Collaborative with SEMI MSEC 2020

Call for Participation: Industry – University Virtual Meeting
Sensors and Machine Learning
Industry-University Event, October 13-14, 2020, 10:30am-12pm
R&D Industry Presentations, Workforce Programs, Virtual Graduate Research Posters

Virtual Meeting on Zoom – Link to be sent after registration

Includes Tiny Machine Learning (TinyML™) Seminars

TinyML is trademark of the TinyML foundation.

Event Sponsored in part by the ASU SenSIP Center

Registration is free but Required – Register Here - Zoom URL will be send after Registration

sensmach.asu.edu

SensMACH 2020 PROGRAM

Tuesday October 13th 2020

Session Chair: Steve Whalley

Opening Remarks, Steve Whalley, Evgeni Gousev, Andreas Spanias

10:30-10:50 – Mike Stanley, Andreas Spanias and Kristen Jaskie
Intro to SensMach, Work Force Development and available learning material

10:50-11:10 – Jamie Lin, Qualcomm, Principal Engineer, Qualcomm AI Research
Tiny Orchestra: A Schedule Under Constraint

11:10:11:15 Virtual ML Posters Covered by Elevator Pitch session from ASU SenSIP Ph D students
Sameeksha Katoch, Kristen Jaskie, Gowtham Muniraly, Vivek Narayanaswami, PhD students (posters on web site)

11:15-11:35 – Daniel Situnayake, Founding tinyML Engineer, Edge Impulse
Embedded machine learning in the real world

11:35-11:55 – Suren Jayasuriya, Assistant Professor, ASU ECEE, AME, SenSIP
Software-defined Imaging: Challenges and Opportunities

11:55-12:05 – Q&A with the Speakers

Wednesday October 14th 2020

Session Chair: Kristen Jaskie

10:30-10:50 – Adam Fuks – NXP, Director of Hardware/Software Architecture, BL Advanced Analog, NXP Semiconductors
Tiny Neural Networks for sensor data analysis

10:50-11:10 – William Clark, Director of GDMS Quantum Laboratory General Dynamics
Quantum Communications and Sensing at General Dynamics

11:10-11:15 Virtual ML Posters Covered by Elevator Pitch session from ASU SenSIP Ph.D students
Ms. Odrika Iqbal, Uday Shankar and Sunil Rao (posters on web site)

11:15-11:35 – Kris Ardis, Executive Director, Micros, Security & Software Business Unit - Maxim Integrated
Cutting the AI Power Cord: Technology to Enable True Edge Inference

11:35-11:55 – Charu Srivastava, Intel, Architect, Client and Computing Group
Building Personal Computing Devices with Sensing at Intel

11:55-12:05 – Q&A with the Speakers
Adjourn

Organizations Participating in SensMACH 2020 Include:

Industry-University Workshop on Sensors & Machine Learning

SensMACH 2020

A Virtual Event: October 13-14, 2020 - 10:30AM - 12pm

In collaboration with the

Semi MEMS & Sensors Executive Congress, MSEC2020 and the **tinyML Foundation**

The ASU Sensor Signal and Information Processing (SenSIP) center will hold an industry-university collaborative *Sensors and Machine Learning* workshop on October 13-14, 2020 - 10:30am - 12pm.

SENS|MACH Program Highlights

- Industry/University Talks: Sensors, Tiny^{ML}, Embedded Machine Learning, Quantum Computing Workforce Programs on Machine Learning / Panel and Virtual Student Poster Presentations

SensMACH registration will provide access to the SensMach program

SENSMACH Register online: http://sensmach.asu.edu

Event Co-sponsored by ASU SenSIP NSF I/UCRC

Contact: **sensip@asu.edu**

sensmach.asu.edu

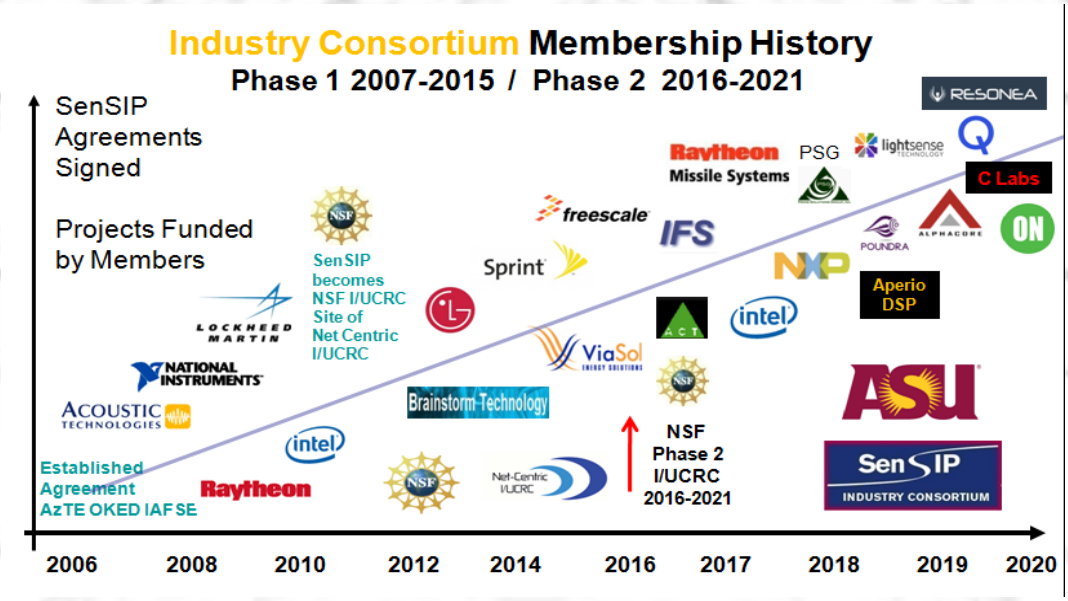
SensMACH is a workshop event launched by the ASU SenSIP Center (NSF I/UCRC)

Collaborator Info:

The MEMS and Sensors Executive Conference 2020 is designed for senior executives across the MEMS and sensors area and adjacent industries. MSEC covers Industry economic and business updates from different aspects of the ecosystem, together with forward-looking strategic and technology trends. Areas covered by MSEC include key technologies and markets in medical, sensors for entertainment and augmented reality, environmental, food/agriculture, and wearable devices. The growth in existing and emerging opportunities in MEMS and sensors together with the resulting new software and systems needs are also covered. More at: MSEC 2020

tinyML Foundation is a non-profit professional organization focused on supporting the fast-growing branch of ultra-low power machine learning technologies dealing with machine intelligence at the very edge of the cloud. These integrated "tiny" machine learning applications require "full-stack" (hardware, system, software, and applications) solutions including machine learning architectures, techniques, and approaches capable of performing on-device analytics. A variety of sensing modalities (vision, audio, motion, environmental, health monitoring, etc.) are used with extreme energy efficiency, typically in the single milliwatt (and below) to enable ML at the boundary of the physical and digital worlds. More at tinyML

The sensors signal and information processing (SenSIP) center and industry consortium was established in 2007. SenSIP houses use-inspired research and trains students in areas that include sensor and information systems, machine learning, digital signal and image processing, and wireless sensor networks. Applications addressed include integrated sensing, biosensors, security, sustainability, 5G and low power systems, radar, and vehicular sensing. The center is also an Industry/University Cooperative Research Center (I/UCRC) sponsored by NSF and several industry members and government labs. Industry members of SenSIP include: CI Labs, NXP, ON Semi, Qualcomm, Raytheon, Sprint (T-mobile) and several SBIR type companies: Alphacore, Lightsense, PSG, Poundra and Resonea. The membership history since 2007 is shown below:



Tutorial Info on Sensors and Machine Learning

In previous live SensMACHs we held a tutorial session on machine learning which this year it could not be scheduled. We intend though to schedule this SensMACH tutorial in the near future. Information below:

Short Course: A Primer on Machine Learning for Industry Engineers and Managers

Description of Course: This tutorial provides an introduction to the principles and applications of machine learning algorithms, software and applications. The tutorial begins with an introduction to the basics of pattern matching, feature extraction, and supervised and unsupervised learning. The lecture then covers basic methods such as the k-means, support vector machines, neural nets and deep learning. The coverage is at at high level for beginners featuring functional block diagrams, qualitative descriptions, and software examples. The course connects algorithms with sensor applications including health monitoring, IoT, and security applications.

Topics: Qualitative Overview, What is machine learning?, Use in Sensors and Big Data, Algorithms and Software, Beginings from Vector Quantization and Cell Phones, Feature Extraction, K-means, Adaptive Neural Nets, Support Vector Machines, Bayesian Methods, Deep Learning, Embedding machine learning on sensor boards, Applications; IoT, health monitoring, security; smart campus, smart cities; social implications, software tools, embedded ML.

Useful SenSIP Related References and Survey Papers:

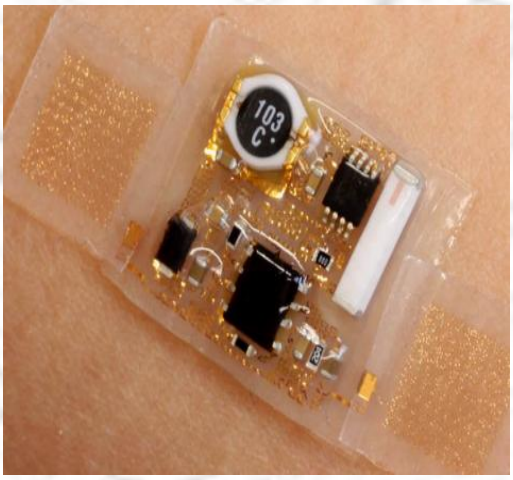
M. Stanley and Jong Ming Lee, Sensors for IoT Applications, March 2018, ISBN 9781627054638, editor Andreas Spanias, Synthesis Lectures Algorithms and Software, Morgan and Claypool Publishers, 113 Pages.

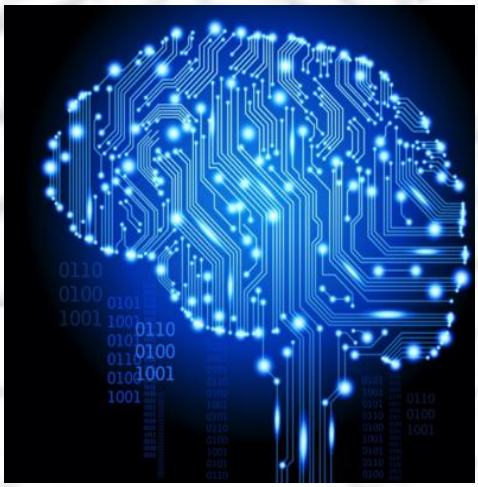
K. Jaskie and A. Spanias, "Positive and Unlabeled Learning Algorithms and Applications: A Survey," Proc. IEEE IISA 2019, Patras, July 2019

U. Shanthamallu, A. Spanias, C. Tepedelenlioglu, M. Stanley, "A Brief Survey of Machine Learning Methods and their Sensor and IoT Applications," Proceedings 8th International Conference on Information, Intelligence, Systems and Applications (IEEE IISA 2017), Larnaca, August 2017.

S. Rao, S. Katoch, V. Narayanaswamy, G. Muniraju, C. Tepedelenlioglu, A. Spanias, P. Turaga, R. Ayyanar, and D.Srinivasan, "Machine Learning for Solar Array Monitoring, Optimization, and Control," Synthesis Lectures on Power Electronics, Morgan & Claypool, Ed. J. Hudgins, Book, 91 pages, ISBN: 9781681739076, Aug.. 2020.

Sensors **Machine Learning** **IoT**





Presentation Abstracts - SensMACH 2020

Michael Stanley[+], Andreas Spanias and Kristen Jaskie, ASU SenSIP, +Former NXP Scientist

This presentation describes collaborative industry research and workforce development training programs on machine learning of SenSIP at ASU. The bulk of the presentation will focus on exploring content and the structure of an introductory course on machine learning (under development) which emphasizes intuition over mathematics in understanding machine learning techniques. Some of this work was motivated by work done at NXP on embedded machine learning and also by parallel work done at ASU as part of the SenSIP-NXP consortium relationship on embedded sensor systems.

Tiny Orchestra: A Schedule Under Contraint, Jamie Lin, Qualcomm

Neural networks have been increasingly popular on edge and tiny devices. In this talk, we will start with a motivation to highlight the significance of neural network scheduling under resource constraints. We will then discuss about some practical techniques towards optimal scheduling.

Embedded machine learning in the real world, Daniel Situnayake

Advances in machine learning and edge compute mean sophisticated ML models can now run on ultra-low-power microcontrollers, extracting meaning from raw sensor data without the need for connectivity. This fast-paced and exciting talk will introduce the audience to the state of the art in embedded machine learning, explore what is possible with today's tools, and highlight some of the use cases that promise to make it a key technology of the next decade

Software-defined imaging: Challenges and opportunities, Suren Jayasuriya, ASU

Software-defined imaging is an emerging paradigm where vertically-oriented research across algorithms, software and hardware enable image sensing to be energy-efficient, configurable, and adaptive to environmental conditions. This can leverage sensor primitives or knobs such as quantization, regions-of-interest, quantization, and exposure effectively for feedback systems and optimized image capture. In this talk, I'll present a variety of works on predictive object tracking and adaptive quantization for energy-efficient computer vision. In particular, I'll focus on recent work analyzing RAW images and their quantization for visual SLAM, an important use-case in robotics. This is the just the beginning of research efforts to allow visual computing of the future to fully exploit the programmability and flexibility of image sensor hardware

Tiny Neural Networks for sensor data analysis, Adam Fuks, NXP

Machine Learning (ML) is quickly becoming pervasive in many applications due to its ability to extract and summarize information in such a way, that seemingly intelligent decisions can be made based on its output. Although this capability has been long known about, the last few years have brought major advances in several aspects which make ML capable to shrink to a tiny footprint. The major advances include :

- Model training improvements
- Quantization from Floating Point to small fixed point integers
- Innovative new NN topologies

In this presentation we will be looking at a couple of innovative topologies known as Temporal Convolutional Networks (TCN) and Autoencoders which can be implemented cheaply in hardware but also bring the promise of low memory-footprint Time Series Analysis as well as in-situ training for Anomaly detection respectively.

Quantum Communications and Sensing at General Dynamics, William Clark, General Dynamics

General Dynamics Mission Systems specializes in the research, design, development and transition of advanced communications and sensing systems for Customers in the Federal, Defense and Intelligence communities. In this

presentation, we will share some of our open research in Quantum entanglement-enhanced communications and sensing, and a glimpse of the future these technologies may enable.

Cutting the AI Power Cord: Technology to Enable True Edge Inference, Kris Ardis, Maxim Integrated
AI and deep neural networks promise to open up inventions we haven't even dreamed of, but our best technologies to give machines the ability to see and hear are power hungry and costly. Maxim is working on new technology that will enable AI to exist at the true edge of the IoT, giving embedded devices intelligence while running off a battery

Building Personal Computer Devices with Sensing at Intel, Charu Srivastava, Intel
A brief look at the challenges of system design, development & integration of sensing capabilities that make personal computing devices smarter and adaptable to users and their environment

SensMACH Industry-University Workshop Organizers

Stephen Whalley has 30+ years of experience in the semiconductor, MEMS, and sensors industries in various design, applications, ecosystem creation, marketing, and strategy management roles. He has a strong strategy and business acumen, as well as the ability to drive complex cross-industry initiatives and collaborative industry ecosystem building. Steve's career includes more than 25 years with Intel Corporation in pan-European and US functions, where he directed multiple product and technology development programs. He has led and served on multiple industry association and advisory boards in the semiconductor, MEMS, and sensors arenas impacting numerous successful technology developments such as USB, PCI, and others.Steve earned a Bachelor of Science Degree in Electrical Engineering, graduating with Honors from the University of Salford, England. He also received a Master's Degree in International Management from the American Graduate School of International Management at Arizona State University ("Thunderbird") in Phoenix, Arizona. Steve's most recent roles have been with Microtech Ventures as a managing director for mergers and acquisitions and as a strategic consultant to SEMI's MEMS and Sensors Industry Group (MSIG).

Evgeni Gousev is a Senior Director of Engineering in Qualcomm Research. He leads HW R&D org in the Silicon Valley Center and is also responsible for developing ultra low power embedded computing platform, including always on machine vision AI technology. He has been with Qualcomm Technologies, Inc. since 2005 after joining from IBM T.J. Watson Research Center where he drove projects in the field of advanced silicon technologies. From 1993 to 1998, Dr. Gousev held academic professorship appointments with Rutgers University and Hiroshima University (1997). Evgeni holds a M.S. degree in Applied Physics and a Ph.D. in Solid-State Physics. He has co-edited 24 books and published 163 papers and is an inventor on more than 60 issued and filed patents.

Andreas Spanias is a professor in Electrical at Arizona State University (ASU). He is also the director of the Sensor Signal and Information Processing (SenSIP) center and the founder of the SenSIP industry consortium (also an NSF I/UCRC site). His research interests are in the areas of speech processing, machine learning and sensor systems. He and his student team developed the computer simulation software Java-DSP. He is author of two textbooks on Audio Coding and DSP. He contributed to more than 300 papers, 10 monographs ,11 full patents, 10 provisional patents. He served as Associate Editor of the IEEE Transactions on SP and as General Co-chair of IEEE ICASSP-99. He also served as the IEEE Signal Processing Vice-President for Conferences. Andreas Spanias is co-recipient of the 2002 IEEE Donald G. Fink paper prize award and was elected Fellow of the IEEE in 2003. He was elected Distinguished Lecturer for the IEEE Signal processing society in 2004. He received the 2018 IEEE Region 6 Educator Award (across 12 states). He was elected recently as Senior Member of the National Academy of Inventors (NAI).

Presenters at SensMACH 2020

Mike Stanley spent almost four decades in the semiconductor field at Motorola, Freescale and NXP in areas ranging from circuit design to machine learning. He is author/co-author of 8 patents, numerous publications, and is a contributor to Measurement, Instrumentation and Sensors Handbook, 2nd edition. Mike was inducted into the MEMS & Sensor Industry Group Hall of Fame in 2015 and is a Senior Member of the IEEE and IEEE Standard 2700-2014 contributor. He co-authored "Sensor Analysis for the Internet of Things", published in 2018 by Morgan & Claypool Publishers. Mike continues his association with the Sensor, Signal & Information Processing Center (SenSIP) at A.S.U. and is one of the organizers for the Phoenix Chapter of the TinyML organization.

Kris Ardis is an Executive Director in the Micros, Security & Software Business Unit at Maxim Integrated. He began his career with Maxim as a software engineer and holds two U.S. patents. In his current role, Ardis is responsible for Edge Artificial Intelligence accelerators, Secure and Low Power Microcontrollers, and Software Algorithms. He has a B.S. in Computer Science from the University of Texas at Austin

Dr. William Clark, Director of Quantum Laboratory | Fellow General Dynamics Mission Systems (GDMS). William earned his Ph.D. in Theoretical Atomic, Molecular and Optical (AMO) physics from the University of Colorado, Department of Physics and the JILA Quantum Physics Institute in Boulder, Colorado in 1998. William has more than two decades of industry experience in Systems design, development and integration of next generation tactical and strategic communications systems, including software defined radio and networking technologies, and active and passive sensing systems. William is the director for the GDMS Quantum Laboratory, leading Quantum R&D projects in support of Space and Intelligence Systems (SIS), Ground Systems (GS) and the Maritime and Strategic Systems (M&SS) business areas, exploring the practical use of quantum technologies for secure and covert communications, remote sensing and signal processing

Adam Fuks, Director of HW/SW Architecture in NXP Semiconductors, graduated with First Class Honors in Electronics and Micro-Electronics Engineering from Brunel University, United Kingdom in 2000. In his 20 year career he has been working on Low Power, efficient Application Processors, MCUs and DSPs, both in terms of VLSI hardware architecture/design and also Algorithms/Applications/Embedded software. His particular areas of specialization are Digital Signal Processing and Artificial Intelligence. Adam has been doing work on algorithm investigations as well as hardware design for ML acceleration.

Kristen Jaskie is a Ph.D. student with SenSIP in the Electrical Engineering department at ASU, advised by Dr. Spanias and specializing in Machine Learning and Signal Processing. She received her B.S in Computer Science from the University of Washington and her M.S. in Computer Science specializing in AI and Machine Learning (ML) at the University of California San Diego. She owns her own consulting company and was a faculty member and department chair in Computer Science at Glendale Community College. Her research has been focused on semi-supervised learning and solving the Positive Unlabeled learning problem. She is writing a monograph on the subject to be published early next year. Kristen has applied this work to solar panel fault modeling, Covid-19 detection research, and remote sensing.

Suren Jayasuriya is an assistant professor jointly between the departments of Arts, Media and Engineering (AME) and Electrical, Computer, and Energy Engineering (ECEE). Before, he was a postdoctoral fellow at the Robotics Institute at Carnegie Mellon University. He received his doctorate in 2017 from the ECE Department at Cornell University, and a bachelor's in mathematics and in philosophy from the University of Pittsburgh in 2012. His research focuses on designing new types of computational cameras, systems, and visual computing algorithms that can extract and understand more information from the world around us.

Jamie Lin is a Principal Engineer at Qualcomm AI Research (QAIR), where he works on neural network architecture and acceleration design. Prior to joining QAIR, he worked on wireless signal processing design in 3G, 4G, and 5G. He received his M.S.E.E. degree from Purdue University, and holds more than 80 granted patents globally.

Daniel Situnayake - Founding TinyML Engineer at Edge Impulse. Daniel is a technical leader in the field of embedded machine learning, known also as TinyML. He authored the field's leading textbook, and sits on the organizing committee of an international network of over 3,700 embedded machine learning engineers. He currently heads TinyML R&D at Edge Impulse, the leading startup in the embedded machine learning space. Daniel previously led developer outreach for edge machine learning technologies at Google.

Charu Srivastava is an Architect in the Client and Computing Group at Intel Corporation. She is focused on building personal client's platforms with low power sensing features. She joined Intel in 2010 and has worked as a technologist on various products like Wireless Display & Miracast Standards, Graphics, RealSense 3D camera, Visual Processing Units and Ultra Low power integrated cameras. Originally from India, she lived in Bahrain and Muscat during her growing years. She earned her bachelor's degree in Computer Engineering from National Institute of Technology, India and her master's in Computer Science (Embedded Systems) from University of California, Irvine. She is married and has two children.

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PhD Students of ASU SenSIP Presenting

Odrika Iqbal is a PhD student at Arizona State University in the School of Electrical, Computer and Energy Engineering (ECEE). She is co-advised by Dr. Andreas Spanias and Dr. Suren Jayasuriya. She did her bachelor's in Electrical and Electronic Engineering at Bangladesh University of Engineering and Technology. She is a research associate with the SenSIP center. Her research interests include computational imaging, computer vision and tiny ML for embedded computer vision systems.

Sameeksha Katoch is a Ph.D. student in electrical engineering at Arizona State University (ASU). She received her Masters in electrical engineering from ASU in 2018 and a Bachelors in electronics and communication engineering from the National Institute of Technology, Srinagar, India, in 2015. She has interned with Lawrence Livermore National Laboratory and Prime Solutions Group, Inc. over the past summers. She is a research associate with the SenSIP center and her research interests include developing privacy conscious deep learning models for applications in healthcare and utilizing task/domain semantics for understanding and improving deep learning model performance on a wide variety of tasks.

Vivek Sivaraman Narayanaswamy received his bachelor's degree in electronics and communication engineering from S.S.N College of Engineering, Anna University, Tamil Nadu, India, in 2017. He is currently a Ph.D. student in the school of electrical, computer and energy engineering at ASU, Tempe, AZ. He is a research associate with the SenSIP center. He has interned with Lawrence Livermore National Laboratory (LLC) during the summers of both 2019 and 2020 where he worked upon developing solutions for inverse problems and explainable AI respectively. He also interned with Qualcomm R&D during the summer of 2018. His research interests include applications of machine learning for signal processing applications. In particular, he works in using machine leaning for speech and audio applications, inverse problems, and explainable AI. He is also keenly interested in working upon machine learning tools that can be utilized for solar array monitoring.

Uday Shankar Shanthamallu is currently a Ph.D. student in electrical engineering at Arizona State University (ASU). He received his Master's degree in electrical engineering from ASU in 2018 and a Bachelor's degree in electronics and communication engineering from the National Institute of Engineering, India, in 2011. He is a research associate with the SenSIP center and his research interests include representation learning for graphs using machine learning and deep learning techniques. He is currently working on building robust graph neural network models to defend against graph adversarial attacks. He has interned with Lawrence Livermore National Laboratory during the summers of 2019 and 2020 where he worked on building predictive models for the human brain connectome. He has also worked on sensor data analytics for anomaly detection while interning at NXP Semiconductors.

Kristen Jaskie is a Ph.D. student with SenSIP in the Electrical Engineering department at ASU, advised by Dr. Spanias and specializing in Machine Learning and Signal Processing. She received her B.S in Computer Science from the University of Washington and her M.S. in Computer Science specializing in AI and Machine Learning (ML) at the University of California San Diego. She owns her own consulting company and was a faculty member and department chair in Computer Science at Glendale Community College. She is a research associate with the SenSIP center Her research has been focused on semi-supervised learning and solving the Positive Unlabeled learning problem. She is writing a monograph on the subject to be published early next year. Kristen has applied this work to solar panel fault modeling, Covid-19 detection research, and remote sensing.

Gowtham Muniraju received the B.E. degree in electronics and communications engineering from Visvesvaraya Technological University, India, in 2016, and the M.S. degree in electrical engineering from Arizona State University, Tempe, AZ, USA, in 2019. He is currently pursuing the Ph.D. degree with the School of Electrical, Computer and Energy Engineering, Arizona State University. He is a research associate with the SenSIP center and his research interests include distributed computation in wireless sensor networks, distributed optimization, computer vision and deep learning. He has interned at Lawrence Livermore National Labs as a student research intern, NXP semiconductors as a machine learning intern and MathWorks as a EDG intern at statistical machine learning group.

Sunil Rao received a B.E. degree in electronics and communications engineering from Visvesvaraya Technological University, India, in 2013, and an M.S. degree in electrical engineering from Arizona State University, Tempe, AZ, USA, in 2018. He is currently pursuing a Ph.D. degree at the School of Electrical, Computer, and Energy Engineering, Arizona State University. His research interests include solar array fault classification using machine learning, signal processing, and deep learning. He is a research associate with the SenSIP center. He has interned at Robert Bosch LLC as an audio analytics intern in the Human Machine Interface (HMI) group. Sunil is also a recipient of the IEEE Irv Kaufman student award in 2018.

Robina Sayed is the SenSIP business operations specialist at Arizona State University He has been with Arizona State University since 2016. She organized several SenSIP events including the annual SensMACH industry meeting.