Jeremy Speth

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I am currently a Senior Research Scientist at Presage Technologies working on camera-based physiological measurement with machine learning. Prior to joining Presage, I completed my PhD at University of Notre Dame under the guidance of Professors Adam Czajka and Patrick Flynn. My research spans camera-based physiology, biometrics, signal processing, machine learning, and computer vision. I have experience working all the way from data collection of large video datasets of human subjects to the estimation of physiological signals such as blood volume pulse and respiration from video. My applied interest is building robust algorithms for health measurement from ubiquitous mobile phones. My general research interest is in machine learning for signal estimation and discovery.

EDUCATION

Ph.D. in Computer Science and Engineering   July 2019 - November 2023
University of Notre Dame - Computer Vision Research Lab   Notre Dame, Indiana, USA
Dissertation: Camera-Based Physiological Measurement in an Open World
Advisors: Dr. Adam Czajka and Dr. Patrick Flynn

M.S. in Computer Science and Engineering   May 2022
University of Notre Dame - Computer Vision Research Lab   Notre Dame, Indiana, USA
Dissertation Proposal: Remote Vitals Estimation in an Open World
Advisors: Dr. Adam Czajka and Dr. Patrick Flynn

B.S. in Computer Science and Engineering   August 2016 - May 2019
University of Nevada, Reno - Computer Vision Lab   Reno, Nevada, USA
Magna Cum Laude, Recipient of Senior Scholar Award

PROFESSIONAL EXPERIENCE

Senior Research Scientist   January 2024 - Present
Presage Technologies   Hybrid (St. Louis, Missouri, USA)
Camera-based measurement of several physiological signals such as blood volume pulse, respiration, and blood pressure. Directly organizing and managing a large-scale data collection including signal acquisition from several sensors/cameras, data processing, protocol design, and training collection interns.

Research Intern   May 2023 - September 2023
Digital Health Lab, Samsung Research America (SRA)   Remote (Mountain View, California, USA)
Camera-based physiological monitoring in the presence of motion. My research during the internship resulted in 2 patent applications and an ICASSP paper.

Graduate Research Assistant   July 2019 - November 2023
University of Notre Dame   Notre Dame, Indiana, USA
Research in remote vitals estimation using deep learning and signal processing. Collected multiple large-scale video datasets with simultaneous recordings of physiological signals. Trained multiple state-of-the-art video models to improve pulse estimation in unconstrained settings. Contributed to the latest research on self-supervised learning for periodic signals.

Research Intern   September 2021 - December 2021
Philips   Cambridge, Massachusetts, USA
Evaluated multiple algorithms for remote pulse estimation on compressed videos, and developed a novel video compression method with minimal damage to the signal quality. This work led to a patent application.

Undergraduate Researcher   August 2018 - July 2019

University of Nevada, Reno   Reno, Nevada, USA
Worked with Dr. Emily Hand to develop weakly supervised models for improving facial attribute recognition. Developed and published a method called verification filtering for finding noisy labels in the multi-label setting.

Undergraduate Researcher   May 2018 - July 2018
University of Notre Dame   Notre Dame, Indiana, USA
Worked with Dr. Peter Kogge to develop scale-free bipartite graph generators, and used them as a benchmark for graph processing with the Hopcroft-Karp algorithm.

PATENT APPLICATIONS

Nathan Vance, **Jeremy Speth**, Siamul Khan, Adam Czajka, Kevin W. Bowyer, Diane Wright, Patrick Flynn, Nathan Carpenter, Leandro Olie, "Deception detection," U.S. Patent Application No. 18/115,414, 2023.

Jeremy Speth, Nathan Vance, Patrick Flynn, Adam Czajka, "Non-contrastive Unsupervised Learning of Physiological Signals from Video," U.S. Patent Application No. 63/424,606, 2022.

Jeremy Speth, Patrick Flynn, Adam Czajka, Benjamin Sporrer, Lu Niu, Nathan Carpenter, Leandro Olie, "Trustworthy Anomaly-Aware Remote Pulse Estimation," U.S. Patent Application No. 63/388,984, 2022.

Jeremy Speth, Patrick Flynn, Adam Czajka, Kevin Bowyer, Nathan Carpenter, Leandro Olie, "Video based detection of pulse waveform," U.S. Patent Application No. 17/591,929, 2022.

JOURNAL PUBLICATIONS - PEER-REVIEWED

Jeremy Speth, Nathan Vance, Patrick Flynn, Adam Czajka, "SiNC+: Adaptive Camera-Based Vitals with Unsupervised Learning of Periodic Signals," *submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*, 2024; pre-print available at `https://arxiv.org/abs/2404.13449`

Jeremy Speth, Nathan Vance, Benjamin Sporrer, Lu Niu, Patrick Flynn, Adam Czajka, "MSPM: A Multi-Site Physiological Monitoring Dataset for Remote Pulse, Respiration, and Blood Pressure Estimation," *submitted to IEEE Transactions on Instrumentation and Measurement (TIM)*, 2024; pre-print available at `https://arxiv.org/abs/2402.02224`

Aidan Boyd*, **Jeremy Speth***, Lucas Parzianello*, Kevin Bowyer, Adam Czajka, "Comprehensive Study in Open-Set Iris Presentation Attack Detection," *IEEE Transactions on Information Forensics and Security (TIFS)*, 2023.

Nathan Vance, **Jeremy Speth**, Siamul Karim Khan, Adam Czajka, Kevin Bowyer, Diane Wright, Patrick Flynn, "Deception Detection and Remote Physiological Monitoring: A Dataset and Baseline Experimental Results," *IEEE Transactions on Biometrics, Behavior, and Identity Science (TBIOM)*, 2022.

Jeremy Speth, Nathan Vance, Patrick Flynn, Kevin Bowyer, Adam Czajka, "Unifying frame rate and temporal dilations for improved remote pulse detection," *Computer Vision and Image Understanding (CVIU)*, 2021.

CONFERENCE PUBLICATIONS - PEER-REVIEWED

Jeremy Speth, Korosh Vatanparvar, Li Zhu, Jilong Kuang, Alex Gao, "Freq2Time: Weakly Supervised Learning of Camera-Based rPPG from Heart Rate," *in Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, 2024.

Jeremy Speth, Nathan Vance, Patrick Flynn, Adam Czajka, "Non-Contrastive Unsupervised Learning of Physiological Signals from Video," *in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2023; pre-print available at `https://arxiv.org/pdf/2303.07944` **(highlight paper award - top 10% of accepted)**

Lu Niu, **Jeremy Speth**, Nathan Vance, Benjamin Sporrer, Adam Czajka, Patrick Flynn, "Full-Body Cardiovascular Sensing with Remote Photoplethysmography," *in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (CVPRW) on Computer Vision for Physiological Monitoring (CVPM)*, 2023; pre-print available at `https://arxiv.org/pdf/2303.09638` (**best paper award**)

Nathan Vance, **Jeremy Speth**, Benjamin Sporrer, Patrick Flynn, "Promoting Generalization in Cross-Dataset Remote Photoplethysmography," *in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (CVPRW) on Computer Vision for Physiological Monitoring (CVPM)*, 2023; pre-print available at `https://arxiv.org/pdf/2305.15199`

Jeremy Speth, Nathan Vance, Benjamin Sporrer, Lu Niu, Patrick Flynn, Adam Czajka, "Hallucinated Heartbeats: Anomaly-Aware Remote Pulse Estimation," *The 16th International Joint Conference on Biomedical Engineering Systems and Technologies: BIOSIGNALS*, ISBN 978-989-758-631-6, pp. 106-117, 2023; pre-print available at `https://arxiv.org/pdf/2303.06452` (**shortlisted for best student paper award**)

Jeremy Speth, Nathan Vance, Patrick Flynn, Kevin Bowyer, Adam Czajka, "Remote Pulse Estimation in the Presence of Face Masks," *in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshop (CVPRW) on Computer Vision for Physiological Monitoring (CVPM)*, 2022; pre-print available at `https://arxiv.org/pdf/2101.04096`

Jeremy Speth, Nathan Vance, Patrick Flynn, Kevin Bowyer, Adam Czajka, "Digital and Physical-World Attacks on Remote Pulse Detection," *in Proceedings of the IEEE Winter Conference on Applications of Computer Vision (WACV)*, 2022; pre-print available at `https://arxiv.org/pdf/2110.11525`

Jeremy Speth, Nathan Vance, Adam Czajka, Diane Wright, Kevin Bowyer, Patrick Flynn, "Deception Detection and Remote Physiological Monitoring: A Dataset and Baseline Experimental Results," *International Joint Conference on Biometrics (IJCB)*, 2021; pre-print available at `https://arxiv.org/abs/2106.06583`

Jeremy Speth, Emily M. Hand, "Automated label noise identification for facial attribute recognition," *The IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW)*, 2019.

RESEARCH PRESENTATIONS

Invited Talk: Unsupervised Learning from Video   August 2023
Tidal Team at Google X
Presented SiNC, an unsupervised learning method for estimating periodic signals from video, with applications in camera-based physiology. (Hosts: Sophia Abraham and Cory Schillaci)

Presentation: Unsupervised Learning of Physiological Signals from Video   May 2023
2nd MSU-ND Computer Vision and Biometrics Workshop   East Lansing, Michigan, USA
Presented non-contrastive unsupervised learning methods for estimating the blood volume pulse and respiration from video.

Poster Presentation   March 2020
University of Notre Dame 14th Annual Poster Contest   Notre Dame, Indiana, USA
Presented large-scale data collection and multimodal camera synchronization for remote pulse estimation from visible-light video.

Tutorial Presentation   March 2019
University of Nevada, Reno Computer Vision Lab   Reno, Nevada, USA
Presented general tensor processing pipelines in TensorFlow v1 for model creation and training.

HONORS AND AWARDS

- Best Dissertation Award, IEEE Biometrics Council, 2024.
- Best Paper Award - Computer Vision for Physiological Measurement Workshop (CVPM; in conjunction with CVPR 2023), Vancouver, Canada, June 2023.
- Outstanding Reviewer - IEEE/CVF International Conference on Computer Vision (ICCV), 2023.

REVIEWS

- IET Biometrics
- IEEE Transaction on Circuits and Systems for Video Technology (TCSVT)
- Elsevier Pattern Recognition (PR)
- IEEE Transactions on Information Forensics and Security (TIFS)
- IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)
- IEEE/CVF Conferene on Computer Vision and Pattern Recognition (CVPR)
- IEEE/CVF International Conference on Computer Vision (ICCV)
- IEEE International Joint Conference on Biometrics (IJCB)
- IEEE Transactions on Biometrics, Behavior, and Identity Science (TBIOM)
- IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)