SAND2018-12748PE

Common Senior Design Project
“Senior Design Bonanza”

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Karl Walczak/ 2616

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Agenda

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Topics	Time	Owner
Introductions - Ice Breaker	10:00-10:20	Teams
Sponsor Kick-Off and Review of Charter	10:20-10:30	Jim and Jared
Review Project, Timeline, Next	10:30-10:45	Karl
Q&A	10:45-11:00	Karl

Senior Design ***Bonanza***

- ***Bonanza***:
  - Merriam-Webster:
    - a **situation or event that creates a sudden increase in wealth**, good fortune (**innovation**) , or profits.
    - a **large amount of something desirable**.
  - dictionary.com:
    - Rich mass of ore, as found in mining
    - A **source of great and sudden wealth or luck**
  - TV show (queue the music):
    - 1959 Western
    - Based around the Cartwright family
    - about family/**groups solving problems together**

Introduction – Ice Breaker

Sandia National Laboratories

- **Name**
- **Role**
- **School**
- **Team Name**

NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

CU Boulder

FORT LEWIS COLLEGE

Fort Lewis College

Durango, Colorado

ROCHESTER INSTITUTE OF TECHNOLOGY R·I·T 1829

THE UNIVERSITY OF TEXAS AT AUSTIN

HOWARD UNIVERSITY 1867

The University of Akron

Sandia Management Team

Primary:

- James M. Redmond
- Jared McLaughlin

Supporting:

- Tommy D. Woodall
- Audrey Morris-Eckart
- Jamey T. Bond
- Theresa E. Cordova

Logistics:

- Freddie Romero

Location:

Sandia National Laboratories of New Mexico

Schools and Mentors

School	Faculty Mentor/s	Sandia Labs Mentor/s
CU Boulder	Nicole Labbe	Mike Ross / 1553 Brian Macumber / 2616
Fort Lewis College	Megan Paciaroni	Karl Walczak / 2616
Howard University	Grant Warner Charles Kim	Tim O'Hern / 1512
The University of Texas at Austin	Richard Crawford	Michelle Pang / 9131
North Carolina Agricultural and Technical State University	Mookesh Dhanasar Daniel Limbrick	Quincey Lower / 2569
University of Akron	D. Dane Quinn	Adam Brink / 1556
Rochester Institute of Technology	Kenneth Mihalyov	Nick Leathe / 2616

Senior Design Bonanza: Charter

- Bring multiple universities/colleges together to address the same design challenge to **innovate**
- **Academic engagement,** Common Sandia Design Project sponsorships
  - Leveraging resources, minimizing costs, maximizing exposure (across institutions), and having fun
- **Building and promote collaborative networks** between Sandia Labs and University faculty
- **Brand recognition**
- **Attract talent**

Project Overview and Context

Environmental sensing network:

- Systems and components designed at Sandia are designed to function in an array of environments during their lifetime
- Real-time sensing is feasible for a range of applications and environments. However, selecting, designing, integrating, and analyzing arrays of data real-time is not a trivial task
- High fidelity data is invaluable, it can be used to improve future designs, enhance security, increase efficiency, assess health, and track performance

Advanced Technologies to Ensure Global Peace

- Nuclear Weapons
  - Stockpile Stewardship
  - Life Extension
- Missile Systems
  - Offensive & Defensive
  - Hypersonics
- Secure Transportation
- Secure & Resilient Energy Grid
- Force & Asset Protection
  - Robotics
  - Physical Security
  - Intrusion Detection & Denial
- Space Systems
- Surveillance & Reconnaissance
  - Synthetic Aperture Radar
- WMD Counterterrorism and Response

Sandia designs and deploys high consequence systems. Understanding the environments thereof is imperative.

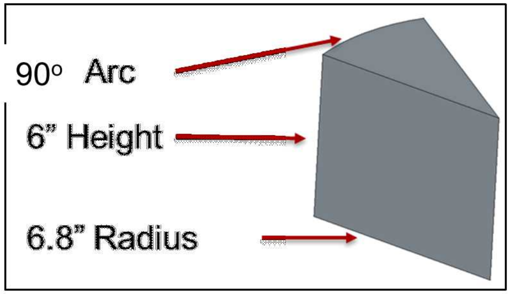
Objective

- Design, build, and test a fully integrated sensing device with near real time analysis, potential applications (inform future designs, enhance security, increase efficiency, assess health, and track performance)
  - When feasible utilizing modeling and simulation to validate design selection and experimental results

Requirements

Required Sensing Environments:

- Must fit within the **Mechanical Envelope, shown to the right**
  - Device mounting bolt pattern 1 x 1" pitch with ¼-20 thread
- Hardware, software, final presentation, and final report, delivery to Sandia/NM by May
  - Make arrangements with Sandia mentors



Mechanical Envelope

Environments	Operating range
Vibration	20 to 5000 Hz
Light irradiation	0 to 1000 $W\text{-}m^{-2}$
Temperature	-20 to 70 °C
Relative humidity	5 to 90 % RH
Linear acceleration	0 to 10 G
Orientation	Orthogonal coordinate frame
Proximity	0.028 m^3
Air composition	hydrogen, oxygen, carbon dioxide, carbon monoxide, nitrogen

Requirements and Discussion

- **Stretch requirements (not required but nice to have)**:
  - Actively respond to any or all environments (such as, cool if it exceeds 70 ^{o}C, warm if it is below -20 ^{o}C, shade if it is exposed to greater than 1000 W-m^{-2})
  - Sense material changes with time (aging)
  - Wireless (charging, data transfer)
  - Sense pH
  - Synchronous sampling and timestamping
  - Electromagnetic radiation magnitude and direction

Final Presentation Evaluation

- Evaluation criteria includes:
  - Ease of integration of the hardware and software
  - Ability to accurately sense environments (self report)
  - Volumetric footprint
  - Design process
  - Power usage
  - Data-rate
    - Steady environment
    - Dynamic environment (e.g., temperature is changing, light intensity is changing…etc.)
  - Cost
  - Novelty
  - Robustness
  - Weight-to-capability ratio
  - Uses of additively manufactured components

Q&A and Conclusion

- **Next Meeting:**
  - Proposed December 4th Preliminary Design Review and open forum
    - Slide deck template will be supplied by Sandia Mentors
  - Proposed February 6th Baseline Design Review and open forum
  - Proposed April Final Design Review
- **Soon to be released Collaboration Resource**

(Thanks to Freddie Romero and Michelle Audrey-Pang)

  - Send your Sandia Mentors
    - Name and email addresses
    - Team photo
    - Logo
  - Sharepoint site
    - Promote collaboration between teams
    - Post team updates
    - Open forum for Q&A

Q&A and Conclusion

Questions	Answers
What is the sensitivity requirement of the sensors?	Operate across sensing range at a rate that provides an accurate measurement.
Data rate?	Operate at a rate that provides an accurate measurement for the environment. During quasi-steady state conditions there is little value in collecting data at a high rate, however, during transient conditions collecting at a faster rate would provide greater insight to what the device is experiencing. Build logic into device that adjusts sampling rate based on if the environment is changing (i.e., if environmental change is sensed increase sampling rate to twice the rate at which the environment is changing' if the environment is stable sample at 10 hz.
Is the power supply provided? And if so, what are the requirements/guidelines for the power source? Or do the teams need to integrate a power source into their device (and in turn allocate space for this within the confines of the mechanical envelope)?	During normal conditions an external power supply will be available however, the device should also be able to function (maybe not at the capability) without supplementary power for at least four days. One recommendation is that the teams power their devices via the data acquisition and controller boards with some type of battery, however, if they develop other method/approaches that is good also.
For data acquisition and storage will we be doing something similar to summer where the data will be run to an external source that can record and store (i.e. wires running from the device to a computer that we can get the raw test data off of after testing)? Or does the device that each team makes need to have a method for recording and storing data internally? (If I recall correctly for SPRINT the devices didn't need to store data from testing, and the collected sensor data given to the teams after each testing cycle for their analysis.)	Yes, and yes, This is similar to NW SPRINT with data acquisition and storage during nominal conditions, however, during non-ideal conditions the additional requirement is that the device have internal/onboard storage and power for at least four days.
Are sensors/hardware is being provided?	No sensors are being provided.
I know one of the evaluation criteria will be cost of the final device (I assume it's the final cost of the device and now the cost that each team spent on the project as a whole), so it's up to mentors and teams to figure out a budget and to work towards making a good device at as low of a cost as possible, right?	The device will be evaluated based on total material costs (not team budget), so it is up to the teams to make it as low cost as feasible
What is meant by the proximity environment? That the device is capable of sensing within the volume specified in the table?	Proximity environment, sensing the closeness of physical things in the environment. Team are required to be able to detect "objects" within the cubic foot surrounding their device. (assumes the device is smaller than a cubic foot)
For light irradiation is the intention to detect intensity? And is there a known source or should we assume anything in the visible spectrum?	The teams are measuring the power per unit area of light. This could be natural or artificial, 0 to 1000 W/m^2. For example, on a sunny day with clear skies, at sea level the irradiance is typically 1 sun or 1000 W/m^2. In ABQ since we are higher in elevation the power per unit area is greater…Here is a link to sensors that teams could use: https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=2822

Proximity sensing