EAGER: Biometric Authentication using Noncontact Cardiovascular Signals

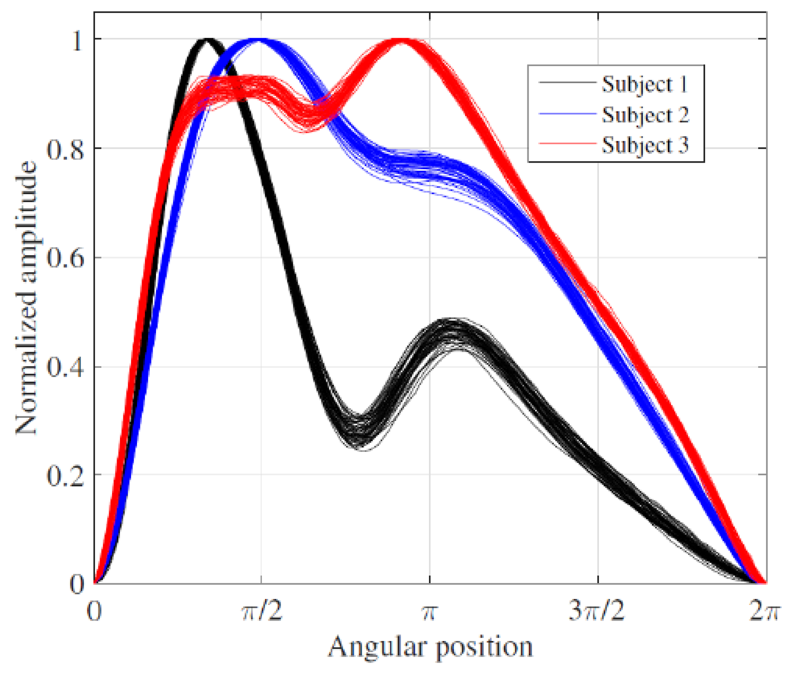
Dr. A. Lynn Abbott[1], Dr. Abhijit Sarkar[2], Yogesh Deshpande[3], and Surendrabikram Thapa[3]

[1]Professor, Virginia Tech [2]Senior Research Associate, Virginia Tech Transportation Institute

[3]Graduate Student, Virginia Tech

https://www.nsf.gov/awardsearch/showAward?AWD_ID=2136915

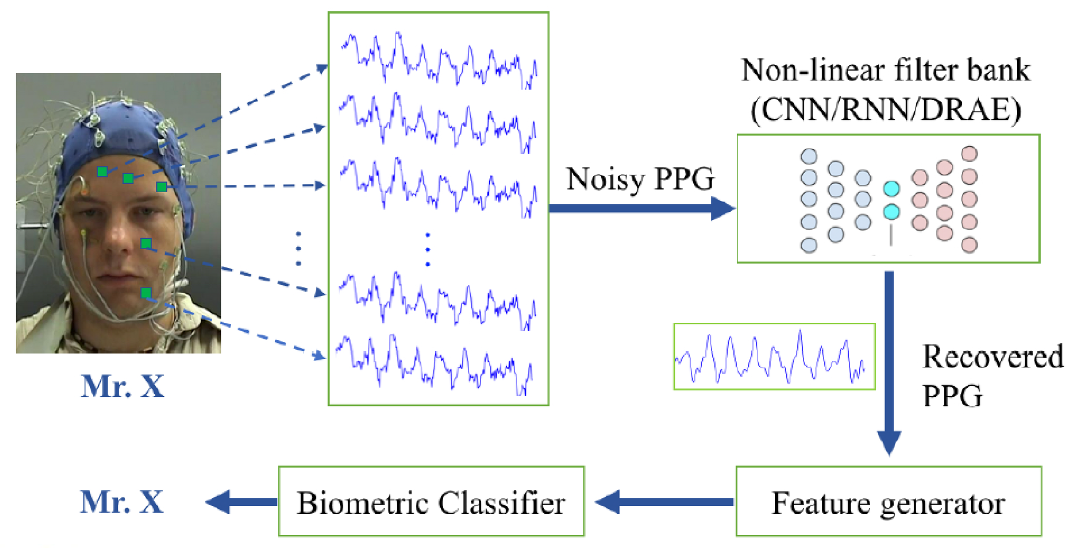
Goal: We are developing novel *biometric authentication* techniques based on activity of the cardiovascular system. The mechanism of interest is photoplethysmography (PPG), which refers to the use of illumination-based sensors to record local volumetric changes in peripheral blood circulation. Unlike typical PPG sensing which requires contact with the skin, this project is concerned with *noncontact recovery of PPG signals using a video camera*. This approach is known as remote photoplethysmography (rPPG).

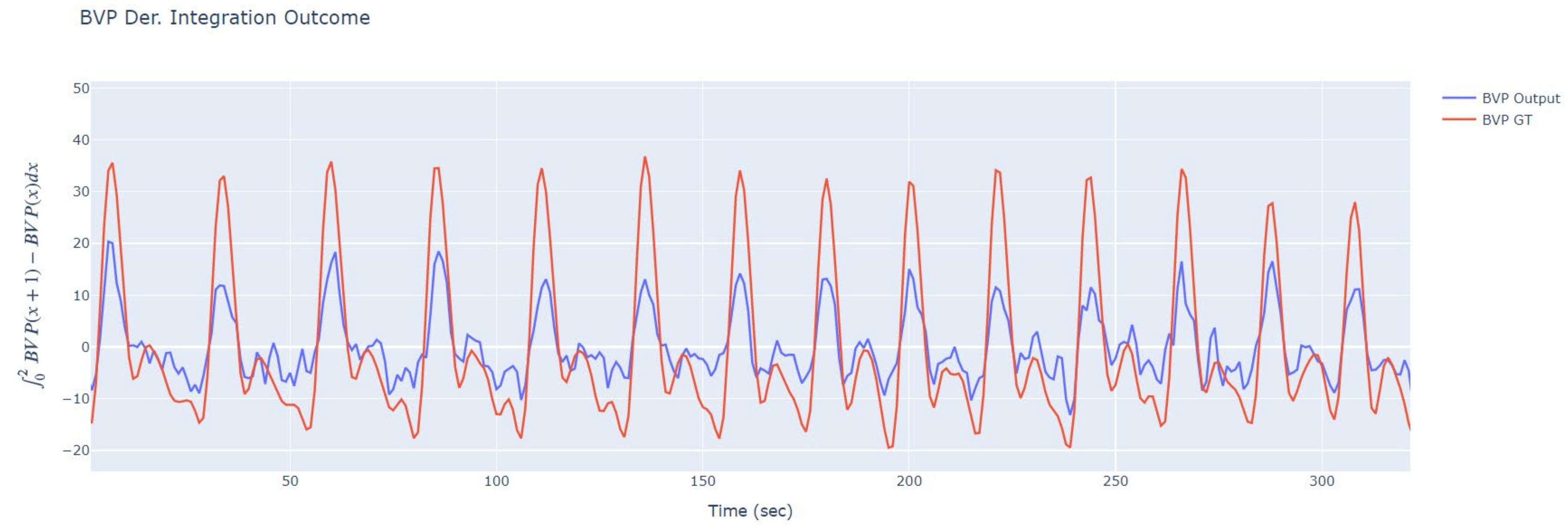


Key challenges: Other researchers have used camera-based rPPG to estimate heart rate by observing exposed skin on a person's face. However, additional details of the PPG signal must be recovered in order to perform authentication. Details of interest are the systolic peak, dicrotic notch, and diastolic peak. Problems due to head movement, facial hair, and uneven illumination must be addressed.

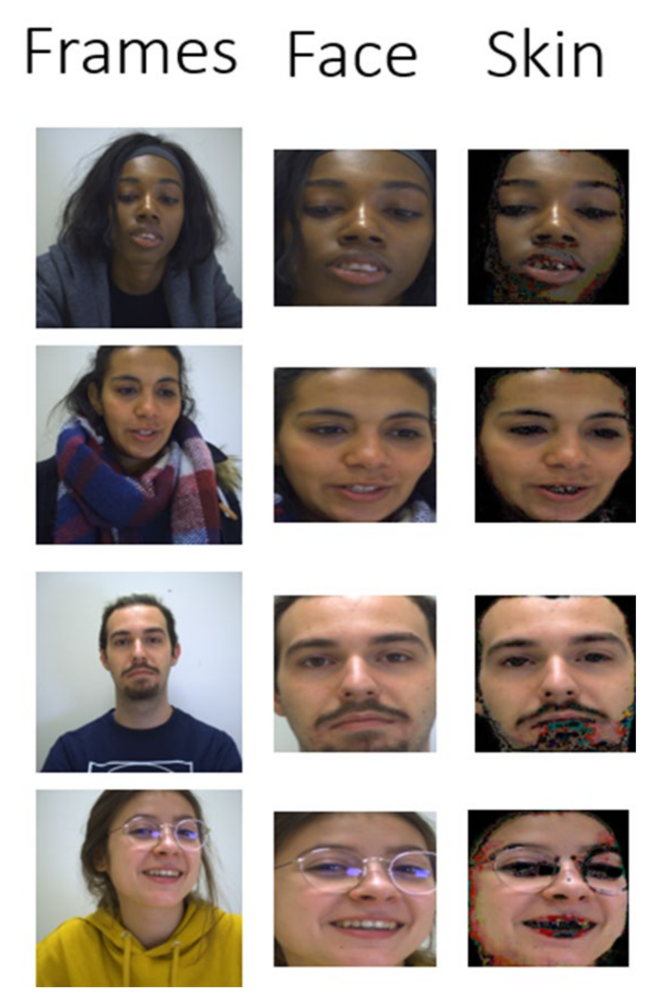
Scientific impact: This project is expected to lead to new theoretical insights related to sensing of cardiovascular activity. More broadly, the work can also be applied to representation and understanding of similar quasiperiodic bio signals. We will also characterize the effects of imaging parameters and external factors on rPPG performance, and any new insights will benefit many other research efforts.

Approach 1: Detect skin regions on the face, and provide successive video frames to a deep network[1]. The output is a representation of the underlying PPG signal.





Approach 2: Train a denoising autoencoder (DAE) to convert a noisy PPG signal to one that is suitable for biometric authentication. This approach extends our previous work with signal representation and analysis[2].



Dataset: UBFC-Phys

Broader impacts:

At the *societal* level, our work may lead to a new modality for continuous authentication that can benefit cybersecurity and law enforcement, including border control; the work may eventually be used for improved health monitoring.

Education and outreach activities will include incorporation of these ideas into graduate and undergraduate courses; *broader participation* is expected, motivated in part by our new color-invariant approach to automated skin detection[3].

References:

[1] Chen, W. and McDuff, D., 2018. DeepPhys: Video-based physiological measurement using convolutional attention networks. In *Proc. European Conference on Computer Vision (ECCV)*, pp. 349-365.

[2] Sarkar, A., Abbott, A. L. and Doerzaph, Z., 2016. Biometric authentication using photoplethysmography signals. In *Proc. IEEE International Conference on Biometrics Theory, Applications and Systems (BTAS)*, pp. 1-7.

[3] Xu, H., Sarkar, A., and Abbott, A. L., 2022. Color invariant skin segmentation. To appear in *Proc. IEEE CVPR Workshop on Fair, Data-Efficient, and Trusted Computer Vision (TCV)*.

The 5th NSF Secure and Trustworthy Cyberspace Principal Investigator Meeting (2022 SaTC PI Meeting)
June 1-2, 2022 | Arlington, Virginia