ABHIJIT SARKAR

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Dr. Sarkar is a Research Associate in the Virginia Tech Transportation Institute's Division of Freight, Transit, and Heavy Vehicle Safety, Behavioral Analysis and Applications group. He has nine years of research experience in the field of transportation safety and has been part of several federal- and state-funded projects related to the predictive analysis of driver behavior, vehicle-to-vehicle applications, naturalistic driving studies (NDSs), driver distraction and attention monitoring, and operations of heavy vehicles. His current research focuses on behavior predictive safety analysis of drivers from NDS data; traffic behavior analysis from traffic cameras; and the development of deep learning models from NDS video data for the automatic detection of driver behavior, driving context, and events outside the vehicle as they relate to roadway safety. He has served as PI and Co-PI for multiple projects. He has significant experience working with applications of computer vision, machine learning including deep learning, signal processing, statistical modeling, biometrics, physiological signal, natural language processing, and big data analysis. He has been the PI/Co-PI or Project Manager on 13 projects totaling over $3.8 million and has made significant contributions to multiple other projects. These projects include funded research projects sponsored by, Federal Motor Carrier Safety Administration (FMCSA), Federal Highway Administration (FHWA), National Science Foundation (NSF) National Highway Traffic Safety Administration (NHTSA), National Academies of Sciences Engineering and Medicine, National Surface Transportation Safety Center for Excellence (NSTSCE), Safety through Disruption (Safe-D) University Transportation Center (UTC), National Institute of Health (NIH), and numerous proprietary companies. Dr. Sarkar has more than 20 publications and technical reports, and software development experience in both academia and industry for 12 years..

SKILLS & INTERESTS

Computer Vision, Machine Learning, Cardiac Biometrics, Face Anti-spoofing, Remote Plethysmography, Signal Processing, Autonomous vehicle, Driver Safety, Deep Neural Network, Statistical Data Analysis, Affective Computing, Physiological Signals, Diver State Monitoring, V2X.

EDUCATION

- **Doctor of Philosophy** (July 2017)
  Virginia Tech *Blacksburg, VA, USA*
  - Electrical and Computer Engineering
  - Dissertation title: – *Cardiac Signals: Remote Measurement and Applications*
- **Master of Technology** (2009)
  Indian Institute of Technology Kharagpur (IITKgp) *Kharagpur, India*
  - Electrical Engineering – *Control Systems Engineering*
  - Thesis title: *Modeling and fault diagnosis of Automotive HVAC system*
- **Bachelor of Engineering** (2006)
  Jadavpur University *Kolkata, India*
  - Major: Electrical Engineering – *Instrumentation (specialization)*

RESEARCH EXPERIENCES

- **Research Associate** (Apr 2021 onwards)
  Division of Freight Transit and Heavy vehicle, Virginia Tech Transportation Institute (VTTI) *Blacksburg, VA, USA*
  - Performing cutting edge research in the field of Transportation research, human factor and artificial intelligence including machine learning, computer vision and big data analysis.
- **Research Associate** (Feb 2018- Apr 2021)
  Center for Truck and Bus Safety, Virginia Tech Transportation Institute (VTTI) *Blacksburg, VA, USA*
  - Performing cutting edge research in the field of Transportation research, human factor and artificial intelligence including machine learning, computer vision and big data analysis.

- **Research Assistant** (Jun 2017 – Feb 2018)
  Virginia Tech Transportation Institute (VTTI) *Blacksburg, VA, USA*
  – Study motion and dimension of tractor trailer using on-board monocular camera for V2V application.
- **Summer Intern** (May 2016 – Aug 2016)
  Apple Inc. *Sunnyvale, CA, USA*
  – Special project group, Software.
- **Graduate Research Assistant** (May 2012 – May 2017)
  Virginia Tech Transportation Institute (VTTI) *Blacksburg, VA, USA*
  – Research topic: Application of machine intelligence and data analysis in vehicular technology including, driver fatigue analysis, head pose estimation, motion segmentation for heavy vehicle, data watermarking, deployment of V2X technology.
- **Summer Intern** (May 2010 – Aug 2010)
  Delphi Inc. *Kokomo, IN, USA*
  – Research Topic : Optimal PWM strategy for Allison Motor
- **Graduate Research Assistant** (Aug 2009– Dec 2011)
  Department of ECE, Virginia Tech *Blacksburg, VA, USA*
  – Research topic: Sensorless control of Switched Reluctance Motor for Ramu Inc., a subsidiary of Regal Beloid.
  – Fault analysis of six phase permanent magnet synchronous machine (PMSM).
  – I have been a **graduate intern** during the Fall 2010 with Ramu Inc.
- **Graduate Trainee Engineer** (Aug 2006 – Jul 2007)
  Siemens Limited *Kolkata, India*
  – I have worked as a core team member in the sales & marketing team, Eastern India, and a system design engineer for Siemens building technology division.

PUBLICATIONS

- D. Datta, **A. Sarkar**, C. Winkowski, A. L. Abbott, J. Hickman, M. Camden, J. Sudweeks, "Detecting Gaze Location From Temporal Relations of Driver Face Pose using Recurrent Neural Network", Transportation Research Board Annual Meeting (2021, accepted)
- C. Winkowski, **A. Sarkar**, A. Svetovidov, J. Hickman, A. L. Abbott, "Residual Network-Based Driver Gaze Classification In1naturalistic Driving Studies", Transportation Research Record (2021, under review) – accepted at TRB Annual meeting 2021
- V. Sundharam, **A. Sarkar**, J. Hickman, A. L. Abbott, " Characterization, Detection, And Segmentation Of Work Zone1scenes From Naturalistic Driving Data", Transportation Research Record (2021, under review) – accepted at TRB Annual meeting 2021
- I. Papakis, **A. Sarkar**, A. Karpatne (2021), "A Graph Convolutional Neural Network Based Approach for Object Tracking Using Augmented Detections With Optical Flow", 24th IEEE International Conference on Intelligent Transportation Systems. (Accepted)
- **A. Sarkar**, H. Alabeigi, A. McDonald, G. Markulla, J. Hickman, (2021), "Role of Peripheral Vision in Brake Reaction Time During Safety Critical Events", 65th International Conference for Human Factor and Ergonomics Society (Accepted)
- **A. Sarkar**, A. Krum, R. Hanowski, J. Hickman (2021). Responsibility Sensitive Safety Analysis of Truck Following in US Highway. In International Conference on Applied Human Factors and Ergonomics (pp. 119-126). Springer, Cham.
- I. Papakis, **A. Sarkar**, & A. Karpatne, (2020). GCNNMatch: Graph Convolutional Neural Networks for Multi-Object Tracking via Sinkhorn Normalization. arXiv preprint arXiv:2010.00067
- I. Papakis, **A. Sarkar**, A. Svetovidov, J. Hichman, L. Abbott, "A CNN-Based In-Vehicle Occupant Detection and Classification Method Using SHRP 2 Cabin Images", Transportation Research Record: 0361198121998698.
- **A. Sarkar**, J. Hickman, A. McDonald, G. Markkula, W. Zhang, "Steering Or Braking Avoidance Response In Rear-End Crashes And Near-Crashes: A Decision Tree Approach", Accident Analysis and Prevention, v.*154*, p.106055, 2020.

- **A. Sarkar**, L. Stowe, A. Petersen, Tractor Trailer BSM parameters Estimation for Smart Tractor V2V deployment using Cameras. In Future Active Safety Technology towards Zero Accident (FAST-zero), Sept 2019.
- **A. Sarkar**, R. Hanowski, J. Engstrom, A Comprehensive Study on the Impact of Cut-In Events in Deployment of Truck Platooning. In Future Active Safety Technology towards Zero Accident (FAST-zero), Sept 2019.
- A.J. Krum, A. Miller, **A. Sarkar**, S. Soccolich, J. Engstrom, R.J. Hanowski, K. Grove, & J. Hickman, (under review). Naturalistic Driving Data Baseline for Highly Automated Commercial Motor Vehicle On-Highway Applications. (Contract No. DTMC7517F00058; TO DTMC7517F00058). Washington, D.C.: Federal Motor Carrier Safety Administration, USDOT.
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph. "Universal Skin Detection Without Color Information". In Applications of Computer Vision (WACV), 2017 IEEE Winter Conference on (pp. 20-28). IEEE.
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph, "Biometric Authentication Using Photoplethysmography Signals," Biometrics Theory, Applications and Systems (BTAS), Sept 2016 **(Awarded best poster)**.
- Reginald Viray, **Abhijit Sarkar**, Zachary Doerzaph, "Virginia Connected Vehicle Test Bed System Performance (V2I System Performance)", Technical Report, Connected Vehicle/Infrastructure University Transportation Center (CVI-UTC), May 2016.
- **A. Sarkar**, A. L. Abbott, Z. Doerzaph, and Kayla Sykes, "Evaluation of Video Magnification for Nonintrusive Heart Rate Measurement," IEEE International Conference on Control Measurement and Instrumentation, Jan 2016 **(Oral)**.
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph, "ECG Biometric Authentication Using a Dynamical Model," IEEE International Conference on Biometrics: Theory, Applications and Systems, Sept 2015 **(Oral)**.
- **A. Sarkar**, Z. Doerzaph, and A. L. Abbott, "Video Magnification to Detect Heart Rate for Drivers," Research report, NSTSCE.
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph, "Assessment of Psychophysiological Characteristics Using Heart Rate from Naturalistic Face Video Data," IEEE International Joint Conference on Biometrics, Sept 2014.
- L. Stowe, A. Petersen, Ujwal Krothapalli, Andrew Krum, Ryan Mott, James Petersen, Abhijit Sarkar, "Heavy Vehicle V2V Basic Safety Message and Implementation Issues for Deployment, Volume II: Final Report - Trailer Identification for BSM Implementation" Final report, National Highway Traffic Safety Administration, Washington, DC (Contract No: DTNH2214D00328L/0002, Under review.
- J. Sudweeks, **A. Sarkar**, J. P. Plummer, "Mask Validation," Final report for SHRP2 Transportation research board of the national academies, Feb 2014
- M. Mollenhauer, M. Song, A. Sarkar, Z. Doerzaph, "Driver Fatigue, Distraction, and Alerting Technology – Phase II," Final research report prepared for SBIR, Sept 2013

CONFERENCE PRESENTATION

- I. Papakis, **A. Sarkar**, A. Svetovidov, J. Hichman, L. Abbott, "A CNN-Based In-Vehicle Occupant Detection and Classification Method Using SHRP 2 Cabin Images", 100th Annual meeting of Transportation Review Board, 2021 (Accepted)
- R. Viray, **A. Sarkar**, Z. Doerzaph, "Virginia Connected vehicle Test Bed System Performance for V2I deployment", SAE WCX, 2018, ID – 18AE-0272.
- **A. Sarkar**, C. Klauer, J. Pearson, R. Hanowski, J. Hankey, "Overview and Preliminary Analysis of Canada Truck Naturalistic Driving Study", Seventh International conference on NDRS, 2018, Blacksburg, VA. (here)
- Miller, A., Sarkar, A., Klauer, C., Pearson, J., Hankey, J., Hanowski, R. (2018, October 2). Overview of Canada Truck Naturalistic Data with Crash and Near Crash Types and Comparable US Data. Transportation Association of Canada, Saskatoon, Saskatchewan, Canada.
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph, "Skin Detection for SHRP2 Face Video", Fifth International conference on NDRS, 2016, Blacksburg, VA. (here)
- **A. Sarkar**, A. L. Abbott, and Z. Doerzaph, "Assessment of physiological characteristics of Drivers Using Heart Rate from SHRP2 Face Video Data", Fourth International conference on NDRS, 2014, Blacksburg, VA. (here)

Public Dataset Creation

- Sudweeks, Jeremy; Sarkar, Abhijit; Plummer, J.P.; McClafferty, Julie; Perez, Miguel A.; Hankey, Jonathan, 2016, "Mask Head Pose Validation Study Dataset", https://doi.org/10.15787/VTT1/DAFUH5, VTTI, V4
- Sarkar, Abhijit; Papakis, Ioannis; Svedovidov, Andrei; Hickman, Jeffrey S.; Abbott, A. Lynn, 2020, "Annotation of Blurred Cabin Imagery for Passenger Detection in SHRP2 NDS Data", https://doi.org/10.15787/VTT1/WS8ORW, VTTI, V1

- Sudweeks, Jeremy; Sarkar, Abhijit; Plummer, J.P.; McClafferty, Julie; Perez, Miguel A.; Hankey, Jonathan, 2016, "Mask Head Pose Validation Study Dataset (Clipped)", https://doi.org/10.15787/VTT1/QSFIIG, VTTI, V3

External Funding

- **Title: Video analytics for automatic annotation of driver behavior and driving situations in naturalistic driving data,**
  - *Role:* Principle Investigator,
  - *Sponsor:* Federal Highway Administration
  - Contract no: 693JJ319C000004,
  - Amount Awarded: $813,574;
  - Project duration: 08/27/2019-08/26/2021.
  - Public Link: https://govtribe.com/award/federal-contract-award/definitive-contract-693jj319c000004
- **Title: Development of an Infrastructure Based Data Acquisition System (iDAS) to Naturalistically Collect the Roadway Environment,**
  - Role: Principle Investigator,
  - Sponsor: US Department of Transportation (Part of Safe-D UTC project),
  - Amount Awarded: $168,706;
  - Project duration: 01/01/2019 -01/31/2021
  - Public link: https://safed.vtti.vt.edu/projects/development-of-an-infrastructure-based-data-acquisition-system-idas-to-naturalistically-collect-the-roadway-environment/
- **Title: Analysis of car cut-ins between trucks based on existing naturalistic driving data**
  - Role: Principle Investigator
  - Sponsor: Federal Motor Carrier Safety Administration (FMCSA) , as part of National Surface Transportation Safety Center for Excellence (NSTSCE)
  - Amount Awarded: $40,000,
  - Project Duration: 05/07/2018 – 05/22/2020
- **Title: Face de-identification of drivers from NDS**
  - Role: Principle investigator
  - Sponsor: Federal Motor Carrier Safety Administration (FMCSA) , as part of National Surface Transportation Safety Center for Excellence (NSTSCE)
  - Amount Awarded: $34,000;
  - Tentative start date: Aug 2021 – Jul 2022
- **Title: Baseline Truck Analysis Phase 3**
  - Role: Principle investigator
  - Sponsor: Private
  - Amount Awarded: $250,073;
  - Tentative start date: April 2021 – Dec 2021
- **Title: Baseline Truck Analysis Phase 1**
  - Role: Principle investigator
  - Sponsor: Private
  - Amount Awarded: $39,616;
  - Tentative start date: Dec 2020 – Sept 2021
- **Title: AI and Decision Support Systems for Crash Preventability PAR Processing,**
  - *Role: Principle Co-investigator*
  - Sponsor: Federal Motor Carrier Safety Administration (FMCSA)
  - Contract no: 693JJ420D000005 / 693JJ420F000057,
  - Amount Awarded: $182,400;
  - 09/25/2020 -09/24/2021
  - Current status: Ongoing
  - Public Link: https://www.federalcompass.com/award-contract/693JJ420D000005

- **Title: EAGER: Biometric Authentication using Non-contact Cardiovascular Signals**
  - Role: Principle Co-investigator
  - Sponsor: National Science Foundation
  - Amount Awarded: $187,723
  - Project Duration:
  - Current status: Ongoing
- **Title: Introductory Research into Artificial Intelligence Uses in ADAS and ADS Technologies**
  - Role: Principle Co-investigator
  - Sponsor: NHSTA
  - Amount Awarded: $497,052
  - Project Duration: Sept 2021 – March 2023
- **Title: Wildlife Corridor Action Plan**
  - Role: Principle Co-investigator
  - Sponsor: Virginia Department of Transportation
  - Amount Awarded: $75,000
  - Project Duration: Sept 2021 – Sept 2022
- **Title: ADS On-Road Evaluation Methods for Heavy Trucks**
  - Role: Principle Co-investigator
  - Sponsor: NHSTA
  - Amount Awarded: $1,215,947
  - Project Duration: Sept 2021 – Sept 2023
- **Title: Truck Crash Avoidance**
  - Role: Principle Co-investigator
  - Sponsor: Private
  - Amount Awarded: $110,000
  - Project Duration: Sept 2020 – July 2021

COMPUTER SKILLS

- **Operating Systems:** Windows, MacOS, Linux, Unix
- **Programming Language:** Matlab (10+ years), Python, SQL, R
- **Tools and Libraries:** Tensorflow, ROS, OpenCV, PyTorch

PATENTS

- A. Sarkar, A. L. Abbott, and Z. Doerzaph, " Biometric Identification and Biometric Authentication of Individuals Using a Dynamical Model of ECG Signal." U.S. 62/215,420 (Provisional, 8th Sept 2015 – 7th Sept 2016),
- A. Sarkar, A. L. Abbott, and Z. Doerzaph, " Biometric Identification and Biometric Authentication of Individuals Using a Dynamical Model of ECG Signal." U.S. 62/383842 (Provisional, 6th Sept 2016 – 5th Sept 2017).

PROFESSIONAL SERVICES AND MEMBERSHIP

- **Professional Services**
  - Member of Academic Advisory Council: Partners for Automated Vehicle Education (In process)
- **Professional Membership**
  - IEEE
  - ITS society, IEEE
  - Biometric council, IEEE
  - Sensors council
- **Technical Reviewer (Exact number may be updated)**
  - WCX17: SAE World Congress Experience.

- Information Fusion, Elsevier (Total Review – 12).
- SAE, JACV (Total Review – 8)
- Applied Sciences — Open Access Journal (Total Review – 1)
- EURASIP Journal on Information Security
- Transportation Research Record (Total review: 1)
- Winter Conference of Computer Vision, 2021 (Total review: 2 papers)
- Automated Vehicle Safety, 2020 (Total review – 3)

- **Mentorship (Thesis/ GRA supervision)**
  - Surendrabikram Thapa (MS, CS, Virginia Tech)
  - Yogesh Deshpande (M. Engg, ECE, Virginia Tech)
  - Ioannis Papakis (MS, CS, Virginia Tech), serving as Co-advisor (thesis) – Expected completion May 2021
  - Andrei Svetovidov (PhD, CS, Virginia Tech)
  - Han Xu (MS, ECE, Virginia Tech), serving as Co-advisor (thesis) – Expected completion Dec 2021
  - Shagun Johari (MEngg, ECE, Virginia Tech), served as committee member– Completed July 2021
  - Vaibhav Sundharam (Mengg, ECE, Virginia Tech), served as committee member– completed July 2021
  - Hsin Han Hsieh (MEngg, ECE, Virginia Tech), serving as committee member – Expected completion Dec 2021
  - Yu Guo – (MEngg, ECE, Virginia Tech), Technical advisor, Completed May 2020.
  - Prerit Jain – (MEngg, ECE, Virginia Tech), Technical advisor, Completed Oct 2020.
  - Past Graduate students: Wenyan Huang, Frederik Schewe
  - Virginia Tech Graduate Undergraduate Mentoring Program (Spring 2017)

- **Invited Talk**
  - "Role of Computer Vision in Transportation Research and Autonomous Vehicle"- presented at Kalyani University, India
  - "Computer Vision and Machine Learning for Autonomous Vehicle" – invited lecture in the BMSE 5984, Virginia Tech, Fall 2018. (Teaching)
  - "Computer Vision and Machine Learning for Autonomous Vehicle" – invited lecture in the BMSE 5984, Virginia Tech, Fall 2020. (Teaching)

SCHOLASTIC HONORS

- CESCA outstanding student award, 2017, Virginia Tech.
- Best poster award at IEEE BTAS, 2016.
- Selected for Doctoral Consortium at IEEE BTAS 2017, IEEE WACV 2017.
- Selected for Doctoral Consortium at IEEE BTAS, 2016. My mentor was Prof. Mark Nixon.
- Received Bronze at Virginia Tech Annual GSA Symposium for oral presentation.
- Research grant from National Surface Transport Safety Center for Excellence (NSTSCE), Jan 2014 – Dec 2014.
- Ministry of Human Resource Development (MHRD) scholarship for Masters study, Aug 2007 – May 2009.
- All India Rank 174 (19000 students) in Graduate Aptitude Test in Engineering (Electrical) – 2006.