Annual ONR NEPTUNE Program Review

6th– 8th November 2017

United States Naval Academy
Annapolis, MD

Agenda

ONR NEPTUNE Program Review

6-8 November 2017
USNA, Annapolis, MD

<u>Monday, 6 November, 2017</u>
Rickover Hall 103

1000-1200	***Registration***
1300-1315	Welcome Maria G. Medeiros, ONR
1315-1345	Welcome CAPT Dave Roberts, USNA Dean of Math and Science
1345-1430	USNA NEPTUNE Project Summaries (3 projects) Dianne Luning Prak / Judith Harrison / Paul Trulove
1430-1500	***Break***
1500-1615	NPS NEPTUNE Project Summaries (5 projects) Dan Nussbaum
1615-1700	MIT NEPTUNE Project Summaries (3 projects) Steven Leeb
1700	Adjourn
1830	**Dinner (TBD)**

<u>Tuesday, 7 November 2017</u>

Rickover Hall 103

0730-0830 ***Registration***

0830-0900 ESTEP
Marissa Brand

0900- 1015 Purdue NEPTUNE Projects Overview (6 projects)
Maureen McCann

1015-1100 Stanford University & H4Di
Jeff Decker

1100-1200 **Get Takeout Lunch**

1200-1400 NEPTUNE Poster Session (**<u>Rickover Hall 301)</u>**

1400-1600 Tour of USNA

Wednesday, 8 November 2017

Rickover Hall 102

0730-0830 ***Registration***

0830-1000 ASU NEPTUNE Project Summaries (6 projects)
Joe Sanchez

1000-1030 Challenge Summit Overview
Ray Dick

1030-1050 ***Break***

1050-1130 UC Davis NEPTUNE Project Summaries (7 projects)
Benjamin Finkelor / Siva Gunda

1130-1200 NEPTUNE Updates
Maria G. Medeiros, ONR

1200 ***Adjourn***

Monday, November 6th

Welcome

Maria Medeiros
Office of Naval Research

NOTES

Welcome

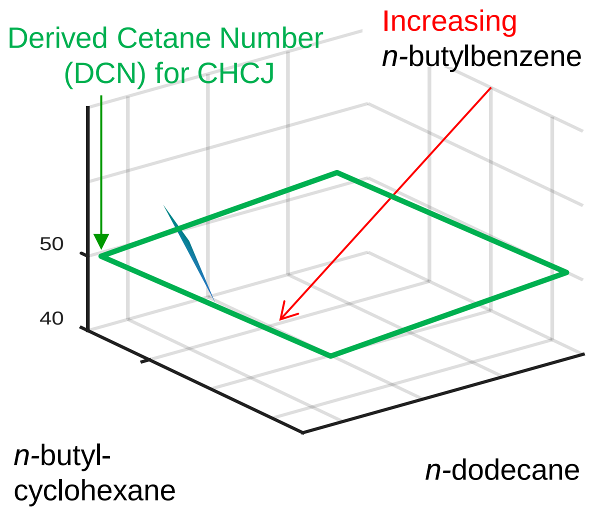
CAPT Dave Roberts

USNA Dean of Math and Science

NOTES

Investigation into the Impact of Chemical Composition on Measured and Predicted Fuel Properties and on the Resulting Combustion in Military and Test Diesel Engines

U.S. Naval Academy



Student(s) Info:

MIDN 1/C Sonya Ye (m177158@usna.edu)

MIDN 1/C Margaret McLaughlin (m174158@usna.edu)

Professor POC Info: *Chemistry*

Dianne Luning Prak, prak@usna.edu

Paul Trulove, trulove@usna.edu

Current Project Funding
Start Date: June 2015
End Date: Dec. 2017

Objectives:

- Measure the physical and chemical properties of fuels important for transport & combustion
  - Density, viscosity, speed of sound
  - Flash point, surface tension
  - Bulk modulus from speed of sound & density
- Develop simple mixtures to match properties
  - Use selected major components from fuel analysis to prepare mixtures that match properties and combust in diesel engines
- Use project-based learning on fuel-related issues to educate Naval Academy midshipmen

Product Schedule/ Milestones:

- Formulate surrogate mixtures for Catalytic Hydrothermal Conversion (CHC) diesel & jet fuels provided by NAVAIR
  - Two-component mixtures with aromatic compounds
  - Three-component mixtures with aromatic compounds

Current Status/ Accomplishments:

- Surrogate mixtures formulated to match CHC Jet fuel
  - manuscript submitted to *Energy and Fuels*
  - *Figure above shows Derived Cetane Number of CHCJ can be matched by 3-component mixtures*
- Surrogate mixture work for CHC Diesel fuel - ongoing
- 3-component mixture properties
  - Hexyl- or butylbenzene, *n*-dodecane or *n*-hexadecane, and *n*-butylcyclohexane
  - published in *Journal of Chemical and Engineering Data*

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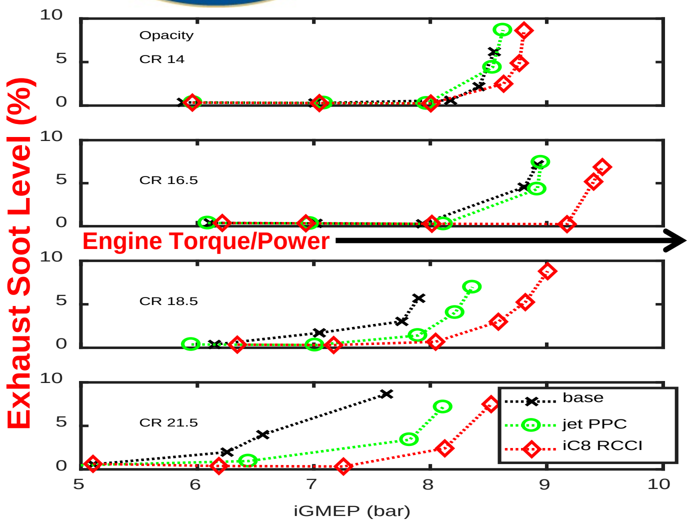
NOTES

Determination of the Impact of Chemical Composition on Measured and Predicted Fuel Properties and the Resulting Combustion in Military Diesel Engines

U.S. Naval Academy



**Higher engine Torque/Power (iGMEP) is achieved with New combustion Modes in Navy Engines (PPC) with jet fuel & (RCCI) with iso-octane.

Student(s) Info:

1/C Michael Walker, 1/C Harrison Yosten and 1/C Will Gomperts

Professor POC Info:

Jim Cowart, cowart@usna.edu

Mechanical Engineering

Project Start/End Date: June 2016/Dec 2017

Objectives:

- Perform Navy fuels diesel combustion testing/evaluation with colleagues and students in the USNA Chemistry and Mechanical Engineering Departments.
- Perform engine and combustion rig testing with Navy fuel surrogates developed by USNA Chemistry and fuels provided by NAVAIR.
- Improve the Navy's understanding of fuel physical properties on combustion in Navy diesel engines.
- Use project-based learning on fuel-related issues to educate Naval Academy midshipmen.
- Experimentally explore hydrogen augmentation in diesel engines for potential efficiency/power improvements.

Current Status/ Accomplishments:

- CHCJ and CHCD fuels/surrogates further tested & shown to be very similar in actual diesel engine combustion.
- Partially Premixed Combustion (PPC) and Reactivity Controlled Compression Ignition (RCCI) experiments show that military diesel engine maximum power can be increased **by 3 to 27%** without a soot penalty. Moderate additional improvements have been shown with a second fuel applied to the engine's intake airflow (see figure upper left on quad chart**). PPC and RCCI area new advanced-alternative combustion modes applied to diesel engines.
- Numerous technical papers have been published and submitted during the past semester. Midn Harrison & Gomperts are working on their Bowman Scholar technical reports, while Midn Mike Walker is working on his Trident Scholar project.

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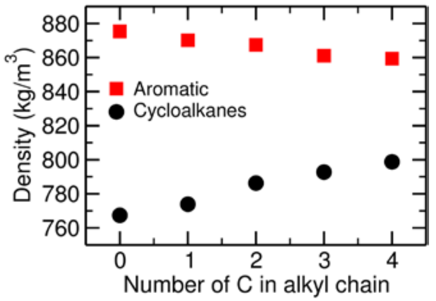
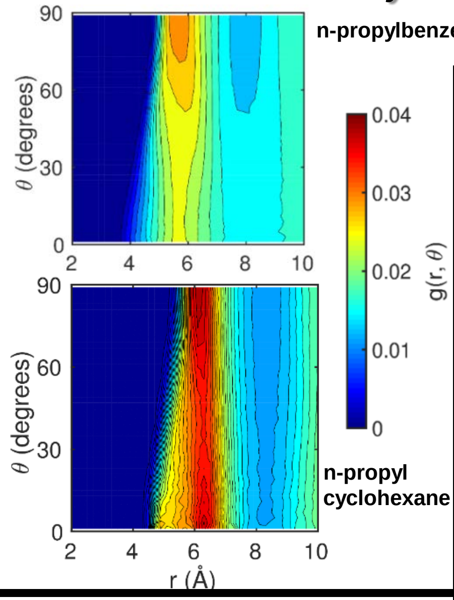
NOTES

Investigation into the Impact of Chemical Composition on Measured and Predicted Fuel Properties and on the Resulting Combustion in Military and Test Diesel Engines

U.S. Naval Academy





(top) *Predicted* densities as a function of carbon atoms in the side-chain. **(rt)** Angular radial distribution functions (*g*) showing different preferred angles (θ) between rings for compounds with a 3 carbon side chain. Different orientations lead to different densities etc.

Student(s) POC Info:

Micah Z. Gustafson, m172364@usna.edu

Professor POC Info:

Judith A. Harrison, jah@usna.edu

Chemistry Department

Current Project Funding

Start Date: June 2015

End Date: Dec. 2017

Objectives:

- Use molecular dynamics (MD) simulations to **predict the properties** (physical and transport) of fuels.
- To link molecular-level liquid structure to physical property predictions and to use simulations to examine a **larger compositional phase space** than is feasible to examine experimentally.
- Properties to be predicted are: density, bulk modulus, viscosity, surface tension, excess volume, and thermal conductivity of fuels as a function of composition.
- Develop algorithms as needed to examine liquid structures and calculate properties.
- Compare data to experiment as needed to verify validity of potential functions for heavy hydrocarbons.
- Use project-based learning on fuel-related issues to educate Naval Academy midshipmen.

Product Schedule/ Milestones

- Examined the properties & molecular-level liquid structures of pure alkylbenzenes and alkycyclohexanes, which are two of the classes of hydrocarbons that comprise the 3 component surrogates for Catalytic Hydrothermal Conversion (CHC) diesel and jet fuels.
- Differences in the orientation of rings linked to density and bulk modulus trends.

Current Status/ Accomplishments

- Demonstrated that it is possible to link molecular-level structural changes to predicted physical properties.
- Two manuscripts based on this work are in preparation.
- MIDN Gustafson presented a poster at the American Chemical Society National meeting in April 2017.
- MIDN Gustafson graduated after doing research for two years on this project.

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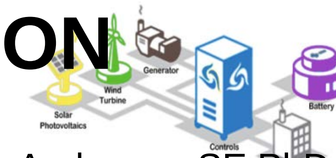
NOTES

MICROGRID OPTIMIZATION



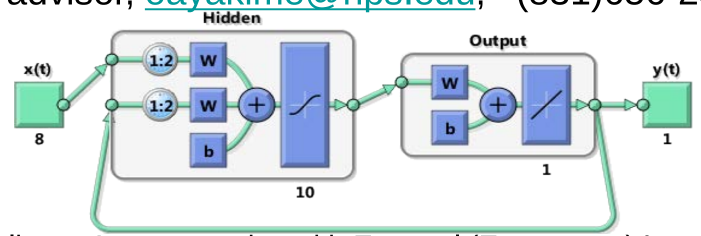
Description of Project

Framing and evaluating the problem of optimizing renewable energy microgrids to enhance energy security for remote islanded naval installations will be conducted. An operational microgrid on three remote islands will be used for initial data collection. Optimization of controls using Complex System and machine learning tools to include predictive modelling will be explored during this initial PhD research phase.

Student – William Anderson, SE PhD Student

LCDR Kyle Kobold, SE M.S. Student

Professor POC Info: Dr. Oleg Yakimenko, PhD advisor, oayakime@nps.edu, (831)656-2826



Nonlinear Autoregressive with External (Exogenous) Input (NARX) Neural Network closed loop training model used for predictive modelling in MATLAB

Objectives

- Define and frame problem to be solved in PhD thesis research
- Determine how best to approach this problem
- Evaluate research done to date
- Determine best tools to incorporate in research to include EnergyPLAN and MATLAB's neural network toolbox for machine learning
- Determine data needed to be collected
- Evaluate data from Isle of Eigg, Samsø Island and El Hierro microgrids
- Produce report that identifies follow-on dissertation research approach to optimize a green microgrid's control system for remote islands

Product Schedule/ Milestones

April 2017: Information gathering and literature review

May 2017: Data collection and analysis on Samsø Island, DK, Isle of Eigg, UK

November 2017: Present white paper at ICRERA San Diego

December 2017: Data collection and analysis on El Hierro, Spain

December 2017: Synthesize data, produce report

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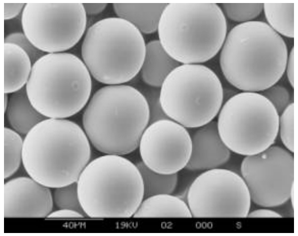
NOTES

Microsphere-Based Material for Thermal Insulation of Diver Suits



Student(s) POC Info: USMC Capt. J. Brown, jmbrown1@nps.edu; USN Lt J.A. Oldenkamp, jaoldenk@nps.edu

Professor POC Info: E. Kartalov, PhD, Associate Professor, Physics Dept, NPS, epkartal@nps.edu

Project Start Date: 04/01/2017
Project End Date: 03/31/2017

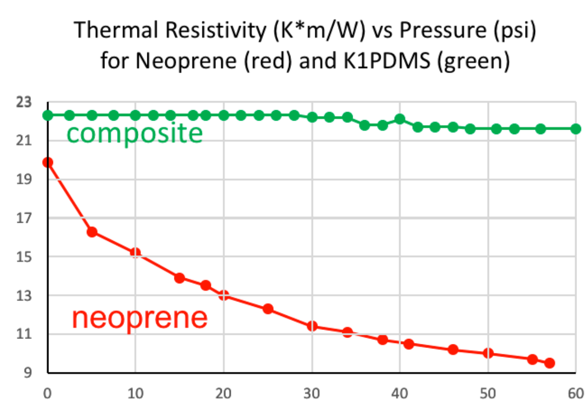
Objectives:

1. Proof of principle for material (Q1)
2. Optimization to maximize thermal resistivity at adequate flexibility (Q2-Q3)
3. Build molds and cast a suit piece-by-piece (Q3-Q4)

Product Schedule/ Milestones

see objectives by project quarter

Current Status/ Accomplishments



- proved principle
- optimized
- now building suit

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NOTES

Model Predictive Control and Estimation of Microgrids at FOBs

Project Start Date: 01/09/2016
Project End Date: 30/06/2018

Student(s) POC Info:

CPT Ivan Bermudez, USA

LCDR Kevin Garcia, USCG

CPT Erik Kiser, USA

Professor POC Info:

Profs. A. J. Krener and H. Zhou

Department of Applied Mathematics, NPS

Objectives:
Forward Operating Bases (FOBs) currently use spot generation. Each tent is serviced by its own generator(s). The next version of FOBs will use a microgrid to service all the tents and this is expected to reduce fuel consumption by up to thirty percent. We believe that by using Model Predictive Control (MPC) techniques fuel consumption can be reduced by an additional ten percent.

Product Schedule/ Milestones

31/12/2017: Development and verification of a mathematical model of a FOB microgrid with storage devices, solar power and variable load. Optimization over fixed time horizon.
30/06/2018: Optimization over a moving horizon.

Current Status/ Accomplishments

Mathematical model developed and coded into GAMS. Mixed integer linear programs solved by CPLEX. Data on energy demand over days, weeks and months has been collected.

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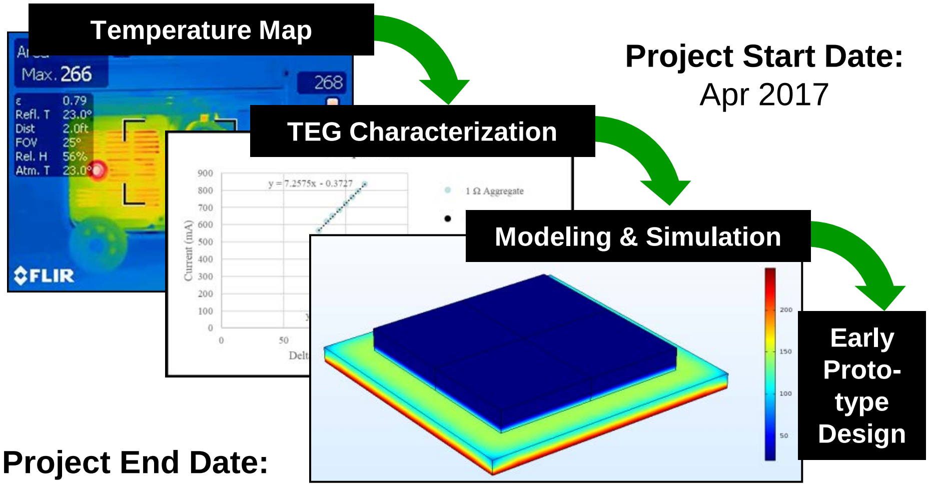
NOTES

Harvesting Waste Heat with Thermoelectric Generators



Project Start Date:
Apr 2017

Project End Date:
Dec 2018

Student: CPT Ron Moreno, rjmorneo@nps.edu

Professors: Tony Pollman & Dragoslav Grbovic, pollman@nps.edu, 831.656.6061

Objectives:

(1) Obtain a heat engine temperature map
(2) Experimentally characterize TEG output for engine operating temperatures
(3) Parametric model/simulation of TEG performance with COMSOL
(4) Build a harvesting device proto-type to demonstrate proof of concept
(5) Report power output & IR reduction

Schedule/ Milestones/Accomplishments

- ☑ Apr – Obtained temperature map
- ☑ Aug – Finished characterization experiments
- ☑ Sep – Modeled a TEG element with COMSOL (simulation matched experiments)
- ■ Oct – Parametric simulation of multiple TEGs
- ☐ Nov – Prototype design & construction(?)
- ☐ Dec – Report out & conference paper

Current Status

Parametric modeling of multiple TEGs to inform small-scale prototype design

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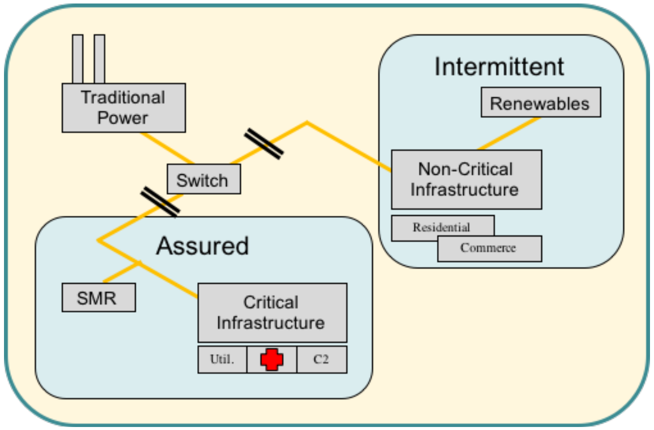
NOTES

An Assured Power Distribution System: The Ultra-Secure Micro-Grid Powered by Small Modular Reactors



Project Start Date: March 1, 2017
Project End Date: December 30, 2017

Professor Craig F. Smith
cfsmith@nps.edu
831-656-2185

Participating Student(s):

CPT James Bowen, USA
CPT Drake Brewster, USA
LT Jeffrey Asch, USN
LCDR Gregory Brandt, USN
Capt John Gats, USMC

Objectives:

- Primary Objective: to investigate the potential for a highly robust, resilient and supply-independent micro-grid concept that can supply assured power in the aftermath of intentional or accidental disruption.
    - This initial effort represents a scoping assessment to identify the path forward for research and concept design to address protection against the full array of threats and to select and assess integration with and protection of a supply-independent small nuclear power system.

Product Schedule/ Milestones

01MAR17	Project start
31JUL17	Identify approaches for protection
31AUG17	Initial protected grid concept
31OCT17	Assessment of reactor options
30NOV17	Identify further research/demo needs
30DEC17	Project completion briefing

Current Status/ Accomplishments

- Completed identification of desired attributes of an SMR, approaches for protection and initial concept
- Completed IPR briefing (CPT Brewster) at MIT
- Continuing identification of reactor options, and completing an economic analysis for a military base application

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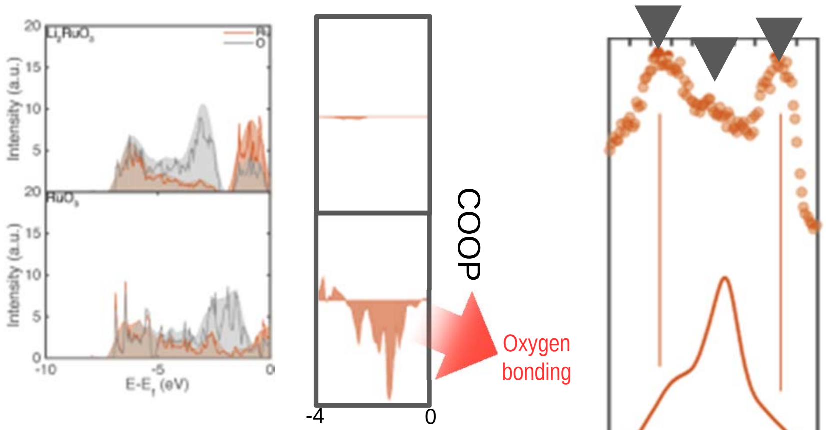
NOTES

Exploiting oxygen anion redox for high-energy rechargeable lithium batteries



Project Start Date: 1/1/2016
Project End Date: 12/31/2018

Student(s) POC Info: Ms. Pinar Karayaylali, pinark@mit.edu; **Mr. Yang Yu**, yuy@mit.edu; **Mr. Patrick Linford** ,U.S. Army, Captain; plinford@mit.edu

Professor POC Info: Yang Shao-Horn, W.M. Keck Professor of Energy, MIT, Cambridge, MA 02139; shaohorn@mit.edu; 617 253 -2259

Objectives:

In this project, we will elucidate the fundamental parameters that trigger and govern reversible oxygen redox phenomena in the first year, and apply fundamental mechanistic insights into developing new cost-effective electrode materials that exhibit reversible oxygen redox for greater capacities than conventional lithium-ion battery positive electrode materials.

Product Schedule/ Milestones

In the first year, we will establish a hypothesis on the oxide electronic structure features that give rise to reversible oxygen redox. In the second year, we will apply fundamental understanding of the requisites of band structure that allow oxides (Li_2RuO_3) to favor reversible bulk oxygen redox while suppressing oxygen gas evolution, to design new oxides free of precious metals.

Current Status/ Accomplishments

Oxygen K-edge X-ray emission (XES) and absorption (XAS) spectroscopy allowed us to experimentally probe the density of state of the materials and indicated that the charge-transfer gap is correlated with the oxygen redox.

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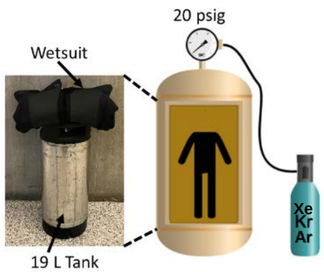
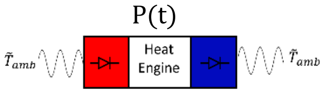
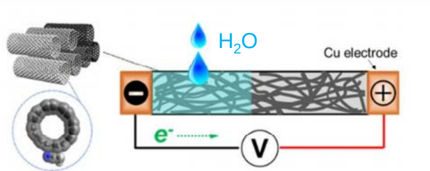
NOTES

Thermal Management Technologies for Low Temperature Undersea Dive Persistence: A Novel Arctic Diving Suit







Project Start Date:
Project End Date:

Student(s) POC Info:

Jeffrey Moran (j_moran@mit.edu)

Ping Wei Liu (pingwei@mit.edu)

Anton Cottrill (cottrial@mit.edu)

Albert Tianxiang Liu (atliu@mit.edu)

Professor POC Info:

Michael S. Strano (strano@mit.edu; 617-324-4323)

Jacopo Buongiorno (jacopo@mit.edu; 617-253-7316)

Matteo Bucci (mbucci@mit.edu; 617-715-2336)

Objectives:

Material design:

We explore important modifications to conventional neoprene materials, including combined porosity engineering and nanocomposite coating to persistently reduce the effective thermal conductivity by a target factor of three - allowing significantly enhanced dive persistence in arctic, aquatic environments.

Ambient energy harvesting from thermal resonators:

We propose to incorporate a newly-developed energy harvesting device, which is based on thermal diodes and draws from ambient thermal fluctuations, into the dive suit as a means to generate usable electricity for heat generation and other regulatory purposes.

Asymmetric doping of SWNT fibers with H_2O:

Using the recently developed theory of Excess Thermopower, we propose to generate electricity from exposing SWNT fibers to H_2O. Once the diver is in water, energy is generated as electricity and can be used for heat generation and other regulatory purposes.

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Product Schedule/ Milestones

Material design:

- Phase 1: develop theoretical models of thermal and mass transport in neoprene foam
- Phase 2: fabricate neoprene foam with optimal structure and composition parameters
- Phase 3: test/assessment and further optimization with nanocomposite coatings

Ambient energy harvesting from thermal resonators:

- Phase 1: develop a high-performance phase change thermal diode
- Phase 2: incorporate the phase change thermal diode into a thermal resonance device
- Phase 3: demonstrate power generation from undersea thermal fluctuations using the constructed device

Asymmetric doping of SWNT fibers with H_2O:

- Phase 1: develop the basic SWNT fiber conduit system
- Phase 2: study generation mechanism and design criteria with pure H_2O
- Phase 3: determine the effect of salinity on the performance

Current Status/ Accomplishments

Material Design:

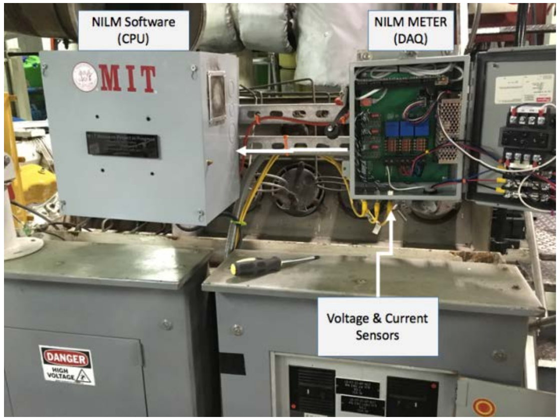
We have reduced the thermal conductivity of commercial foamed neoprene by approximately 50% by infusing high-molecular-weight inert gases, and demonstrated the utility of this material towards enhanved dive persistence. Two manuscripts are currently in preparation.

Ambient energy harvesting from thermal resonators: We have developed a theory for, and experimentally demonstrated, two types of optimized thermal diodes based on phase change materials. We have developed a theory for, and constructed, a thermal diode-based thermal resonator. Two papers have been published and one is currently in review.

Asymmetric doping of SWNT fibers with H_2O: We have demonstrated a persistent open circuit voltage (~100 mV) with pure H_2O. We have a paper currently in preparation.

NOTES

Combat Power Monitor



Combat Power Monitor prototype installed on USCGC SPENCER

Project Start Date: 01/01/2016
Project End Date: 12/31/2018

Student(s) POC Info: LT Thomas Kane (USCG), ENS Spencer Shabshab (USN), John Donnal (now USNA); Gregory Bredariol (USCG); Daisy Green

Professor POC Info: Steven B. Leeb

MIT Room 10-069

77 Massachusetts Avenue

Cambridge, MA 02139, sbleeb@mit.edu, 6172539360

Objectives:

- Design and demonstration of prototype sensors.
- Parallel construction of conventional nonintrusive current/voltage monitor.
- Demonstration of a prototype software approach (NilmDB)
- Development of "downstream" training for zonal installations of CPMs.
- Laboratory or field study to demonstrate data collection and analysis potential for a ship.

Product Schedule/ Milestones

- Prototype sensors (Q1-Q4, demo Q4).
- Parallel construction of conventional nonintrusive current/voltage monitor (Q1-Q4, demo Q4)
- Demonstration of a prototype software approach (NilmDB) (Q5)
- Installation on USCGC Spencer (Q5-Q8)
- Laboratory or field study to demonstrate data collection and analysis potential for a ship. (Q5-Q8)

Current Status/ Accomplishments

- Sensor tests on USCG SPENCER.
- Additional tests on USCG ESCANABA.
- Supporting tests on board USNA YP fleet.
- Presentation to Philadelphia USN power team (N. Spivey)
- Installations on USCGC SPENCER and ESCANABA
- ASNE Publication Q1 2017
- Sensors Conference Q1 2017

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NOTES

Tuesday, November 7th

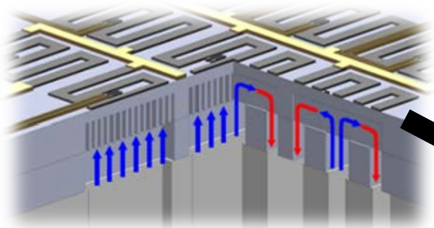
ESTEP

Marissa Brand

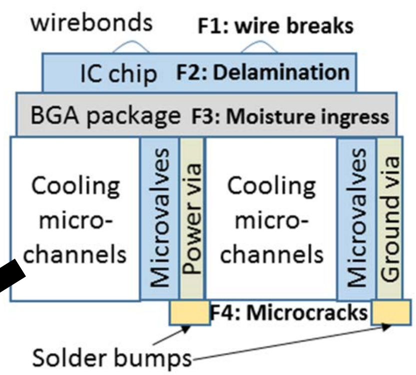
NOTES

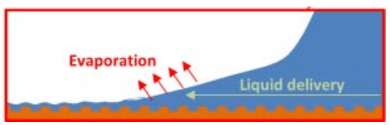
Reliability of Next-Generation Thermal Management Systems for High-Power Naval Electronics

Embedded, Liquid-Cooling-Based Thermal Management



Potential Failure Mechanisms





Role of Micro-Layer Evaporation

Student Info:

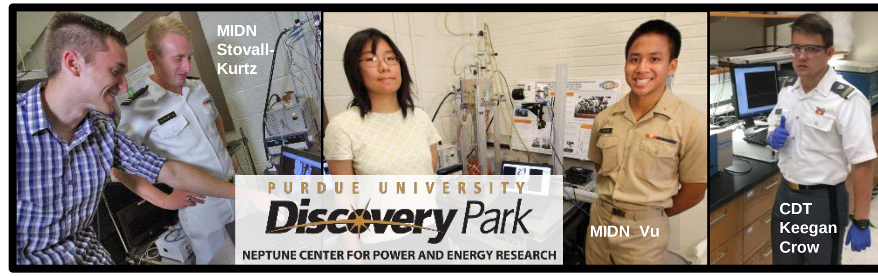
David Kortge, PhD Student, dkortge@purdue.edu

Helen Lai, PhD Student, lai25@purdue.edu

Professor POC Info:

Justin Weibel, Mech Engr, jaweibel@purdue.edu

Peter Bermel, Elec&Comp Engr, pbermel@purdue.edu



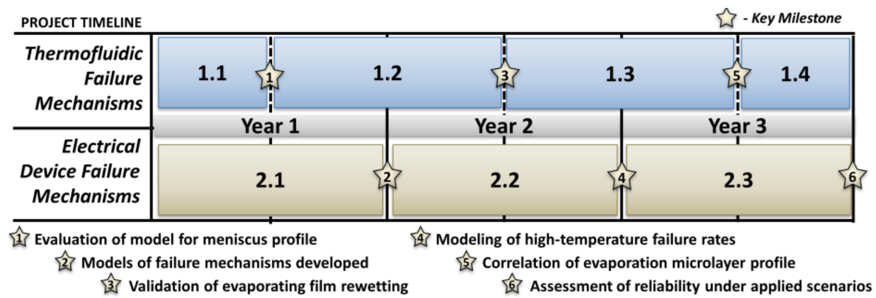
Naval platforms will rely on high-performance thermal management strategies to further increase the power density of electronic devices and provide tactical advantages in next-generation systems

Objectives:

Electronic device reliability in the presence of embedded liquid cooling can be affected by several key failure mechanisms: moisture ingress, corrosion, cracking, delamination, and liquid dryout. All of these mechanisms can be modeled, validated, and optimized.

Project Start Date: 9/15/2016

Project End Date: 9/14/2019



Current Status & Recent Accomplishments:

We made substantial progress on three items:

(1) development of a thin-film evaporation model for wetting liquids on structured surfaces,

(2) measuring the near-contact-line liquid meniscus shape at the nano/micro-scale, and

(3) identifying a fully-validated compact model of the initial performance of Naval power electronics.

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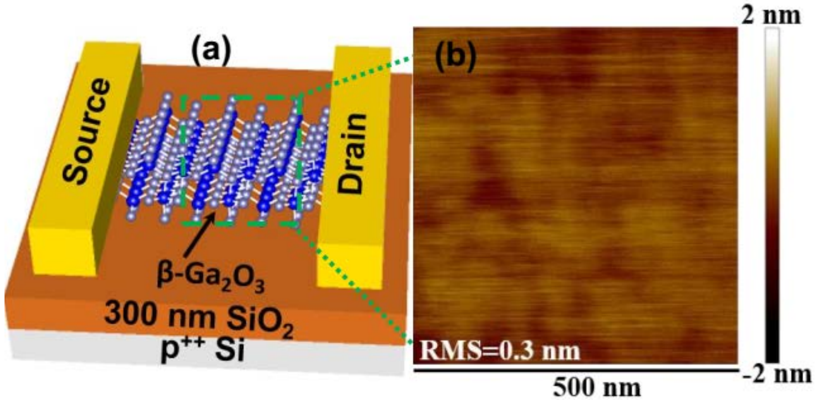
NOTES

Ultra-wide Bandgap Semiconductor β-Ga_2O_3 Interface Engineering for Naval Power Electronics Applications via Atomic Layer Epitaxy



Project Start Date: 9/15/2016
Project End Date: 9/14/2019

Student POC	Email
Jinhyun Noh	noh12@purdue.edu
Evan Schlenker	eschlenk@purdue.edu

Faculty POC	Email	Phone
Peide Ye	yep@purdue.edu	765-494-7611
Peter Bermel	pbermel@purdue.edu	765-496-7879

Objectives:

To apply an atomic layer epitaxy (ALE)-grown dielectric to β-Ga_2O_3 with the highest interface quality, thus leading to demonstration of unprecedented device performance for naval power electronics applications (e.g., high power densities and high frequency operation)

Product Milestones	End Date
Realize ALE dielectric on β-Ga_2O_3 surface	9/14/17
Measure interface recombination/cf. D_{it}	9/14/17
Fine-tune ALE process for low D_{it}	9/14/18
Build initial b-Ga_2O_3 MOSFET with ALE	9/14/18
Realize high voltage power switches	9/14/19
Recruitment of Navy personnel	9/14/19
Partnering and tech transfer with Navy	9/14/19

Current Status/ Accomplishments:

We made substantial progress in fabricating a beta gallium oxide-on-insulator (GOOI) device with promising performance, using a variable-thickness atomically flat β-Ga_2O_3 nanomembrane to control V_T. The lifetime was 20% that of III-V materials, suggesting significant room for improvement.

 This work has been supported by ONR: N00014-15-1-2833

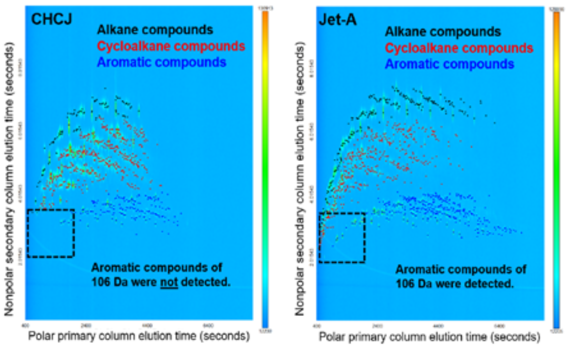
NOTES

Design of Next Generation Renewable Fuels

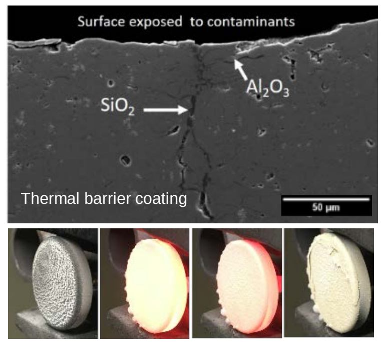
PURDUE UNIVERSITY Discovery Park

NEPTUNE CENTER FOR POWER AND ENERGY RESEARCH

GCxGC/(EI)TOF MS measurements for CHCJ and Jet-A



Air plasma spray coating infiltrated by fuel contaminants



Project Start Date: May 2017 Project End Date: May 2020

Points of Contacts:

Students: Mark Romanczyk (mromancz@purdue.edu); Katherine Wehde (kwehde@purdue.edu); Petr Vozka (pvozka@purdue.edu); Jorge Ramirez Velasco (ramir134@purdue.edu); Lan Xu (xu851@purdue.edu); Brent Modereger (bmodereg@purdue.edu)

Midshipmen: Nathaniel Roe (roe13@purdue.edu); Eion Keating (ekeatin@purdue.edu); Alex Gordon (gordo105@purdue.edu); John Healy (healy3@purdue.edu)

Cadet: Pankaja H. Dissanayake (C18Pankaja.Dissanayake.lk@usafa.edu)

Professors: Hilkka Kenttämaa (hilkka@purdue.edu); Gozdem Kilaz (gkilaz@purdue.edu); Rodney Trice (rtrice@purdue.edu)

Objectives:

1. Establish the chemical composition of conventional aviation fuel (Jet A) and alternative fuel blending components (HEFA, CHCJ, SIP, Sasol IPK and ATJ).
2. Identify compounds that significantly influence fuel properties.
3. Continue to develop the database of fuel composition/ property characteristics.
4. Identify and quantify the contaminants in different types of resilient fuels and their effects on critical gas turbine components.

Product Schedule/ Milestones

- The investigation on the propensity of different aromatic compounds to swell o-ring seals is in progress.
- Correlations between the extent of swelling of o-rings seals and tensile strength are under investigation.
- Training and educating naval midshipmen continues.
- Identification of the mechanisms by which contaminants obliterate gas turbines' thermal barrier coatings (TBCs) is ongoing.

Current Status/ Accomplishments

- Method development for o-ring studies has been completed.
- Semi-quantitation of compounds in Catalytic Hydrothermal Conversion Jet fuel (CHCJ) was completed in collaboration with Dr. D.J. Luning-Prak, U.S. Naval Academy.
- Manuscripts on the analysis of CHCJ, aromatic dopants' propensity to swell o-ring seals and their effects on tensile strength, identification of aromatic compounds in fuels by using APCI/CS_2 mass spectrometry, and effects of biofuel impurities on the hot corrosion of TBCs have been submitted.

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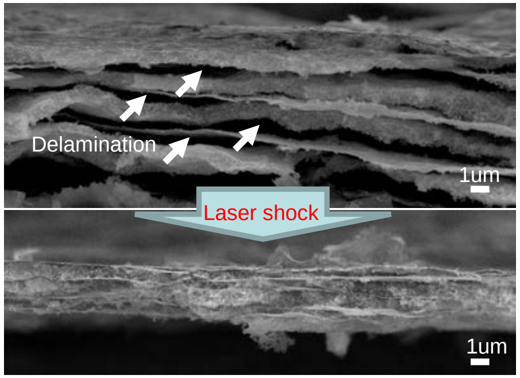
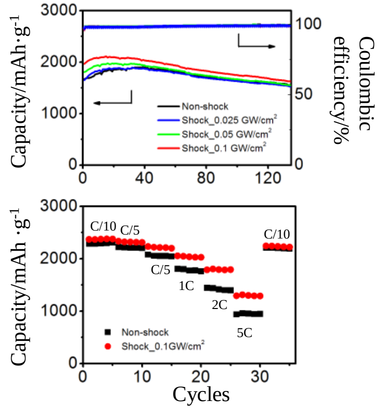
NOTES

Laser assisted large-scale manufacturing of 2D/0D nanocomposites for high energy density and high power output Li-ion batteries





Project Start Date: June 2017
Project End Date: May 2020

PURDUE ENGINEERING

Student(s) POC Info:

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Professor POC Info:

Gary J. Cheng gjcheng@purdue.edu

Kejie Zhao kjzhao@purdue.edu

Objectives:

- Develop a low-cost and large–scale laser assisted manufacturing process for high power output Li-ion batteries (LIB) with 2D/0D nanocomposite electrodes;
- Find out the material and structural bottlenecks of nanocomposite LIB electrodes and understand how laser assisted approaches can improve the performance of nanocomposite electrodes.
- Use simulation tools to understand the mechanisms behind laser shock manufacturing methods and relate key manufacturing parameters with the performance of the final product.

Product Schedule/ Milestones

- Period 1. Build platform to manufacture nanoengineered 0D/2D nanocomposites with Laser-assisted additive manufacturing.
- Period 2. Simulate and prediction the strains and defects distribution during laser manufacturing of 0D/2D nanocomposites.
- Period 3. Design and fabrication of strain / defect engineered graphene/SiNPs layers
- Period 4. Conduct mechanical characterization using SPM/SEM hybrid system
- Period 5. Understanding the process-property relationship with In-situ TEM observation of real-time electrochemical behaviors
- Period 6. Study the Electrochemical performance of graphene/SiNPs nanocomposites.

Current Status/ Accomplishments

- Layer by layer 2D/0D nanocomposite anode has been roll printed;
- Laser shock pressing procedure has been developed;
- Molecular dynamics simulation is being developed to study strain and defect engineering;
- Electrochemical testing of the nanocomposite battery is obtained.

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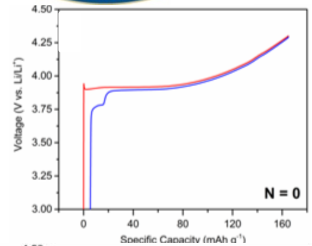
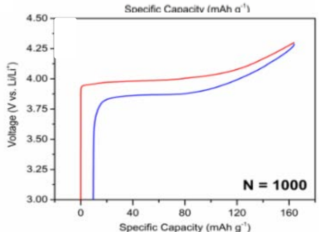
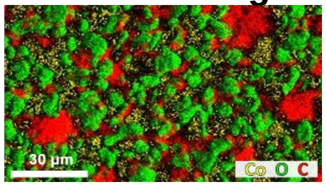
NOTES

NEPTUNE: In-situ Examination of Thermal Runaway in Lithium-ion Batteries under Dynamic Loading and High Temperatures using Nanomechanical Raman Spectroscopy

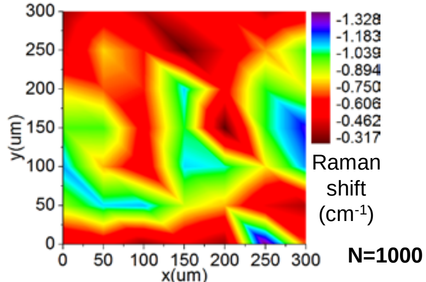




First cycle voltage profiles for mechanically impacted cathode



EDS analysis of pristine $LiCoO_2$ electrode

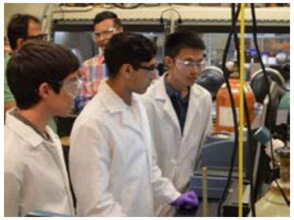


Raman mapping of impacted cathode ($LiCoO_2$)

3-Year Project
Start Date: August 2016 End Date: August 2019

Students POC Info:

Ryan Adams adams265@purdue.edu
Bing Li li1825@purdue.edu
Naval ROTC: William Kellerhals II
Multiple USMA Midshipmen Projects
Year 1 (2017): Cadets Megan Kinsey; Jafr Kazmi; Ommon Okazaki



Cadet Kazmi: battery charging analysis

Professor POC Info:

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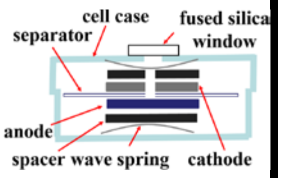
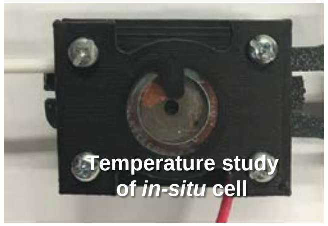
Vilas Pol vpol@purdue.edu
Tom Adams thomas.e.adams@navy.mil
Corey Love corey.love@nrl.navy.mil

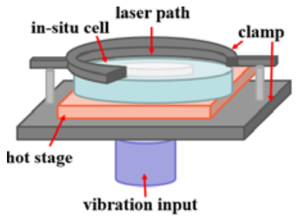
Cadet Kinsey: Li-ion battery assembly

Objectives:

- Evaluate influence of dynamic impact on battery behavior, and provide information for cell design and transportation
- Design and optimize *in-situ* Nanomechanical Raman coin cell for in-service behavior analysis
- Understand origin of thermal runaway via Nanomechanical Raman analyses, and in-battery sensors
- Evaluate battery resilience to extreme conditions in service and transport
- Develop system for prediction / control of battery emergencies with machine learning







Product Schedule / Milestones

- Analyze charge-discharge behavior of custom battery at elevated operating temperature, and evaluate *in-situ* chemical changes with Raman spectroscopy analysis --- Mar 2018
- Evaluate coupling effect of elevated temperature and dynamic load on battery under storage and service conditions --- Jul 2018
- Prepare cell with dynamic and thermal preloaded electrodes, compare in-service performance, and evaluate preload effect on defect initiation via *in-situ* Raman analysis --- Dec 2018
- Implement electrode morphological changes to control solid electrolyte interface (SEI) formation under static and dynamic loading and demonstrate improvement in load dependent failure resistance --- Jun 2019

Current Status/ Accomplishments

- Raman mapping of dynamic loaded (impacted) $LiCoO_2$ cathode
- Electrochemical characterization of impacted electrodes in cell
- Design and construction of custom *in-situ* battery cell
- First manuscript titled "Nanomechanical Raman Spectroscopy Imaging of Impacted $LiCoO_2$ Cathode for Li-ion Battery Ageing Evaluation" is almost ready for submission

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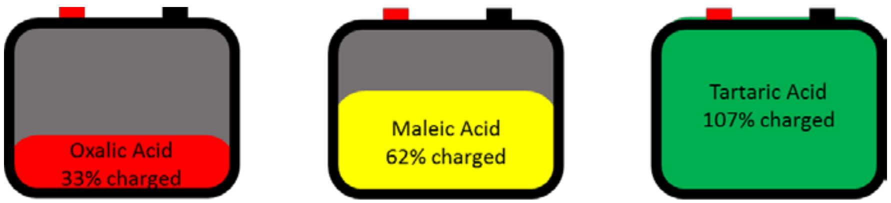
NOTES

Low Cost Catalyst for Portable Hydrogen Generation and On-demand Power

Charge of a 2590 battery achievable with the ABCharger



Full charge 2590 battery

300 g dry reactants	280 g dry reactants	350 g dry reactants
1250 mL water	675 mL water	390 mL water
$91	$108	$96

Tartaric acid as a catalyst:

- Commonly used in food processing and wine making
- High water solubility allows for improved fuel to catalyst ratio

Project Start Date: 9/10/2016
Project End Date: 9/14/2019

PURDUE UNIVERSITY

Students:

Graduate Student: Taylor Groom (tgroom@purdue.edu)
Undergraduate students: Gabby Feldman (Navy ROTC)
Andrew Campbell (Navy ROTC)

Professor & Research Staff:

Dr. Timothée L. Pourpoint (timothee@purdue.edu)
Dr. Michael Drolet
Dr. Robert Orth
Dr. Trenton Parsell
Mr. Jason Gabl

Objectives:

Develop portable, reliable, robust power sources for electronics used by expeditionary forces

- Characterize & use commercially available acid catalysts to decompose ammonia borane and trap ammonia
- Demonstrate robustness and cost advantages over Platinum-based catalysts
- Engineer a low weight, low volume, hydrogen-based portable power system for versatile and simple operation

Product Schedule/ Milestones

Fall 2017:

- Advance prototype design to increase energy density, improve fuel cell interface and monitor reaction temperature
- Initiate scaled system design, including both larger and smaller models of a hydrogen generation device

Current Status/ Accomplishments

✓ Submitted a journal paper on acid catalysts for publication in the International Journal of Hydrogen Energy
✓ Signed a consulting agreement with Protonex, who will provide access to hydrogen-air fuel cells by the end of 2017

Protonex® a Ballard® company

 This work has been supported by ONR: N00014-15-1-2833

NOTES

Hacking for Defense (H4D) Project to Support ONR's Priorities in Cyber-Physical Security for Energy Networks

H4D gives students real-life access to:

- Defense problems
- Industry experience
- Career connections

Program Manager POC Information:

Jeff Decker, jmdecker@stanford.edu

Professor POC Information:

Arun Majumdar, arunava@stanford.edu

Sally Benson, smbenson@stanford.edu

Tom Byers, tbyers@stanford.edu

Current Project Funding

Start Date: September 2017

End Date: August 2020

Objectives:

- Educate students on lean startup and innovation methods so that they may solve cyber-physical security for energy network challenges
- Train defense personnel on lean methods to better enable them to leverage commercial solutions for solving government challenges
- Establish an accelerator capability to transition H4D teams with viable concepts into working prototypes
- Conduct outreach to the military-affiliated community at Stanford University
- Expand the H4D course to NEPTUNE schools nationwide

Product Schedule/ Milestones:

- Conduct lean startup bootcamps and courses for government personnel beginning in Fall 2017
- Deliver an H4D course in Spring focused on cyber-physical security for energy networks in the School of Engineering
- Launch the H4D accelerator capability by Fall 2018

Long-Term Goals:

- Grow a professional workforce capable of solving real-world national security and policy problems
- Train 10 new universities in conducting the H4D course per year for a total of 20 colleges by the end of Year 3
- Create a 21st Century "ROTC" for technology and entrepreneurship students can contribute to national security by solving government challenges

NOTES

Wednesday, November 8th

Lidar for Wind Farm Control
Lidar Prototype for Autonomous Vehicles

Project /End Date: Fall 2016 – Dec 2017

Student(s) POC Info:

Matt Barger: mattbarger22@gmail.com

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Stephanie Matherly: smatherly09@gmail.com

Kyle Wiegert:kyle.wiegert@asu.edu

Daniel Butler: Afterthought62@cox.net

Shawn Mills: millss_@msn.com

Professor POC Info: Ron.Calhoun@asu.edu

Objectives:

1. Veterans/grad students establish photonics lab
2. Design educational test equipment for Sensor School.
3. Vet involvement in design prototype lidar for autonomous vehicles
4. Validate new wind retrieval method and develop enhanced detection algorithms for Doppler lidar.
5. Sensor School – curriculum development
6. Journal publications of a) new wind retrieval algorithm and b) augmented reality in atmospheric science, c) gust impact prediction for wind turbines.

Product Schedule/ Milestones

1. Establish Photonics Lab – first 9 months
2. Testing equipment & Student Hands-on Training - 2017 - present
3. Summer 2017 participate in design of new lidar Prototype

Current Status/ Accomplishments

1. Photonics Lab up and running
2. Student photonics experiments & presentation completed
3. Prototype lidar designed & mostly assembled
4. 3 Journal Papers written & in editing

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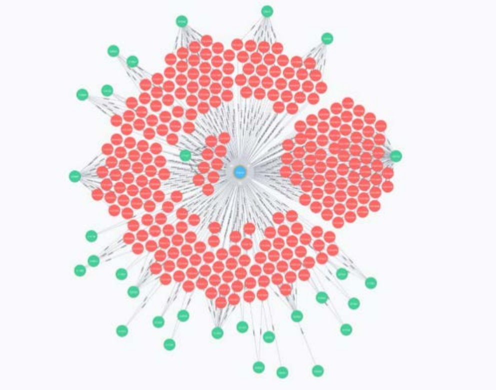
NOTES

HETAI

Hacker Energy Threat Actor Identification



Project Start Date: 10/15/2016
Project End Date: 10/14/2019

Student(s) POC Info:

Vivin Paliath (Army veteran)

Cody Iwertz (Army ROTC)

Professor POC Info:

Paulo Shakarian (Army Veteran)

Objectives:

1. Understand factors contributing to hacker reputation
2. Create decision support algorithms to better counter actions of hacking communities
3. Pilot experiment on association of darkweb data with infrastructure enterprise network events (based on data availability)

Product Schedule/ Milestones

- Hacker social network analysis infrastructure created
- Infrastructure for time-series prediction created, obtained initial results

Current Status/ Accomplishments

- Paper leveraging hacker social networks for vulnerability prioritization accepted to CSS
- Paper on use hacker reputation scoring submitted
- Associated spin-out company won Defense Innovation Challenge

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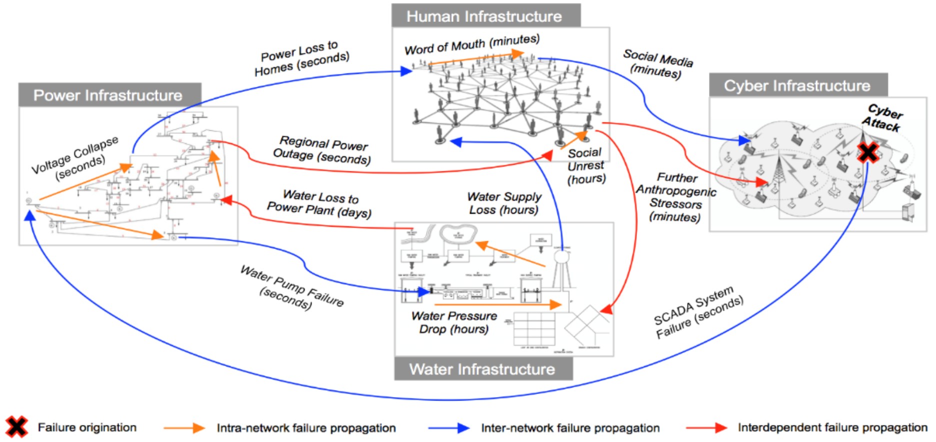
NOTES

RESILIENCE OF CRITICAL INFRASTRUCTURE TO CYBER ATTACKS



Start Date: Sept 2016 **End Date:** Aug 2019

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Anna Scaglione, Professor
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Javier Benavides (US Navy), Research Assistant
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Ed Barela (US Navy), Research Assistant
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Mahdi Jamei, Research Assistant
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John Abbot, Research Assistant
jabbott1@asu.edu

Objectives:

1.Enumerate connections and interdependencies between cyber systems and power, water, and gas infrastructures

2.Provide an interactive decision-support tool that allows strategic and operational personnel to simulate, analyze, and mitigate the effects of cyber events on critical assets

3.Expand applied research for contingency analysis routines for coupled infrastructures including cyber systems

4.Engage industry partners on above threats and prevention

5.Create a "black box" tool for synthetic generation of power, water, gas, and cyber networks to auto-generate n-many infrastructures for scientific inquiry and training

6.Train 20 Veterans, Actives, or S&T personnel in cyber-attack identification and mitigation

Product Schedule/ Milestones

Year 1: Integrate cyber-physical capabilities for power infrastructure to RISE. Develop model for one military base and/or one city with power-cyber infrastructure.

Year 2: Add cyber-physical capabilities for water infrastructure to RISE. Expand RISE simulation tool to water-cyber. Develop basic science for interdependencies of gas-power networks. Conduct training.

Year 3: Add cyber-physical capabilities for gas infrastructure to RISE. Expand RISE simulation tool to gas-cyber. Refine RISE with Navy base and S&T engagement. Conduct training.

Current Status/ Accomplishments

- Enumerated and completed based component models for cyber-elements of power and water infrastructures
- Completed cyber-power infrastructure equation sets
- Trained 7 Veterans in cyber-attack identification & mitigation

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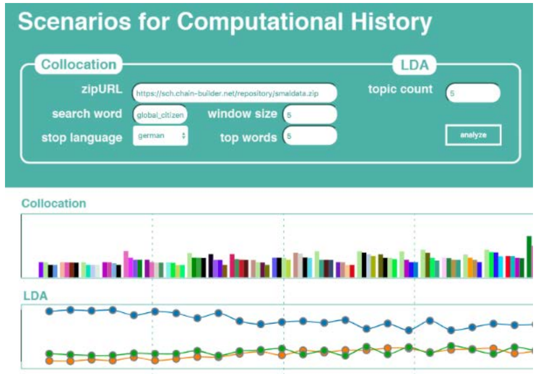
NOTES

Decisions from Data Using Operational Records



Phase 1 End: May 2017
Phase 2 End: December 2017

Project Team

Michael Simeone

Assistant Research Professor

Biosocial Complexity Initiative

Students:

Ashish Kumar Thotakura
Daniel Kercheski (US Navy)
Jamey Shuler (US Navy)
Prathmesh Jirange
Samuel Naveen Benadict Bellam
Kiran Potluri

ARIZONA STATE UNIVERSITY

NEPTUNE Alumni

Tyler Gold
U.S. Air Force

Steffan Nelson:
US Navy

Jared Connor:
US Marines

Objectives

- Enhance organizational learning from physical and paper document/text archives (social media, reports, news). Data sets: nuclear energy plant operations, buildings and facilities energy and reliability
- Design modules for analysis and visualization that organizational leadership can deploy in agile ways
- Train students in designing research around text data
- Emphasize skills in communicating results from data analysis and data science, telling stories from data

Product Schedule/ Milestones

August 2017: Integration of modules into decision support software framework, expand to more document collections

December 2017: Extension of decision support technologies to ASU Facilities and Buildings data

Current Status/ Accomplishments

Integration of operations analytics with multi-display decision support framework

100% Placement of grads in FTE or graduate study

Increase technology leadership skills of participants

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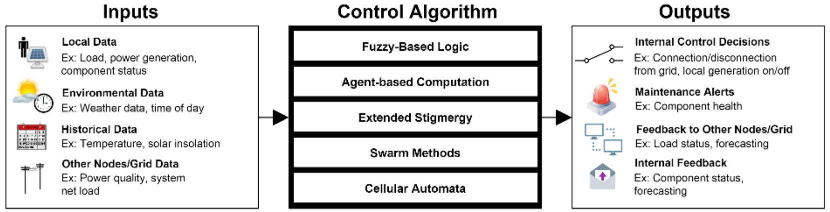
NOTES

CYBERPHYSICAL SIMULATION AND CONTROL OF INTERCONNECTED SELF-ORGANIZING MICROGRIDS



Start Date: Sept 2016 **End Date:** Aug 2019

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Joseph Aorhim (US Marines), Research Assistant
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Derek Hamel, Senior Software Architect
dbhamel@asu.edu

Samantha Janko, Research Assistant
sjanko@asu.edu

Objectives:

1. Develop and test algorithms for self-organizing microgrids that enable self-awareness, self-management, and self-diagnosis without higher-level controls
2. Establish interoperability requirements for plug-and-play microgrids that permit rapid expansion and adaption to changing needs in civilian and military applications
3. Create and test microgrid hardware configurations for mobile deployment with on-board self-organizing controls
4. Train 100 Veterans in microgrid sizing, design, component selection, integration, operation, and maintenance
5. Train 20 Veterans in electric grid operation using real-time SCADA system for transmission and distribution dispatch
6. Expand industry engagement for commercialization

Product Schedule/ Milestones

Year 1: Complete cyberphysical setup with portable microgrid integration & testing at ASU. Capacity building for 30-50 Active, Veteran, or ROTC.
Year 2: Complete cyberphysical setup with portable microgrid integration & testing at one base and/or academy. Work with service branches to scale research and training.
Year 3: Create a technology transfer package for portable self-organizing microgrids and cyberphysical testing environments to reach higher TRL.

Current Status/ Accomplishments

- 2 mobile microgrids setup for experimentation
- 45 Veterans trained in microgrid boot camp
- 25 Veterans trained in real-time grid operation
- 4 publications accepted, 4 in review or in preparation

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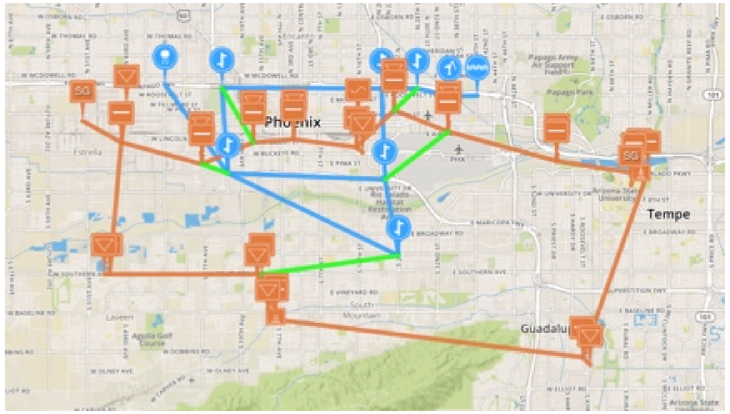
NOTES

SIMULATING MILITARY BASE VULNERABILITY AND RESILIENCE TO EXTREME EVENTS



Start Date: Sept 2016 **End Date:** Aug 2019

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Eitan Gerson (US Marines), Research Assistant
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Derek Hamel, Senior Software Architect
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Emily Bondank, Research Assistant
ebondank@asu.edu

Objectives:

1. Characterize how vulnerabilities in US Military base infrastructure are exacerbated by weather events
2. Evaluate how these vulnerabilities increase the potential of failure within individual infrastructures as well as cascades across multiple infrastructures
3. Provide an interactive decision-support tool that allows strategic and operational personnel to simulate, analyze, and mitigate the effects of extreme events on critical assets
4. Evaluate human-environmental-infrastructure interactions to refine and support decision-making to avoid conflict and increase stability
5. Train 20 Veterans, Active, and S&T personnel in design and control of multiple interdependent infrastructures

Product Schedule/ Milestones

Year 1: Integrate power-water network interconnections and dependencies into a real-time model that can simulate base functionality and system operations. Hold interactive discussions with base operations/managers.

Year 2: Complete one model of a military base or a mock base for research and training purposes. Enumerate options to reduce incidence of failure. Conduct interactive training.

Year 3: Demonstrate infrastructure evaluation tool for Navy and DoD personnel. Conduct interactive training.

Current Status/ Accomplishments

- Completed “alpha” version of decision-support tool RISE
- Interviewed various military personnel and civilians on military base operations
- 2 publications in preparation

 This work has been supported by ONR: N00014-15-1-2867

NOTES

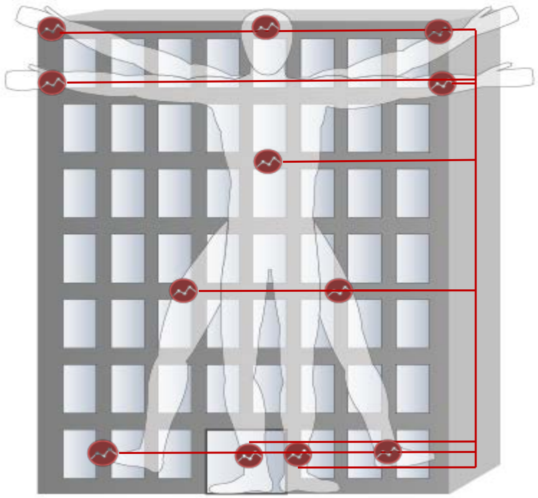
Challenge Summit Overview

Ray Dick

NOTES

Building Sensory System

The **BSS** is a physical, embedded building system that collects, stores and distributes information on environmental and operational parameters commonly utilized by a building's energy consuming equipment.



Students Researchers:

- Bryn Cloud, becloud@ucdavis.edu
- Andrew Chapman, akchapman@ucdavis.edu

Professor and Principal Investigator:

- Michael Siminovitch, mjsiminovitch@ucdavis.edu

Co - Principal Investigator and Project Manager:

- Cori Jackson, cmjackson@ucdavis.edu

Project Start Date: 9/1/2017; **Project End Date:** 8/30/2020

Research Objectives:

- Develop a detailed, practical design for an embedded sensory system for commercial buildings using commercially available technology
- Deploy a multi-room, system prototype including a data storage and distribution platform
- Test the prototype system under controlled laboratory conditions to validate system design

Product Schedule/ Milestones

- 9/1/2017 Project Launch
- 1/31/2018 Inventory and analytical project prototype requirements defined
- 8/31/2018 Building Sensory System prototype specification complete
- 6/30/2019 Laboratory BSS demonstration and evaluation launched
- 12/31/2019 Phase A laboratory evaluation complete (sensing and data storage)
- 6/30/2020 Phase B laboratory evaluation complete (data delivery to end use systems)
- 8/31/2020 Project Complete: BSS functioning prototype and construction process defined, demonstrated and ready for pilot-scale field trial

Current Status/ Accomplishments

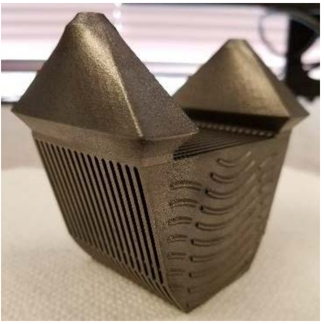
- Project launched 9/1/2017, Research in progress
- Research team assembled, students working on poster for Fall Neptune Conference
- Commercial buildings inventory: energy-consuming systems and equipment: In Progress
- Inventory of commercial building operational and environmental parameters available for automated sensing: In Progress
- Analytical assessment of building construction sequences: In Progress

 This work has been supported by ONR: N00014-17-1-2811

NOTES

High Performance Recuperator for Waste Heat Recovery Cycles

Project Start Date: 01/01/2016
Project End Date: 12/31/2017




Gen II Additively Manufactured HX's (designed by UC Davis; fabricated by collaborator on DE-FE0024064: Carnegie Mellon University, PI: A. Rollett)

Student(s)/Engineers/Post Doc. POC Info

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Professor POC Info:

Dr. Vinod Narayanan- vnarayanan@ucdavis.edu

Objectives of first project

1.Establish a simplified thermal, fluidic, and mechanical model to design the recuperator

2.Validate the mechanical integrity and thermofluidic performance of a chosen design from the model output based on laboratory-scale experiments, and

3.Optimize the design of the recuperator based on realistic constraints of system backpressure

Objectives of continuation project

Scale up of the lab-scale recuperator from prior grant to 10 kW and demonstrate in burner facility at UC Davis

Product Schedule/ Milestones of first project

Months 1-12: Thermofluidic & mechanical model
Month 11-22: Experimental validation
Month 20-24: Design optimization

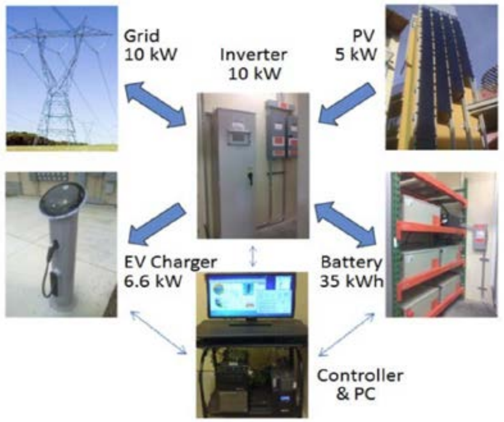
Current Status/ Accomplishments for first project

1. Completed thermofluidic and structural design of second generation (Gen II) AM recuperator (Obj. #1&3)
2. Completed development of mechanical integrity facility for cyclic pressure & temperature testing (Obj. #2)
3. Developed and constructing test facility for Gen II recuperator experiments in simulated exhaust stream (Obj. #2)
4. Successfully AM fabricated Gen II recuperators and welded inlet/outlet fluidic tubes (by external partners)

Distribution Statement A. Approved for public release, distribution unlimited. DCN# 43-3311-17. This work has been supported by ONR: N00014-17-1-2811

NOTES

Modular Solar-Battery Microgrid utilizing 2nd Life Electric Vehicle Batteries with Advanced Energy Management Control



Left: Image of 300kWh Modular Second-Life Energy Storage System. Right: ITS Davis microgrid system architecture.

Students POC Info: Joseph Lacap, jhlacap@ucdavis.edu

Sean Marsh, marsh.sean14@gmail.com

Professors POC Info: Jae Wan Park, jwpark@ucdavis.edu

Principal Investigator POC Info (all projects): Siva Gunda, sgunda@ucdavis.edu

Project Manager POC Info (all projects): Katherine Bannor, kbannor@ucdavis.edu

Project Start Date: 010/01/2017

Project End Date: 09/30/2020

Objectives:

Develop a microgrid system utilizing second-life electric vehicle batteries and advanced energy management system. Demonstrate that the system

- can reduce community's daily average energy demand during peak times by more than 10%.
- can be profitable by selling ancillary services to the CAISO fast regulation market and participating in DR
- can be scaled for applications in military bases
- can be used for grid-independent operation for systems with high power demand and rapid ramp-rates.

Product Schedule/ Milestones

- Oct. 1, 2017 – Dec. 31, 2017: System design and modeling
- Jan. 1, 2018 – June 30, 2018: Battery pack and battery management system development
- Jul. 1, 2018 – Dec. 31, 2018: Controller development and safety review
- Jan. 1, 2019 – June 30, 2019: System installation and pre commissioning tests
- Jul. 1, 2019 – Dec. 31, 2019: System demonstration
- Jan. 1, 2020 – June 30, 2020: Analysis and final report

Current Status/ Accomplishments

- Preliminary microgrid simulation parametrization – October 2017
- Review current control system for inverter and EV charger – October 2017

This work has been supported by ONR: N00014-17-1-2811

NOTES

MDV/HDV Non-Tactical Vehicle Fleet Project

UCDAVIS

Project Start Date: January 1, 2016
Project End Date: December 31, 2017

Student(s) POC Info:

Alex Campbell amcampbell@ucdavis.edu

Eric Racadag, emracadag@ucdavis.edu

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Professor Info:

Dr. Gil Tal, gtal@ucdavis.edu

Objectives:

Conduct a technology review of currently available Alternative Fuel Vehicles (AFV) to determine the most cost efficient types of MDVs and HDVs to support its NTV fleet based on current usage profiles.

1) create a down-selection methodology that identifies MDVs/HDVs
in the Navy/USMC vehicle fleet
2) detail the infrastructure required to support each AFV;
3) outline the upfront costs, state/federal incentives
4) outline techniques and procedures to maximize the efficient usage of these AFVs.

Product Schedule/ Milestones

Conduct a literature review and commercial sources review to determine the methodology to be used (June 1st, 2016)
- Analyze the data set and produce summary statistics report (7 July, 2016)
- Assist in the production of materials for the In-Progress Reviews and participate in In-Progress Reviews (15 August, 2016)
- Develop GIS modeling tool (calibrated) August 2017

Current Status/ Accomplishments

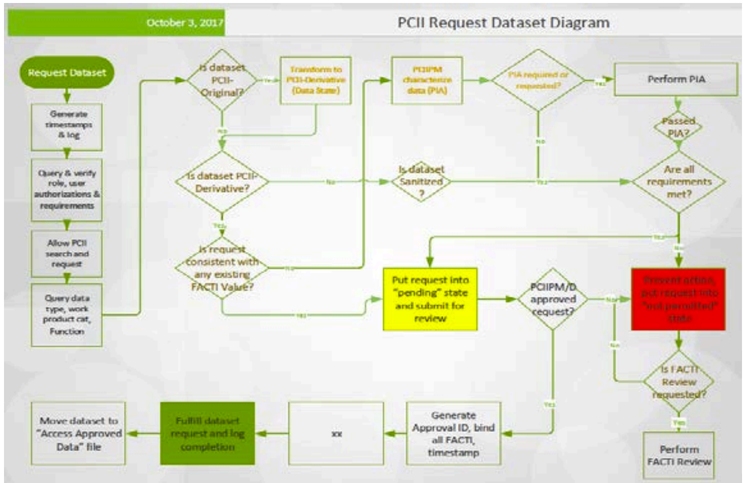
Adding NTC service to base PEV loweds
Analyzing PHEVs in fleet service 85%
Data cleaning and analyzing 100%

This work has been supported by ONR: N00014-17-1-2811

NOTES

Universal Data Platform

UCDAVIS
UNIVERSITY OF CALIFORNIA



Student(s) POC Info: None

Professor POC Info: Frank Loge (fjloge@ucdavis.edu)

Project Start Date: 01/01/2016
Project End Date: 12/31/2017

Objectives:

Develop a cloud based data platform
Import building audit data in platform

Product Schedule/ Milestones

- Trusted database framework. April – December 2016
- Export data into the database structure. January – June 2017
- Develop Analysis and visualization APIs. August 2016-November 2017

Current Status/ Accomplishments

- Development of the trusted data platform – nearing full completion.
- Testing of platform, data input testing
- Full documentation of how the trusted data platform is designed and developed, nearing completion (example diagram shown)

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NOTES

Portfolio-level Energy Auditing and Decision-making Methods & Tools

Project Start Date: 01/01/2016
Project End Date: 06/30/2018

Students POC Info: Liam Pitman, ljpitman@ucdavis.edu

Professors POC Info: Alan Meier, akmeier@ucdavis.edu

Principal Investigator POC Info (all projects): Siva Gunda, sgunda@ucdavis.edu

Project Manager POC Info (all projects): Katherine Bannor, kbannor@ucdavis.edu

Objectives:
Aid the transformation of small and medium (commercial and military) buildings by:

- Development of a “free, open-sourced” cloud – based portfolio level energy analytics platform to aid decision making.
- Development of portfolio-level energy auditing methodologies
- Standardization of methods, and framework for data integrity, collection, and data warehousing
- Identification of cost-effective energy savings measures
- Lower costs through the development of a stratified workforce
- Accelerate deployment with a Market Financing Platform

Product Schedule/ Milestones

- Evaluation of existing data platforms for building energy data. (Preliminary: January – March 2016, ongoing)
- Preliminary model of the energy auditing tool – June 2016
- Resided platform architecture and database framework. Sept 2016 – July 2017
- Export first setts of data into the database structure. Sept 2017 – April 2018
- Completer the first module of the platform: Auditing and energy visualization tool June 2018

Current Status/ Accomplishments

- Hired and on-boarded 3 veteran/dependant student employees to date
- Market research: (1) tools available and (2) opportunities for entry level audit work force – June 2016
- Preliminary data platform concept and structure – Dec 2016
- Document detailing set of measures applicable for small and medium sized buildings and methodologies for calculating energy, peak and financial savings – June 2017
- Software: audit forms in Zoho, html wireframes and wed-optimized forms (2) Vizualization code (3) database structure – June 2017
- Ongoing work to build a cloud based, universal data platform.

Distribution Statement A. Approved for public release, distribution unlimited. DCN# 43-3342-17. This work has been supported by ONR: N00014-17-1-2811

NOTES

Advancing Occupancy Sensing for Lighting Controls in Outdoor Applications

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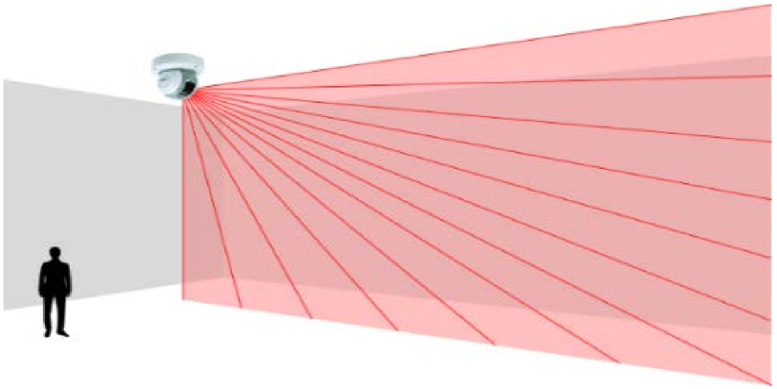

Project Start Date: January 1, 2016
Project End Date: December 28, 2017

Student POC Info: Raeita Mehraban
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Professor POC Info: Dr. Konstantinos Papamichael
CLTC Co-Director, Department of Design
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Objectives:

- Identify the shortcomings of existing occupancy sensing strategies and technologies for outdoor applications
- Develop new, improved occupancy sensing strategies and technologies for outdoor applications
- Demonstrate the improved solution under conditions representative of real-world, outdoor applications

Product Schedule/ Milestones

- ✓ 1/1/2016 - 9/30/2016
  Evaluate Existing Sensing Strategies
- ✓ 10/1/2016 - 6/30/2017
  Formulate New Sensing Approaches
- 7/1/2017 - 12/28/2017
  Implement & Evaluate New Approaches

Current Status/ Accomplishments

- ✓ Have completed evaluation of existing strategies
- ✓ Formulated new sensing strategies
- Implementing and evaluating new approaches

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NOTES

NEPTUNE Updates

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