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