RET Site: NSF Research Experiences for Teachers (RET)
on Sensors and Machine Learning

PI: Andreas Spanias, SenSIP RET Director
Co-PIs: Jennifer Blain Christen, Jean Larson, Mi Yeon Lee
SenSIP Center, ASU

This project is funded by NSF Award 1953745.

People Involved

RET Objectives

A.1 RET Site Objectives

a) introduce teachers/instructors to research by immersing them in government and industry projects;
b) engage instructors in machine learning research and software for sensor and IoT applications;
c) enable instructors to transfer STEM ML concepts from this RET to their classes;
d) immerse participants in training where they present teaching plans to their peers and the RET -C;
e) provide year-round engagement with high schools and community colleges to achieve outcomes;
f) assess all learning and research activities using external evaluation;
g) recruit instructors and teachers who have a deep commitment to diversity and a culture of inclusion;
h) enable participants to train future teachers and instructors in the RET areas;
i) work with RET participants to co-author archival research and education papers;
j) disseminate lesson plans to TeachEngineering.org and align plans with national standards.

Our overarching goal is to instill innovation skills in RET participants and enable them to create, use and disseminate teaching materials that will energize and attract students in STEM areas.

Planned RET Activities

- Participants must complete orientation and several training sessions (fire, IT, lab hazzards, etc)
- Participants will be assigned to different research labs;
- Research assignments will be given to all participants;
- Participants will have a graduate mentor (typically a PhD student);
- All Participants will complete modules and quizzes;
- All Participants will present 2 slides per week on their progress;
- Participants will attend a technical seminar once a week;
- Participants produce an IEEE style report at the end of the experience
- Participants will present posters twice; on June 22 and on July 24
- Participants produce a lesson plan
- Participants are required to implement the lesson plan in class

Modules/ Hybrid Online Schedule
- Subject to Change

SenSIP Hybrid RET Schedule 2020 – Subject to Change

Dates: May 26 – June 30, 2020 (5 weeks) at Arizona State University			Senior Investigators: Andreas Spanias, Jennifer Blain Christen, Jean Larson K. Jaskie – Coordinator / ML Training, R. Sayed: Logistics, M. O'Donnell Assessment		
Expectations: (1) Participate in 5-week virtual program (5/26-6/30) (2) Participate in 4 in-person lab experiences (when available) (3) Develop, present, and implement a lesson plan based on SenSIP research (4) Present a research poster					
	MON	TUES	WED	THURS	FRI
WEEK 1: **5/25 - 5/29** *Synchronous*	Memorial Day	Preparations Access to RET Canvas	ZOOM: 11:30am Intro to SenSIP Research Kick off meeting Intro (**Spanias**) (**Kristen** 20 mins.) **Ruby, Jean** Q&A	ZOOM: 11:30am RETs complete required trainings Safety IT Training	ZOOM: 11:30am Intro to Python RETs first 3 slide report Q&A Begin Work on Abstract Proposal
Asynchronous			**Canvas**: Week 1 Module: Learn more about SenSIP - training module, webinar videos, knowledge check	**Canvas**: Week 1 Module: Learn more about SenSIP - training module, webinar videos, knowledge check	**Canvas**: Week 1 Module: Learn more about SenSIP - training module, webinar videos, knowledge check
WEEK 2: **6/1 - 6/5**	ZOOM: 11:30am	ZOOM: 11:30am	ZOOM: 11:30am	ZOOM: 11:30am	ZOOM: 11:30am

Goldwater Center Labs of Fulton Schools of Engineering

ASU Fulton Schools of Engineering Honor Code

Given the profound impact of engineering on public health, safety and welfare, I recognize the great importance of ethics to the engineering profession. I further recognize that integrity and ethical behavior as an engineer are directly linked to academic integrity and ethical behavior as an engineering student. In recognition of these principles, I promise to act in accordance with ASU's Academic Integrity Policy and Student Code of Conduct at all times, and to encourage others to do the same. Specifically, I affirm that I will:

•Seek out, acquaint myself with, and obey the instructor's rules concerning the materials I am allowed to use and the types of collaboration in which I am permitted to engage in each of my courses.
•Help my fellow engineering students to succeed both academically and professionally, while both following the instructor's guidelines on collaboration and encouraging my classmates to behave ethically.
•Ensure that all of my individual work products reflect my own abilities and not those of someone else. I will never copy the work of others or give others the opportunity to copy mine.
•Contribute a fair share of work to all teamwork in which I participate, and acknowledge the contributions of others. I will accept responsibility for the integrity of all work submitted by my team.
•Use only aids authorized by the instructor during all examinations, quizzes, projects, assignments and other evaluations.
•Provide aid to, or receive aid from other students only as permitted by the instructor.
•Give full credit to others for their words and ideas, whether directly quoted or paraphrased, using proper citation practices in all of my work, including text, figures and computer code, and all materials obtained from the Internet.
•Never act dishonestly including lying, cheating, stealing, or attempting to corrupt the academic enterprise in any way.
•Ensure that all data I record or report are objective, true, accurate and properly documented.
•Treat all students, faculty and staff with respect, courtesy and dignity, the way I would like to be treated myself.
•Recognize that it is how I act when no one else is watching that defines my true character.
•Act at all times with integrity, as the true professional that I am to become.

IEEE Code of Ethics

ASU Fulton Schools of Engineering Honor Code

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;

to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

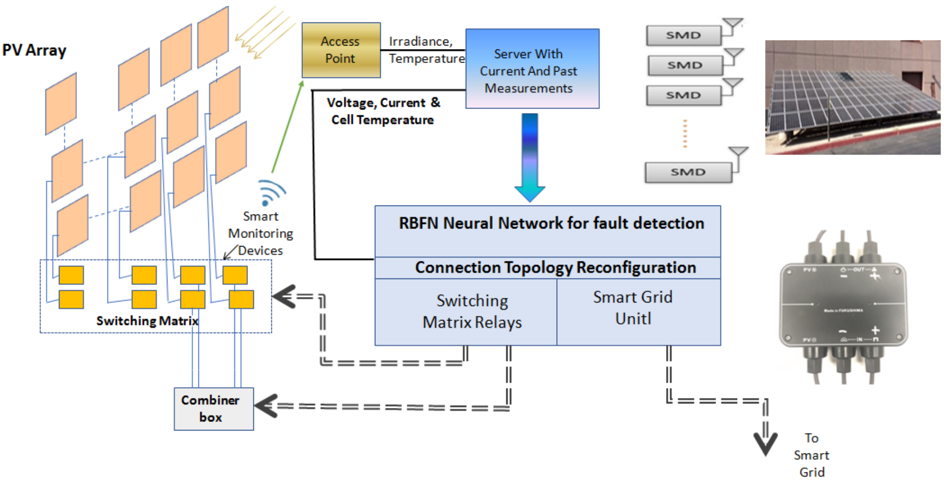
to be honest and realistic in stating claims or estimates based on available data;

to reject bribery in all its forms;

to improve the understanding of technology; its appropriate application, and potential consequences;

to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

Solar System Fault Detection
Advisors: Kristen Jaskie and Andreas Spanias



Machine Learning for Fast Short-Term Energy Load Forecasting

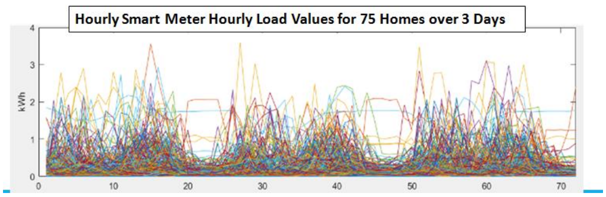
Advisors: Kristen Jaskie and Andreas Spanias

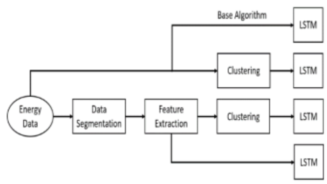
Short-term energy load forecasting is the prediction of energy use one day to one week in the future.

Accurate short-term energy load forecasting is essential for:

- Improving energy efficiency
- Reducing blackouts

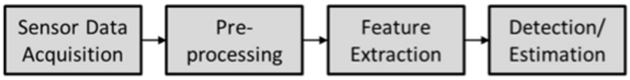
Problem: Improve short-term load forecasting using machine learning techniques and smart meter.





Create Lesson Plan

Technical Topics for Signal Processing for Sensors
Advisor: Andreas Spanias
Graduate Advisors: Kristen Jaskie, Uday Shankar, Sunil Rao



- We will learn about signal acquisition
- Pre-processing and signal segmentation
- Filtering and Elements of Filter Design
- Spectral Estimation Methods and FFT
- Feature Extraction
- K-means algorithm
- MATLAB skill building
- ML Projects

Python / MATLAB Skill Building
GWC 402 and GWC 408

- Will have to complete two video streamed modules
- Most Participants will complete two exercises

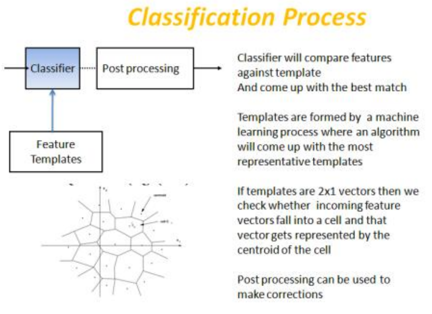
- Learn how to process digital signals from mic sensors
- Learn how to denoise signals
- Learn how to compress signals

Other Signal Processing Modules
A. Spanias

- •Module on Sampling, Quiz
- •Module on Filtering, Quiz
- •Module on FFT and Spectrograms, Quiz
- •Module on Machine Learning, Quiz
- •Module on Project

Machine Learning
Andreas Spanias, Kristen Jaskie and Uday Shankar

- •Learn and program in Python the k means algorithm
- •Cluster data from sensors



Embedded Machine Learning
Andreas Spanias, Kristen Jaskie and Uday Shankar

•Program a machine learning algorithm on an embedded sensor board

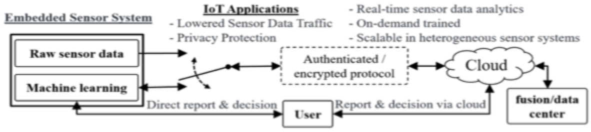
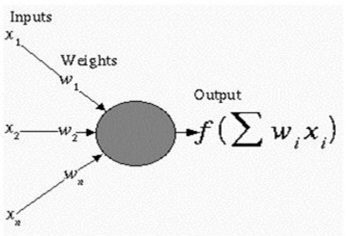
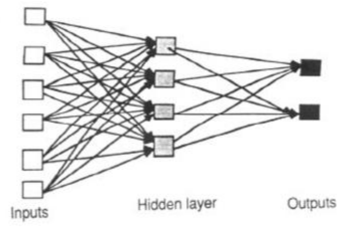


Fig. 2. Embedded sensor and machine learning platforms.

Introduction to Deep Learning
Kristen Jaskie, Uday Shankar

• Complete Module
•Simulation of a simple multi-layer Neural Net





Programming with MATLAB / Python

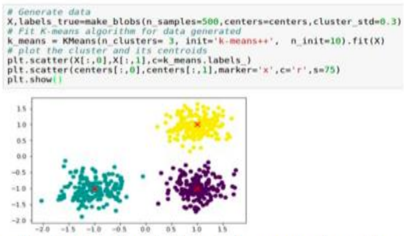


Fig. 7a. Python Simulation for k-means clustering.

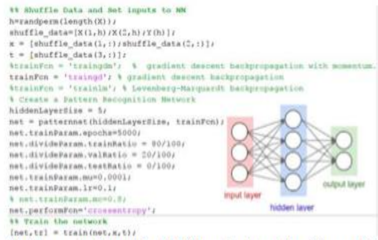


Fig. 7b Sample MATLAB Simulation for Neural Net.

Intro with J-DSP

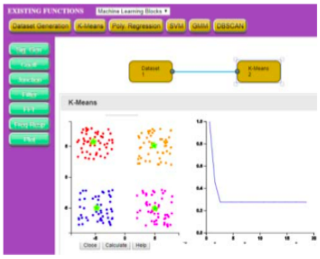


Fig. 6. ASU Custom User-friendly and freely available J-DSP software for ML will be used in the boot camp for online simulations and for understanding basics of ML and DSP algorithms.

In Fig. 6 our object-oriented DSP program, that was used successfully in our REU site and in high schools, is shown. J-DSP has now ML functions to enable participants to run online simulations. RET participants and their students can understand quickly ML clustering concepts using J-DSP [18,103, 130,131].

Several other SenSIP Programs including REU, RET and IRES Participants Recruited from Across the USA

Physiological Monitoring for Childhood

AsthmaSchylar Martinez, Graduate Mentors: Hany Arafa and Paul Stevenson, Faculty Advisor: Dr. Jennifer Blain-Christen

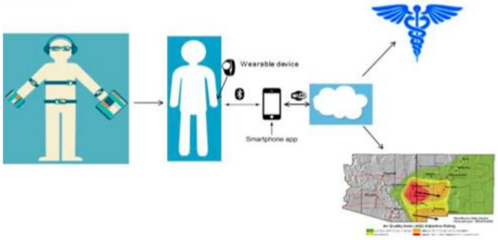
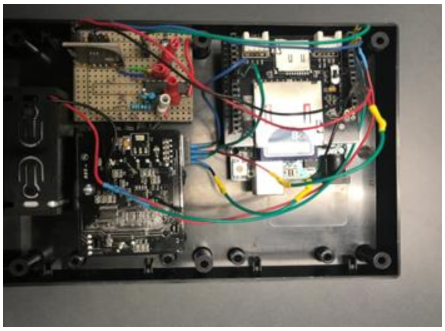


Figure 1: Diagram of how the wearable device will share data with patients, healthcare providers, and environmental maps

Managing Respiratory Disease with Wearable Devices

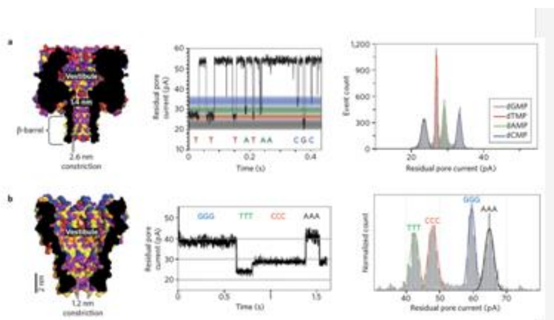
Nandini Sharma, Paul Stevenson, Hany Arafa, Jennifer Blain Christen



Nanopore Sensors and Signal Processing

Melvin Bowers, Advisors: M. Goryll and A. Spanias

Grad. Advisor: Uday Shankar



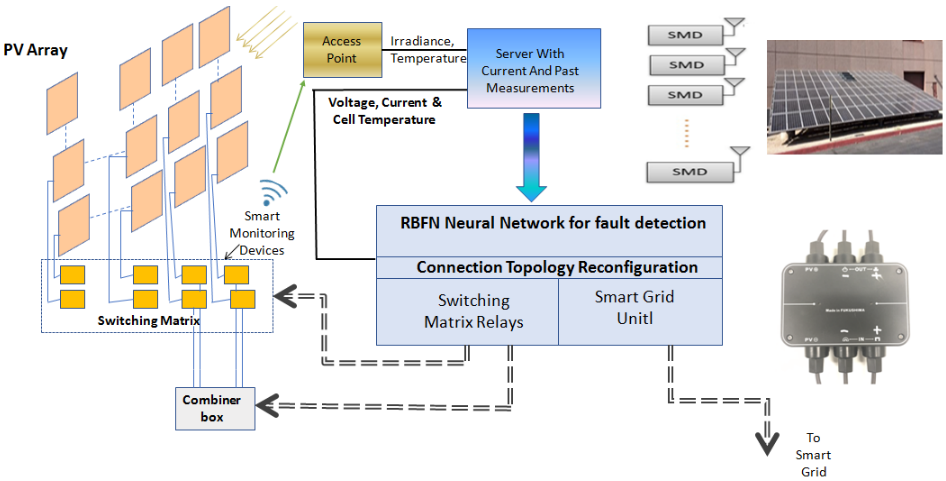
Fluorescent-based Lateral Flow Point of Care Detection of Cervical Cancer Biomarkers in Serum

Meilin Zhu

Uwa Obahiagbon, Karen Anderson

Figure 2. Current Point of Care Device

Solar System Fault Detection
Advisors: Kristen Jaskie and Andreas Spanias



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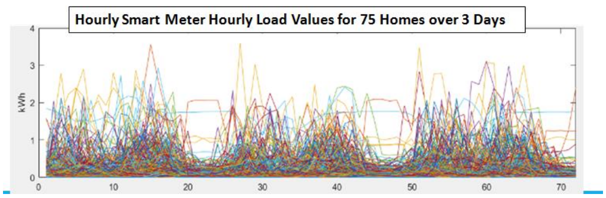

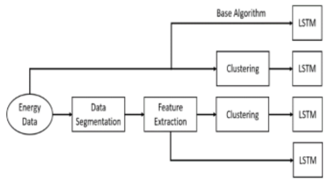

Patent Preparation

Phil Dowd

- Complete Module on Patent Preparation and IP
- Complete a pre-disclosure form

AzTE Arizona Technology Enterprises

Invention Disclosure Form PRIVILEGED AND CONFIDENTIAL	**AzTE Use Only**		
	Tech ID: M17-148P	Date Received: 2/23/2017	
	AzTE Reviewer: Philip Dowd, PhD		
Title of the Invention: (should be brief and descriptive) Distributed Network Center and Area Estimation			
Is the disclosure of this invention regulated by **ANY U.S. export laws and regulations** pertaining to the export of technical data, services and commodities [i.e. International Traffic in Arms Regulations (**ITAR**) and/or Export Administration Regulations (**EAR**)]? ☐ Yes ☐ No			
Potential Inventor(s): (subject to legal review) *Please use additional copies of this page for more than four names*			
Full Name	Sai Zhang	Position	Student
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University Mail Code	5706	Telephone	520-220-0478
Email Address	szhang98@asu.edu	Country of Citizenship	China
Residential Address		City, State, Zip	Tempe, AZ, 85281
Full Name	Cihan Tepedelenlioglu	Position	Associate Professor

Create Lesson Plan


LESSON PLAN TEMPLATE

Created by RET Co-PI Dr. Jean Larson

- Summary and Engineering Connection
- Alignment with Teaching Standards
- Pre-requisite Student Knowledge
- Learning Activities
- Planned Assessments

Assessment by CREST

Table C. Evaluation Methods			
Evaluation Goal	*Data Sources*	*Data Collection Methods*	*Outcome Indicators*
Monitor activities and ensure diversity of RET participants	PI, project staff, participants	Document review and yearly focus group interviews	Data will reflect program activities were completed according to the timeline. Descriptive data on participants and schools will reflect a diverse group.
Examine impact of RET Boot camp	PIs, RFM, participants	Pre &post surveys Interviews	Participants gain ML skills applicable to their RET research. Feedback for annual improvement.
Examine satisfaction rates of RETs	RETs	Survey and focus group interviews	Teachers report satisfaction with the training, mentoring, collaboration, lesson planning.
Analyze changes in teacher knowledge and skills	RETs and mentors	Document review, surveys, and focus group interviews	Using pre- and post- assessments, teachers will report increased knowledge and skills in machine learning research and sensor applications.
Analyze the impact of the program on teacher practices	RETs	Surveys, document review, and observations	Surveys, review of teacher lesson plans and observations will examine teachers knowledge of and confidence in applying practices learned to their lesson plans and classroom instruction.
Examine the integration of content into instruction	RETs	Follow-up surveys and observation	Thorough surveys and observations, examine how concepts have been integrated into subject-area content and classroom instruction.
Analyze dissemination of RETs' lesson plans	RETs and grant staff	Document review	Track all dissemination by RETs -school and profe-ssional presentations, uploads to TeachEngineering
Examine the alignment with AZ & National Standards	RETs	Document review. Survey	Lesson plan reviews examining alignment and consistency with Arizona K-12 Standards, NGSS, ITEEA, and AZ CC Course Competencies [162]
Document student interest & knowledge	RETs' students	Survey	Use survey to examine student lesson perceptions, their interest, engagement, and knowledge gained.

References

- H. Braun, S. T. Buddha, V. Krishnan, C. Tepedelenlioglu, A. Spanias, M. Banavar, and D. Srinivansan, ―Topology reconfiguration for optimization of photovoltaic array output,‖ Elsevier Sustainable Energy, Grids and Networks (SEGAN), pp. 58-69, Vol. 6, June 2016.
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- H. Braun, S. T. Buddha, V. Krishnan, A. Spanias, C. Tepedelenlioglu, T. Takehara, S. Takada, T. Yeider, and M. Banavar, Signal Processing for Solar Array Monitoring, Fault Detection, and Optimization, Synthesis Lect. Power Electronics, J. Hudgins, Ed. Morgan & Claypool, vol. 3, Sep. 2012. [7] Braun, H.; Buddha, S.T.; Krishnan, V.; Spanias,
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- K. Jaskie and A. Spanias, "Positive and Unlabeled Learning Algorithms and Applications: A Survey," *Proc. IEEE IISA 2019*, Patras, July 2019
- Sunil Rao, Andreas Spanias, Cihan Tepedelenlioglu, "Solar Array Fault Detection using Neural Networks", *IEEE International Conference on Industrial Cyber-Physical Systems (ICPS*), Taipei, May 2019.
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- S. Rao, G.Muniraju, C. Tepedelenlioglu, and A. Spanias, "Dropout and Pruned Neural Networks for Fault Classification in Photovoltaic Arrays," Submitted IEEE Trans. PES Letters, April 2020.
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- D. Smith, K. Jaskie, J. Cadigan, J. Marvin, and A. Spanias, "Machine Learning for Fast Short-Term Energy Load Forecasting,"in ICPS, Tampere, Finland, 2020.
- K. Jaskie, D. Smith, and A. Spanias, "Deep Learning Networks for Vectorized Energy Load Forecasting," in IISA, Piraeus, Greece, 2020.

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End of Lecture