

Summer 2020 Undergraduate Research Showcase

Research Poster Session

Honors College
Office of Undergraduate Research

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ONE**



Congratulations!

Thank you for participating
in our programs.

Opening Remarks

Presentations

Closing Remarks

Presentations

Order of Student Presentations

- Hana Ali, LSAMP-SRA
- Achyuth Manoj, URF
- Rebekah Lanning, UGRAP
- Jonathan Coria, UROP
- Sarah Nelson, URF
- Pranav Kadam, UROP
- Binoy George, URF
- Salwa Shoaib, UROP
- Ali Mhowwala, UROP
- Dominique Lange, UROP
- Anura Shrestha, UROP
- Kelle Plummer, URF
- Parvat Sapkota, UROP
- Ijaseun Toluwani, URF
- Nathaniel Steadman, UROP
- Bidur Kaphle, URF

*Peptidoglycan Modifications in
Acinetobacter baumannii Regulate
Carbapenem Resistance*

Hana Ali,

LSAMP-SRA,
Office of Undergraduate Research

Biology & Microbiology

Faculty Mentor: Joseph Boll, Ph.D.



UNIVERSITY OF TEXAS  ARLINGTON



Peptidoglycan Modifications in *Acinetobacter baumannii* Regulate Carbapenem Resistance

Hana Ali

LSAMP-SRA Summer 2020 Presentation - 08-03-2020

University of Texas at Arlington

Faculty Mentor: Dr. Joseph Boll



*Using Machine Learning to
Predict Band Gaps of
Metal-Oxides*

Achyuth Manoj,

Undergraduate Research
Fellowships, Honors College

Physics

Faculty Mentor: Muhammad N. Huda, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



USING MACHINE LEARNING TO PREDICT BAND GAPS OF METAL-OXIDES

Achyuth Manoj, Sajib K. Barman, Muhammad N. Huda



UNIVERSITY OF
TEXAS
ARLINGTON

OFFICE OF UNDERGRADUATE RESEARCH

PREDICTING BAND GAPS OF BINARY TRANSITION METAL OXIDES USING LINEAR REGRESSION

INTRODUCTION

- Density Functional Theory (DFT) is currently used for band gap predictions, but it is computationally expensive.
- Goal is to use Machine Learning as a compromise between reliable prediction and low computational cost.
- Hypothesis that there is a linear relationship between band gap and properties of the atoms in the unit cell of the materials, also known as features.
- The purpose is cost function optimization to find best fit model to predict band gaps.
- 3d and 4f transition metal oxides are targeted for the purpose of this project.
- Algorithm developed using Python for the calculation of the radial distribution function, bond length and coordination number.

FEATURES USED

- ☐ Oxidation States of anion and cation
- ☐ Formation energy of compound
- ☐ Covalent radius of anion and cation
- ☐ Ionic radius of anion and cation
- ☐ Coordination number
- ☐ Bond length
- ☐ Radial Distribution Function

FORMULAE

☐ The formula used to represent the linear relationship:

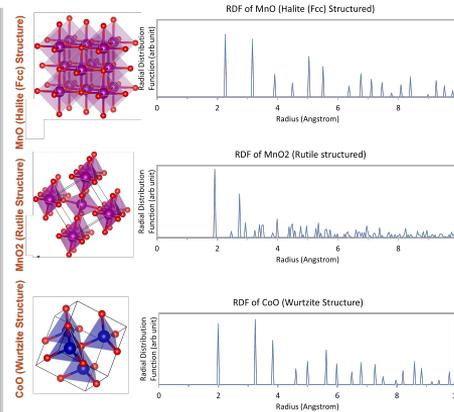
$$h_0(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3 + \dots$$

Where $h_0(x)$ is the predicted band gap, x_1, x_2, x_3, \dots are the features, and $\theta_1, \theta_2, \theta_3, \dots$ are their associated parameters

☐ The formula of Cost function which is minimized to find best model:

$$J(\theta) = 1/2 \sum_{i=1}^m (h_0(x_i) - y(x_i))^2$$

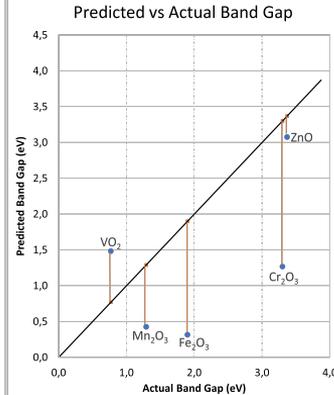
We want to obtain $\theta_0, \theta_1, \theta_2, \dots$ as the result of the model, then we use the first formula to predict band gap



METHODOLOGY

The data is divided into two sets, a training and validation set. The training set is used to train the model and update the parameters. The algorithm used here is known commonly as Stochastic Gradient Descent, which uses the hypothesis to predict the target from the training set, and the error between the prediction and the given output is used to update these parameters and the amount by which the parameters are updated are affected by a learning rate that we provide. Once we obtain a set of usable parameters, we then use a second set, known as the validation set, and compare the predictions made by the algorithm with the targets of the validation set. The cost function is a useful tool for comparison here.

PRELIMINARY RESULTS



NEXT STEPS

- ✓ Optimize the model using Cost function
- ✓ Explore relative weights of the features.
- ✓ Explore other features for the materials
- ✓ Explore other types of fitting
- ✓ Follow the same process for 4f transition metal oxides

DISCUSSION

- All features used were found experimentally, but the target values of band gap in the training set were obtained theoretically by GGA+U calculation.
- The target band gaps of validation set were found experimentally (except VO which has GGA+U calculation).
- Due to this, most of the predictions are far off, but ZnO was predicted with some accuracy, showing room for improvement.
- Suggests that experimental band gap will be more suitable for the training than GGA calculated values.

REFERENCES

1. Machine learning in materials science: recent progress and emerging applications. Tim Mueller, Aaron Glad Kusne, and Rampi Ramprasad; Reviews in Computational Chemistry, Volume 29, First Edition, (2016)
2. Artificial intelligence for materials discovery. Gomes, C., Selman, B., & Gregoire, J. . MRS Bulletin, 44(7), 538-544. (2019)
3. Machine learning in materials science: recent progress and emerging applications. Tim Mueller, Aaron Glad Kusne, and Rampi Ramprasad; Reviews in Computational Chemistry, Volume 29, First Edition, (2016)
4. Iterative minimization techniques for ab initio total energy calculations: molecular dynamics and conjugate gradients. M.C. Payne, M.P. Teter, D.C. Allan; Reviews of Modern Physics, Vol. 64 No.4. (1992)

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*How to
Set Up a Lab*

Rebekah Lanning,

Undergraduate Research
Assistant Program,
Office of Undergraduate Research

Biology & Microbiology

Faculty Mentor: Piya Ghose, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



How to set up a lab

My journey with the brand new Ghose lab

Rebekah Lanning, Idara Ekong, Karen Juanez, Ginger Clark, Piya Ghose



Introduction

This summer I have been taking part in Dr. Ghose's project "hypothesis driven gene identification of *Inp-1* (Lunapark)" In Dr. Ghose's lab we study cell biology, developmental biology, genetics, molecular biology, microscopy and cancer biology. One of the most essential and unexpected skills I developed this summer was how to set up a lab. This summer the Ghose Lab was brand new a *C. elegans* lab and I learned an essential skill as a future researcher looking into becoming a professor.

Essentials of opening a lab

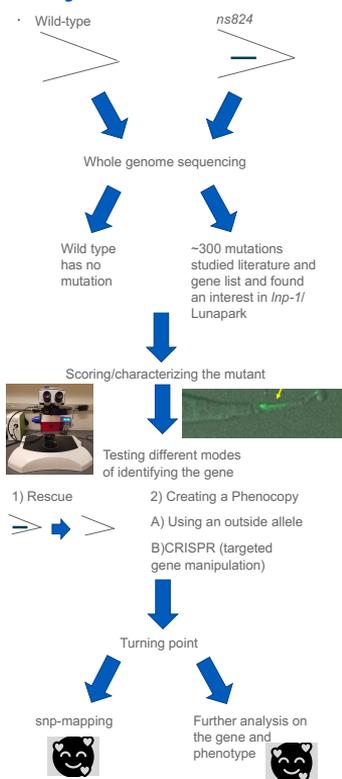
Background

- A PhD and scientific training
- A research question: Compartmentalized Cell Elimination
- A good lab team
- Sufficient funding
- A strong research university
- A good lab space
- A good model system for research

Lab checklist

- Clean the lab and bench area
- Build necessary organizational structures (shelves)
- Clean all glassware
- Interview students often
- Write protocols
- Learn about lab safety
- Equipment

Project directions



Personal Contribution

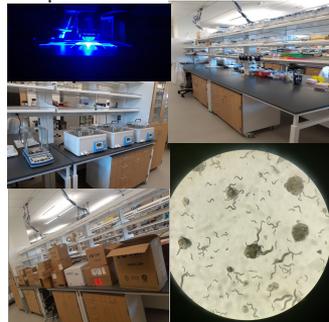
My most prominent contribution was

- Interviewing
- Protocol writing
- Presentations

Personal experience

The skillset I have developed this summer will allow me to successfully continue as an undergraduate researcher and beyond:

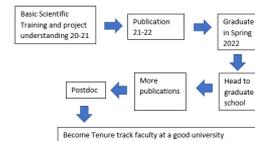
- Scientific article reading
- Presentation
- Bioinformatics skills
- Working collaboratively
- Basic microscopy
- Analytical skills
- Basic of cloning
- Basics of CRISPR
- Remote work
- Self awareness
- How to set up a lab during a pandemic



Conclusion

As I continue to develop as a researcher in the Ghose lab I gain more transferrable and analytical skills over time. In the future, I would like to produce more data and learn how to make posters with less words and more data and diagrams.

Motivations



References

1. Ghose P, Rashid A, Insley P, et al. EFF-1 fusogen promotes phagosome sealing during cell process clearance in *Caenorhabditis elegans*. *Nat Cell Biol*. 2018;20(4):393-399. doi:10.1038/s41556-018-0068-5
2. Gastegger E., Gattiker A., Hoogland C., Ivanyi I., Appel R.D., Bairoch A. *EXPASY: the proteomics server for in-depth protein knowledge and analysis* *Nucleic Acids Res*. 31:3784-3788(2003).
3. National Center for Biotechnology Information (NCBI) [Internet]. Bethesda (MD): National Library of Medicine (US); National Center for Biotechnology Information; [1988] – [cited 2017 Apr 06]. Available from: <https://www.ncbi.nlm.nih.gov/>
4. [15] Serial Cloner. Vers. 2.1. 2015. web.
5. WormBase: a modern Model Organism Information Resource. Todd W. Harris, Valerio Amaboldi, Scott Cain, Juancarlos Chan, Wen J. Chen, Jae Cho, Paul Davis, Sibyl Gao, Christian Grove, Ranjana Kishore, Raymond Y.N. Lee, Hans-Michael Muller, Cecilia Nakamura, Paulo Nain, Michael Paulini, Daniela Racioli, Faye Rodgers, Matt Russell, Gary Schindelman, Kimberly Van Auken, Qinghua Wang, Gary Williams, Adam Wright, Karen Yook, Kevin Howe, Tim Schedl, Lincoln Stein, Paul W. Sternberg (2019) *Nucleic Acids Res*. [akz920](https://doi.org/10.1093/nar/akz920)

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*Self-Diffusion in
2-D Silicon Nitride*

Jonathan Coria,
Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Biochemistry

Faculty Mentor: Peter Kroll, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Self-Diffusion in 2-D Silicon Nitride

An investigation into the temperature dependencies of silicon nitride using molecular dynamic simulations

Jonathan Coria, Dr. Peter Kroll



Introduction

Silicon nitride ceramics are poly-crystalline structures that can have high temperature resistances. Being able to understand the interactions and movement of these molecules at high temperatures can provide useful information to those seeking its potential. The goal of these molecular dynamic simulations is to acquire a mean square displacement and relate it to a diffusion coefficient that can then be used to find activation energies using each compound's temperature dependencies.

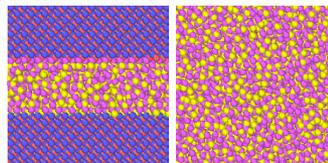
Methods

The simulations are conducted in a molecular dynamics program known as LAMMPS. By setting up an input script and giving ample time for the simulation to run, data that provides information about the mean squared displacement of each element present across certain times and temperature ranges.

Data extraction from simulations

- The initial step is to create a graph comparing the mean squared displacement of nitrogen with respect to time. This is done in order to find the slopes of each mean squared displacement line across different temperature ranges.
- Using the slopes, one can then create Arrhenius plots by calculating the natural log of the slopes with respect to inverse temperature to calculate the activation energies for certain temperature regions.

Models



There are 6 different models on which these simulations were ran on: one with a silicon nitride layer of 7 Å, 15 Å, 24 Å, one which was entirely made of silicon nitride, one in which all the conditions were already at 4000K, and another made entirely of silicon nitride but with all the molecules in new positions. The two models above correspond to the 24 Å model and "infinitely thick" silicon nitride model, respectively.

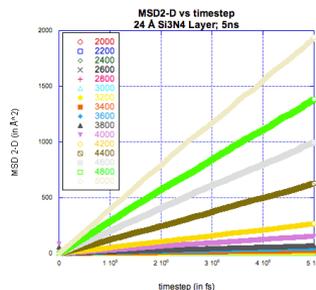


Figure 1: The graph about depicts the mean squared displacement of nitrogen as a function of time for each temperature at which the temperature was held constant for 5 nanoseconds. The slopes of these lines are necessary to finding the activation energy of nitrogen in this model.

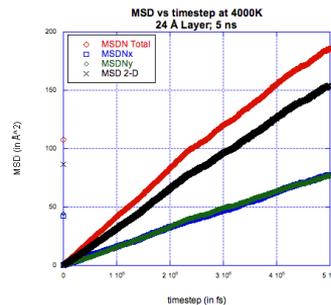


Figure 2: The graph above depicts what is being focused on in these simulations. 2D diffusion corresponds to the x and y components of movement, meaning that the z component is excluded in my calculations. The black line corresponds to the 2D diffusion of nitrogen at 4000K whereas the red line includes the z component.

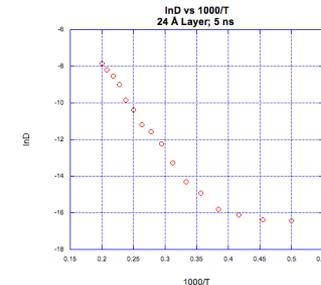


Figure 3: The graph above is an Arrhenius plot of the natural log of each temperature slope as a function of inverse temperature. The kink seen at lower temperatures demonstrates a phase change from a solid state to liquid state, therefore what we are focused on are the linear segments in the liquid state at higher temperatures.

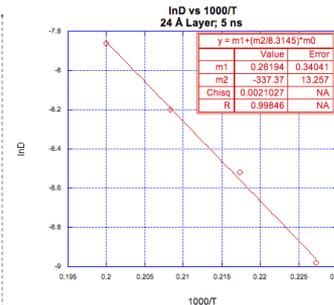


Figure 4: The region between 4400 K to 5000 K, which produces a nice linear line when plotted with an Arrhenius fit and produces an activation energy of 337 kJ/mol for this temperature region.

| Activation Energies | | |
|---------------------|-----------------|-------------------|
| Model | Temp. Range | Activation Energy |
| 7 Å | 4400 K – 5000 K | 834 kJ/mol |
| 15 Å | 4400 K – 5000 K | 353 kJ/mol |
| 24 Å | 4400 K – 5000 K | 337 kJ/mol |
| "Infinite" | 4400 K – 5000 K | 278 kJ/mol |

Results

As the silicon nitride layer increases, the activation energy decreases.

References

Garofalo, S. H., Kamp, Su, X. (2011). Atomistic structure of calcium silicate intergranular films between prism and basal planes in silicon nitride: A molecular dynamics study [Scholarly project]. In Cambridge Core. Retrieved from <https://www.cambridge.org/core/journals/journal-of-materials-research/article/atomistic-structure-of-calcium-silicate-intergranular-films-between-prism-and-basal-planes-in-silicon-nitride-a-molecular-dynamics-study/14238D803E05BADD799B4B1304C8F15>

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Contact Information

Jonathan Coria
jonathan.coria@mavs.uta.edu
UTA Department of Chemistry

*Titration of Glucose Concentrations
in C2C12 Cell Media*

Sarah Nelson,

Undergraduate Research
Fellowships, Honors College

Nursing

Faculty Mentor: Marco Brotto, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Titrating Glucose Concentrations in C2C12 Cell Media

An analysis of the impact insulin resistance has on skeletal muscle

Dr. Marco Brotto, Sarah Nelson, and Matthew Fiedler



Introduction

Insulin deficiency and insulin resistance are common etiologic traits of chronic, long-term hyperglycemia resulting in a subsequent diagnosis of **type II diabetes**. In correlation with the initiatives implemented by the NIH related to precision medicine, it is paramount to perform a methodological analysis of the effects of altering glucose concentrations on cellular metabolic capabilities. Thank you to Mrs. Bobbie Brown of the Honors College and Dr. Marco Brotto of the Bone-Muscle Research Center for giving me the opportunity to ask the question...

How does changing the concentration of glucose in cell media alter the metabolism, development, and acclimation of C2C12 skeletal muscle cells?

Purpose

The overarching goals of my summer research:

- Increase the quality of life and standard of nursing care provided in both out and in-patient settings.
- Improve glucose monitoring and insulin delivery systems.
- Give patients an opportunity to better maintain their blood glucose levels ensuring that a hypo/hyperglycemic crisis is less likely to occur.

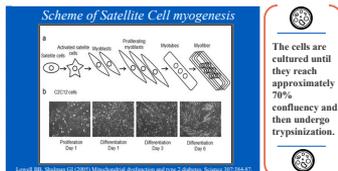


(Figure 1): Insulin Delivery System for Diabetics

Cell Culture and Ongoing Experimentation

C2C12 mouse skeletal myoblast cells will be cultured in a

1. Cell Growth Medium (CGM) (DMEM+FBS+P/S solution) and
2. Placed in a 37°C and 5% CO2 incubator.



After the addition and incubation (7 minutes) of trypsin-EDTA, 5-10 mL of CGM is added and mixed by pipetting

This solution can be transferred to a 15 mL conical vial and centrifuged at 280 ref(g)

Aspiration and resuspension of 1-2 mL of CGM is necessary in order to calculate the cellular density.

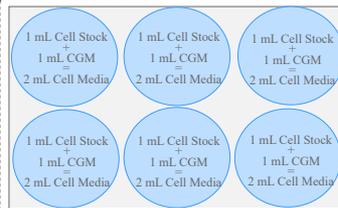
Once cellular density is confirmed by an automated cell counter, dilution of the **cell stock** can be calculated.

*After 24 hours, the old CGM must be removed and switched to differential media (DM) to enable **myogenic differentiation**.

(A) Negative Control Group: untreated differentiated C2C12 cells incubated in DMEM (2.5 g/L glucose) culture media

(B) Experimental Group: treated with a glucose-free DMEM concentrations titrated at 2.5, 10, and 20 mmol/L glucose

6-Well Plate



(Figure 2): 6-Well Plate Concentration Calculation

KEY
Cell Stock = 250,000 cells/mL
CGM = Cell Growth Media
Cell Media = CGM + Cell Stock

Data Analysis

DAPI Stain:

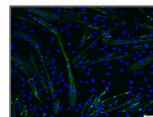
- Stains the nuclear protein

MHC Stain:

- Stains the myosin

Combined (DAPI + MHC):

- Combining a DAPI and MHC stain allows me to observe how many cells worked cohesively to form a myofiber and thus I can generate a **Fusion Index (FI)**. A FI is a measure of myoblast fusion within a myotube, which subsequently represents muscle growth



(Figure 3): Stained C2C12 myotubes



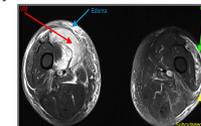
(Figure 4): Fusion Index Software

Conclusions

Due to limitations arising from COVID-19, my experiments are ongoing, and I cannot fully quantify my results as I am still in the cell culturing stage of my experimental design. Based on extensive literature reviews, my expectation is for the rate of skeletal myogenesis to **decrease** as the concentration of glucose **increases** past physiologic levels (5-6 mmol/L). This would confirm my hypothesis that chronic hyperosmolar states place patients with type II diabetes at a high risk for musculoskeletal complications such as diabetic stiff hands syndrome and muscle infarction.



(Figure 5): Prayer sign due to diabetic cheiroarthropathy



(Figure 6): Diabetic Muscle Infarction

Research Experience

This honors research fellowship has given me the opportunity to explore my interest in immunohistochemistry and foundational research science. I have also learned much in the way of microscopy and image processing. My goal is to continue and complete my experiments at the BMRC through this year until I can conclude the impact that glucose regulation and reuptake plays in skeletal muscle growth and healing.

References

1. Brotto M., Isaacson J., Albers E.L. (2016) The muscle-bone connection. In: Duque G., Keat D. (eds) Osteoporosis in Older Persons. Springer, Cham
2. Prashant, P. (2020, June 25). Insulin Delivery Systems Market Research Report. Clinical Advancements by 2025. Becton, Dickinson and Company, Novo Nordisk.
3. Vorpej MA, Abdelhamed NA, Qureshi S, Malik RA. Diabetic muscle infarction: often misdiagnosed and mismanaged. Diabetes Metab Syndr Obes. 2019;12:285-290
4. Yegoritskii Katic, Stevenant Alexander, Marinovic Marcus. Prayer sign due to diabetic cheiroarthropathy. BMJ 2017; 359 :a878

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*Do the Expectations
of an Employer Match
those of an Intern?*

Pranav Kadam,
Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Accounting & Finance

Research Mentors:
Kenyatta Y. Dawson, Ph.D.
& Lei D. Testa, CPA, CGMA

UNIVERSITY OF TEXAS  ARLINGTON





Do the Expectations of an Employer

Match Those of an Intern?

Pranav Kadam, Kenyatta Y. Dawson, Ph.D. and Ms. Testa
College of Business, The University of Texas at Arlington

★ ★ INTRODUCTION

This research analysis is about understanding the attitudes and desires of employers as well as interns who are seeking to complete an internship in accounting companies. Interns or employees have numerous expectations from employers. And not all aspirations are reasonable. At the conclusion of an internship course, for example, an intern was asked what he would recommend to the program director about the upcoming plan to ensure an intern's well-being. The intern recommended that free food be given more often. This assumption of an intern will be unfair, because full-time workers do not have regular lunch or dinner given by their employer.

From the employers' point of view, the intern or employee is paid satisfactorily, and thus, they are supposed to pay for their own food. It is just an example, the little expectation may be unreasonable. My work should seek to determine whether those rational or unreasonable expectations are from the viewpoint of the client and the rationale behind it.

🔗 METHODOLOGY

In order to complete my research I interviewed various interns from different sized accounting firms. This will take about 45 minutes to engage in the research. At this time, the participants will engage on a specified time and date in a semi-structured interview through Zoom. The focus is recognizing the attitudes and desires of managers as well as interns who are seeking to complete an internship at accounting firms. Gathering data could affect the credibility of the subjects if data breach occurs. This must capture and document identifying information with audio and/or images. Pseudonyms and all references resulting from this analysis should be included in final studies.

🔗 RESEARCH EXPERIENCE

Doing an internship in Spring 2020 made me realize that the expectations I had from my employer were very different from the expectations she had from me. It was then that I decided to conduct a research on these expectations of both the employer and the intern to inform the other students. Therefore, with the help of the UROP program and Dr. Dawson I coordinated with various accounting firms to interview their employers and interns. For the interviews, I prepared a questionnaire related to what both the parties expected before starting an internship. In order to prepare the questionnaire I read 10-15 articles published in the last 15 years. The hardest part while constructing the questionnaire was to not have repetitive questions. I was able to complete the questionnaire with the help of Dr. Dawson. Meanwhile I also worked on the consent forms needed to be distributed before the interviewees participated in the research.

To further help the students at my university, my faculty mentor and I decided to publish my research in the university newspaper. For this, my research needed an IRB approval and therefore after completing the paperwork for the IRB approval we will be able to start the interviews.



🔗 ACKNOWLEDGMENT

I would like to thank Dr. Dawson and Mrs. Lei Testa for their continued guidance, support and assistance in my research. Thank you, Ms. Ruthie Brock, for helping me with the research poster. Last but not the least I would like to thank my learning community including Mrs. Stephens, Nathaniel and Dominique.

📄 CONTACT DETAILS

Office of Undergraduate Research
Campus Center (CMPC), #109B
P.O. Box- 19085
Phone: 817-272-6045
Dr. Dawson, Assistant Director, Office of Undergraduate Research
Email Address: kenyatta.dawson@uta.edu
Pranav Kadam, Student Researcher of UROP,
University of Texas at Arlington
Email Address: pranav.kadam@mavs.uta.edu



#gleimCMA

*USING ULTRA WIDE BAND
SENSOR FOR ROBOT
LOCALIZATION IN GPS DENIED
ENVIRONMENT*

Binoy George,

Undergraduate Research
Fellowships, Honors College

Electrical Engineering

Faculty Mentor: Yan Wan, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



TIITLE: USING ULTRA WIDE BAND SENSOR FOR ROBOT LOCALIZATION IN GPS DENIED ENVIRONMENT

BinoY George and Yan Wan (PhD)

BACKGROUND:

In this project, UWB sensors by Decawave (DWM1001-DEV) are used for determining the position of a ground robot. The goal of this experiment is to determine the effectiveness of UWB as an alternative localization technology to GPS.

METHODS

1. Develop trilateration algorithm.
2. Set up a 3-Anchors 1-Tag system.
3. Test all data communication methods.
4. Implement algorithm to determine position



Decawave's UWB Transceiver Module, DWM1001-DEV

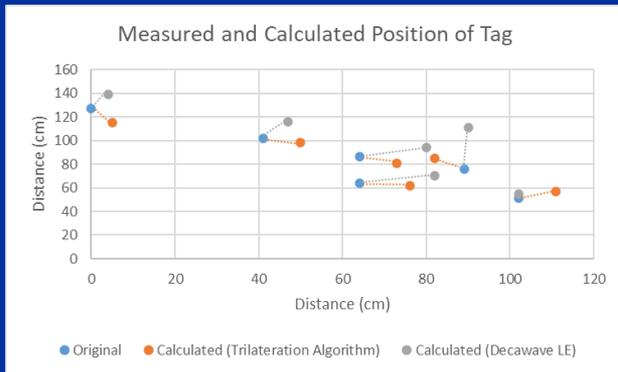
RESULT

The position of the tag within a 127cm*127cm area was determined using the trilateration algorithm created with an accuracy within 20cm. The UART mode of communicating data between sensor and server proved most efficient.

DISCUSSION

The results show that the UWB system can operate at a much higher localization accuracy than GPS. Thus UWb's application in position determination of self driving cars looks promising.

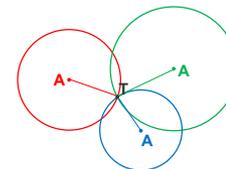
Tests show Ultra Wide Band system capable of localization with an accuracy less than 20 cm.



Scan QR code for test data, code, and references

TRILATERATION

- Two dimensional
- Asymmetrical Double Sided Two Way Ranging Extra Figures
- Linear Least Square method



```
18 = d13 = (x1-x3)^2 + (y1-y3)^2; %which is actually d13 squared
19 = d23 = (x2-x3)^2 + (y2-y3)^2; %which is actually d23 squared
20
21 = A = (x1-x3), y1-y3; x2-x3, y2-y3);
22 = b = (0.5) * ((x3)^2 - (x1)^2 + d13; (x3)^2 - (x2)^2 + d23);
23
24 = x = ((A*A)^(-1)*A*b);
25
26 = ans = x + 83'
```

```
Command Window
New to MATLAB? See resources for Getting Started.
>> Trilateration
Enter first anchor coordinates: [1 5]
Enter second anchor coordinates: [9 8]
Enter third anchor coordinates: [4 6]
Range of tag from first anchor: 3
Range of tag from second anchor: 10
Range of tag from third anchor: 5

ans =

    1.0000
    2.0000

fx >> |
```

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- My mentor, Dr. Wan, for her patient guidance and mentorship
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 - Bishrut for his assistance in the lab work.



*The Relation Between Cognitive
Function and Cerebral Vasodilatory
Reactivity in Young Adults with
Major Depressive Disorder*

Salwa Shoaib,

Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Exercise Science

Faculty Mentor: Jody Greaney, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



The Relation Between Cognitive Function and Cerebral Vasodilatory Reactivity in Young Adults with Major Depressive Disorder

Salwa Shoaib¹, Rauchelle E. Richey¹, Sherri M. Pham¹, John D. Akins¹, Dahlia Mukherjee², Erika F.H. Saunders², R. Matthew Brothers¹, Jody L. Greaney¹



Rationale

- Major depressive disorder (MDD) has been associated with an elevated risk of developing neurocognitive (e.g., dementia) and cerebral vascular (e.g., stroke) diseases. Although the precise neurobiological mechanisms aren't fully understood, cerebrovascular dysfunction is thought to directly contribute, at least in part, to impairments in cognitive function.
- In line with this concept, cerebral vasodilatory responsiveness (an index of cerebrovascular function) is blunted in older adults with MDD (~70 yrs.) and is thought to mechanistically contribute to the link between depression and increased neurocognitive cerebral vascular disease risk².
- In young, otherwise healthy, men and women with MDD, reductions in peripheral endothelium-dependent dilation are evident³. However, to date, limited investigations have examined cerebral vasodilatory responsiveness in young adults with MDD and its relation to cognitive function.
- We tested the hypothesis that greater hypercapnia-induced cerebral vasodilation would be related to greater fluid cognitive ability (i.e., the capacity to process and integrate new information) in young adults with MDD.

Approach

- Adults with MDD had clinically significant depressive symptoms, classified via the diagnostic Mini-International Neuropsychiatric Interview. Depressive symptom severity (PHQ-9) was also assessed. Healthy non-depressed adults (HA) were included as a control group and did not have a family history of MDD or major psychiatric illness.
- Beat-to-beat mean arterial pressure (MAP; finger photoplethysmography), heart rate (ECG), middle cerebral artery blood velocity (MCAv; transcranial Doppler Ultrasound), and end-tidal carbon dioxide concentration (PETCO₂; capnograph) were continuously measured during baseline (i.e., normocapnia) and rebreathing-induced hypercapnia. The increase in cerebral vascular conductance index (CVCI) = MCAv / MAP-1) was calculated from baseline to Δ PETCO₂ = 9 mmHg.
- Cognitive function was assessed using the NIH Toolbox Cognitive Function Battery (iPad). Fluid (the ability to use logic in new situations) and crystallized (the ability to use learned knowledge) composite scores were derived and a total cognitive function composite score was subsequently calculated. A fully corrected T-score was calculated for each participant to account for age, education, sex, and race/ethnicity. Fully corrected T-scores have a normative mean of 50 (standard deviation 10).

Results

Table 1. Participant Characteristics.

| | Age (yrs) | BMI (kg/m ²) | MAP (mmHg) | HDL (mg/dL) | LDL (mg/dL) | HbA1c (%) | PHQ-9 |
|---------------------|-----------|--------------------------|------------|-------------|-------------|-----------|----------|
| HA (n=9; 6 women) | 22 ± 1 | 26.5 ± 0.6 | 82 ± 5 | 54 ± 4 | 80 ± 7 | 5.2 ± 0.1 | 3 ± 1 |
| MDD (n=10; 8 women) | 22 ± 1 | 22.6 ± 1.4 | 81 ± 5 | 64 ± 3 | 83 ± 8 | 5.1 ± 0.1 | 10 ± 2 * |

HA, healthy adults; MDD, major depressive disorder; BMI, body mass index; MAP, mean arterial pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; HbA1c, glycated hemoglobin. Data are ± SEM. *p<0.05 vs. HA

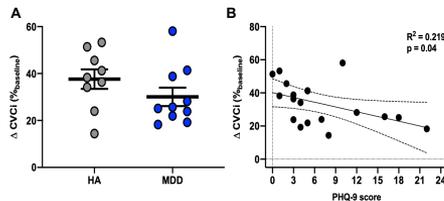


Figure 1: The increases in cerebral vascular conductance index (ΔCVCI (%baseline)) during hypercapnia in healthy adults (HA) and adults with major depressive disorder (MDD; Panel A). The hypercapnia-induced increases in CVCI was not different between groups. However, in all subjects, increased depressive symptom severity (PHQ-9 score) was negatively related to the hypercapnia-induced increase in CVCI (Panel B). Data are mean ± SEM.

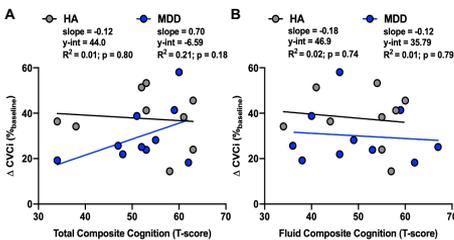


Figure 3: The relation between the total composite cognition (Panel A) or fluid composite cognition (Panel B) and the hypercapnia-induced increase in cerebral vascular conductance index (ΔCVCI (%baseline)) in healthy non-depressed adults (HA) and adults with major depressive disorder (MDD). There was no relation between cognitive function and cerebral vasodilatory responsiveness in either group.

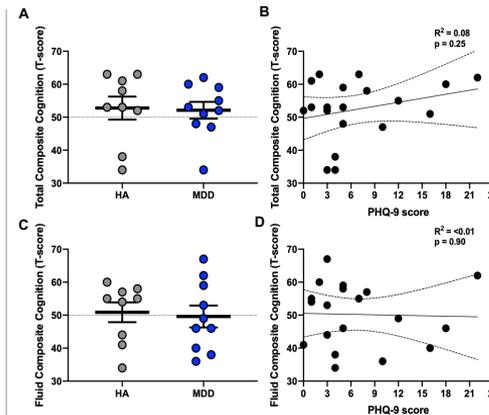


Figure 2: Total composite cognition was not different between healthy non-depressed adults (HA) and adults with major depressive disorder (MDD; Panel A) and was not related to depressive symptom severity (Panel B). Similarly, fluid composite cognition was also not different between groups (Panel C) and not related to depressive symptom severity (Panel D). Data are mean ± SEM. The slope and 95% confidence intervals are presented for the simple regressions.

Conclusion

- These data demonstrate that hypercapnia-induced cerebral vasodilation was negatively related to depressive symptom severity.
- However, neither total nor fluid cognitive function were related to depressive symptom severity.
- Further, contrary to our initial hypothesis, neither total nor fluid cognitive function were related to cerebral vasodilatory responsiveness in either healthy or depressed college-aged adults.
- This study allows us to better understand the underlying workings of MDD on the human body and may aid in developing interventional strategies in the future.

References

- Oberly, R. L., Crosso, E., Avunso, A., John, V. & Loewenstam, D. (2008). Depression and risk for Alzheimer disease: systematic review, meta-analysis, and meta-regression analysis. *Archives of general psychiatry*, 65(5), 530-538. <https://doi.org/10.1001/archpsyc.65.5.530>
- Neu, P., Schattmann, P., Schilling, A., & Hartmann, A. (2004). Cerebrovascular reactivity in major depression: a pilot study. *Psychosomatic medicine*, 66(1), 6-8.
- Greaney, J. L., Saunders, E. F., Sarthanam, L., & Alexander, L. M. (2019). Oxidative stress contributes to microvascular endothelial dysfunction in men and women with major depressive disorder. *Circulation research*, 124(4), 564-574.

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Dr. Jody Greaney, jody.greaney@duke.edu
Neurovascular Psychology Laboratory
College of Nursing and Health Innovation
<https://www.duke.edu/~jog2000>

*Designing Propulsion System
for light weight Electric UAV*

Ali Mhowwala,

Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Aerospace Engineering

Faculty Mentor: Dudley Smith, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Designing Propulsion System for light weight Electric UAV

Ali Mhowwala, Dr. Dudley Smith

Concept

Modern single main rotor/single tail rotor helicopters are complex mechanically, thus heavy and difficult to fly.

Major components include: main rotor, tail rotor, transmission/drive system, main engine, control system, etc.

This research explores a novel approach based on a tip drive propulsion which would remove the need for a tail rotor, transmission/drive and the large primary engine.



Figure 1. Example of a tip drive helicopter (Nagler-Rolz)

If emerging electric technologies were incorporated, this will enable the removal of the main engine and fuel system lessening the complexity.

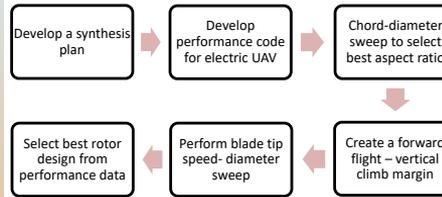
Background

- Tip Drive helicopters work by producing thrust near the tip of the rotor to produce the necessary rotor torque.
- This project involves developing a custom rotor hub with slip ring system for transmitting power and control signals from the non-rotating reference frame (the fuselage) to the rotating reference frame (the rotor).

Challenges

- From the research done previous year, start building tests.
- Design the experiment to test the theory using motor specifications previously calculated.
- Change to analysis and simulation step due to COVID - 19
- Develop rotorcraft synthesis code to evaluate electric UAV performance data.
- Select optimal rotor design based on synthesis results to maximize performance with minimized energy requirements.

Research Plan



Progress

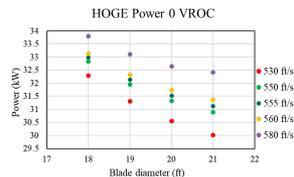


Figure 2: Power Required 0 Vertical rate of climb

Research indicated that at 0 vertical rate of climb, power required changed with diameter. Effect was more pronounced at lower tip speeds. The aspect ratio of blade was 21.

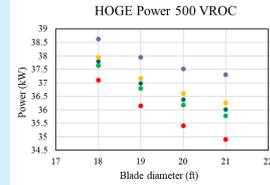


Figure 3: Power Required at different tip speeds

Same trend was observed at 500 VROC, lower diameter more power required. Total power required was still under 40 kW threshold.

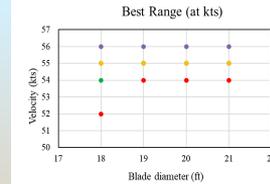


Figure 4: Best Range at different tip speeds

Range didn't vary with the diameter much but did increase with 20 ft/s increments of rotor tip speed.

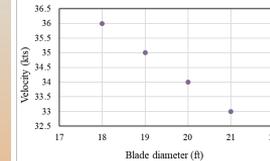


Figure 5: Best Endurance at different tip speeds

Endurance or how much helicopter can stay in air was a function of purely diameter and didn't vary at all with the rotor tip speed.

Conclusions and Future Goals

The goals were modified due to COVID-19 and an analytical synthesis of the system was performed to get the performance data of the system. The preliminary results were promising and the electric propulsion seems to deliver as expected. The design will be further refined based on the data. In future, once the situation improves, plan is to get the hardware and perform tests on a system prototype.

From Oppression to Power
African American Women Voters

Dominique G. Lange,
Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Interdisciplinary Studies: Political Science,
Law & Legal Studies, and Leadership

Faculty Mentor: Rebekah Chojnacki, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



From Oppression to Power African American Women Voters

Dominique G. Lange & Dr. Rebekah Chojnacki



Introduction

This year, the 100th anniversary of women's suffrage, and both the census and presidential election will take place. It is important now, more than ever to establish **understanding about voting behavior and patterns African American women.**

Significance of Research

The information gathered in this research will allow scholars to **understand African American women as an electorate.**

Voter Awareness & Identity

- As the 2020 United States presidential election draws closer, the task of examining the voting history of African American women in the south can provide key details on predicting future voter patterns. American polity outside of a homogeneous lens.

Renewed Understanding

- The information gathered in this research may help scholars to understand African American women as an electorate and better understand the underlying factors of political expression and participation.

Methodology

In a mixed-method approach, research will be conducted using both **quantitative and qualitative methods**, this approach will counterbalance the contemporary research aspect with historical research.

- A. Service Learning
- B. Fieldwork
- C. Interviews

Literature Review

Various peer-reviewed research journals, and books analyze the different perspectives and general consensus regarding the political engagement of African American women.

However, there is an **enormous gap in contemporary peer reviewed scholarship** about African American women voter turnout as well as what factors lead to the group's voter identity.

Research Goals

Moving forward my research will seek to answer **three key research questions:**

- To what extent does age, education, region, socioeconomic status, and voter identity influence voting behavior in the African American women electorate?
- How has the history of voter suppression and intimidation impacted the electoral participation of African American women?
- In what ways does voter suppression continue to hinder the participation of African American women in elections?

Personal Experience

During this experience, I have been able to pay closer attention to my **career goals, academic goals, and research.** I can confidently say that I have progressed as a researcher and learned effective ways to market both myself and my research.

- ✓ Ethics & Integrity
- ✓ Interpersonal Skills
- ✓ Finding "Why"



References

1. Chen, Lu. "A Dual Disenfranchisement."
2. Cole, Elizabeth K., and Abigail J. Stewart. "Meanings of Political Participation among Black and White Women: Political Identity and Social Responsibility." *Carolina, Kimberle*. "Mapping the Margins: Intersectionality, Identity Politics, and Violence against Women of Color"
3. Green, Y. Kees. "A Gilded Spirit: Race, Class, and Sex in the African American Church"
4. Kidd, Q., Peggy, H., Farooq, M., & Murray, M. (2007). *Black Voters, Black Candidates, and Social Issues: Does Party Identification Matter?*
5. Lawson, Steven E. "In Pursuit of Power: Southern Black and Electoral Politics, 1965-1982."
6. Leslie, Joel A. "The Cultural Basis of Party Identification."
7. Smooth, Wendy G. "African American Women and Electoral Politics." *edited by Susan J. Gamell and Richard L. Fus*. *Gender and Elections*

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Lastly, I'd like to recognize the assistance that I received from **Ms. Stephens, Nate, and Pranav.**

*Interconnected Fluid-filled Cells
for Prevention of Concussion:
Pendulum Impact Testing*

Anura Shrestha,
Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Biomedical Engineering

Faculty/Research Mentors:
Alexandra Lindsay &
Muthu Wijesundara, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



INTRODUCTION

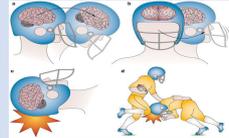


Figure 1: Impact injuries in sports

- Concussion is one of the most prominent sports related injuries that have lifelong consequences like cognitive impairment, sleep disorders, and even death in severe cases
- There are various technologies that have focused on decreasing the injuries related to impact in sports like high-tech mouthguards and helmets
- Our research focuses on the development of a novel design that uses hyper elastic materials that transfer energy from impact through interconnected cells and channels

DESIGN OVERVIEW

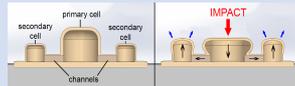


Figure 2: Interconnected fluid filled cells

Key features include:

- Fluid filled primary cell that receives impact
- The impact causes the fluid (air) to be transferred into the secondary cell through channels
- The secondary cells expand to absorb energy minimizing the impact to the person

METHODS

Pendulum Impact Test Setup

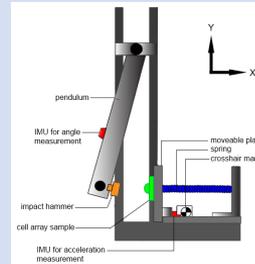


Figure 3: Pendulum Test Setup

VARIABLES TESTED:

- V1: Initial design
- V2: Initial design with a primary cell that has increased radius and height
- 2 Channels: Air cells with 2 channels
- 4 Channels: Air cells with 4 channels

To measure the ability of the cells to reduce the impact force transferred to the base, we set up a pendulum impact test, which was used to measure the reaction force as shown in the Fig. 3.

TEST PROCEDURE

1. The sample cell was attached to the movable plate
2. The pendulum with the impact hammer was dropped at 5m/s
3. A camera was used to record the displacement of the movable plate once it was hit with impact
4. The displacement data was used to calculate the reaction force of the air cells using Hooke's law.

Results

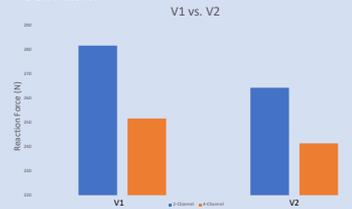


Figure 4: Comparison of force reaction of the air cells

- The average reaction force for air cells was lower in V2 in comparison to V1 as a result of increasing the radius and height of the primary cell (Fig. 4)
- The addition of channels resulted in lower reaction force of the air cells (Fig. 4) as it increases the overall volume for faster distribution of the fluid from the primary cell to the secondary cell

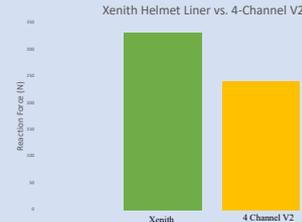


Figure 5: Comparison of force reaction Xenith helmet liner vs 4 Channels in V2 Air cells

- The average reaction force for air cells was lower in 4 channel V2 air cells in comparison to Xenith Helmet Liner cells (Fig. 5)
- We can conclude that our interconnected fluid-filled cells design has impact reduction capabilities comparable to a commercial helmet liner, therefore it has potential to be a competitive design as a full helmet liner

Experience



Continuing my internship at UTARI as an undergraduate intern, I got the opportunity to test the designs that we worked on Spring 2020. It was very interesting to participate in the designing, fabrication and testing of a product. I believe this experience help me further use engineering application to solve medical problems.

Future Considerations/ Goals

Previous research of this concept has proven its capabilities in impact reduction [1]. These results support that this concept has potential as a full helmet liner, and its impact reduction properties are comparable to a commercial helmet liner. We plan to develop a full liner with this design and will test it using a NOCSAE standard drop test.

References

- [1] Lindsay, A. R., Chaudhary, U., Terry, T. N., Haghshenas-Jaryani, M., & Wijesundara, M. B. (2019, November). Interconnected Fluid-Filled Cells Design for Reduction of Linear Acceleration and Force Transfer to Prevent Concussion. In *ASME International Mechanical Engineering Congress and Exposition* (Vol. 59407, p. V003T04A051). American Society of Mechanical Engineers.

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THE STRUGGLE IS REAL
Understanding the Experience of
Struggling Readers at UTA

Kelle Plummer,

**Undergraduate Research
Fellowships, Honors College**

Interdisciplinary Studies:

English & Disability Studies

Faculty Mentors: Sarah Rose, Ph.D.

& Catherine E. Corder, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



THE STRUGGLE IS REAL

Understanding the Experience of Struggling Readers at UTA

Kelle Plummer, Honors College Interdisciplinary Studies Major, working with Dr. Sarah Rose, Dr. Catherine Corder, and Mikila Salazar, studying the Intersection of English and Disability Studies



Introduction

Many students enter college as struggling readers due to low literacy levels and learning disabilities.

Keywords

Literacy: Using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential.

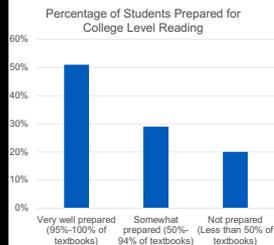
Learning disabilities: A number of disorders which may affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information.

Background

Larger numbers of students with disabilities are attending college. In 2015, that number was 11% equating two million students. Only 13% of these students seek accommodations.

20% of Texas students entering college are not prepared to read college-level textbooks.

This 20% includes students with learning disabilities and low-income students.



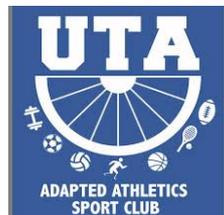
Research Question

How can the University of Texas at Arlington support students with reading difficulties?

Relevance

UTA serves a large number of students in both groups of students.

UTA ranks No.1 in Texas for serving first-generation, low-income students. The university is committed to dynamic and accessible programming for students with disabilities, including the Disability Studies Minor, Movin' Mavs, and Adapted Sports recreation programs.



Method

An Oral History method allows eye-witnesses to an event or experience to be interviewed.

Benefits: These students might be overlooked in a purely scholastic approach. To gain understanding of their personal experience adds depth to the historical record.

Limitations: Memory can be unreliable. Interviewers must suspend their agendas and biases in order to be effective.

This is a continuing research project. In the fall, interested UTA juniors, seniors, alumni, and students who identify as having a learning disability will be asked to participate in the interviews. Interviews will be coded for common themes.

Findings & Future

Findings from this research can lead to further discussion about resources and services that can increase the opportunity for student success.

Access to education has increased in part due to innovations in assistive technology and universal design. Approaching literacy and reading difficulties the same way, can allow an even greater number of critical thinkers to graduate from UTA.

References

- Baer, The Literacy of America's College Students. (2006)
- Learning Disabilities Association of America.org
- National Council on Disability. (2015).
- Perks & Thomson, The Oral History Reader, 3rd edition. (2016)
- UTA.edu.org (2020)
- Wilkins, C. REL Technical Brief -No. 018. (2012).

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Massive data generation for deep learning-based scatter correction of cone-beam computed tomography (CBCT)

Parvat Sapkota,

Undergraduate Research
Opportunity Program,
Office of Undergraduate Research

Physics

Faculty Mentor: Mingwu Jin, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Massive data generation for deep learning-based scatter correction of cone-beam computed tomography(CBCT)

Parvat Sapkota and Mingwu Jin (supervisor)



Introduction

- Cone-beam Computed Tomography (CBCT) is widely used in radiation oncology [1], however, reconstructed images from CBCT suffers from scatter contamination (Fig. 1).
- Deep learning is emerging as an effective scatter correction tool [2]. However, the existing methods have used the human data to train the deep learning programs.
- Goal of this study:** to use realistic digital phantoms to generate massive training samples for and Monte Carlo simulation and deep learning based scatter correction methods.

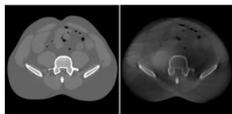


Fig. 1. Left: scatter-free CT image; right: scatter-contaminated CBCT image. (Figure from [4])

Methods

We developed two different classes of phantoms.

• First class of phantoms

For the first class, we used one patient data from the 4D XCAT program [3] to generate 15 different types of phantoms by changing its physical sizes.

Phantom generation using the same patient data

- Set five values for "phantom_height_scale" in the XCAT program, corresponding to 19.6th, 36.8th, 60th, 79.4th, and 98th percentile male height in US, while keeping other parameters default.
- Set five values for "phantom_long_axis_scale" in same ratio to heights previously were set, while keeping other parameters default.

- Set five values for "phantom_short_axis_scale" in same ratio to heights previously were set, while keeping other parameters default.
- #### Display of the thorax of phantoms
- Set "start_slice" and "end_slice" to view the thoracic section of the phantom.
 - Display the images using ITK-SNAP.

• Second class of phantoms

We also generated the second class of phantoms using extra 8 male and 8 female patient data.

Phantom generation using different patient data

- Replace the original .nrb file by the specific patient .nrb file in "heart_base" and "organ_file" parameters.
- For female phantoms, change "gender", "breast_type" and "which_breast" parameters.

Display of the thorax of phantoms

- Whole-body images of each patient were generated, and then imported into the ITK-SNAP program, where the active contour segmentation function was used to get the values of start_slice and end_slice for each phantom.
- Based on these values, the thoracic part was generated and displayed for all 16 patients.

Results

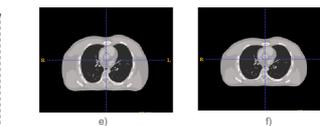
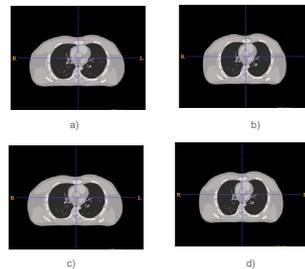


Fig. 2. First class of phantoms (transverse slices across the heart). a & b: Phantoms scaled in height (superior-inferior) (190 cm and 170 cm height, respectively); c & d) Phantoms scaled in the long axis (left-right) (190 cm and 170 cm); e & f: Phantoms scaled in the short axis (anterior-posterior) (190 cm and 170 cm)

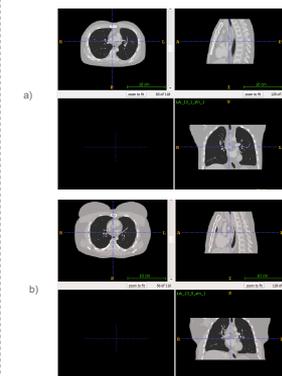


Fig. 3. Second class of phantoms (transverse, sagittal and coronal slices of the thoracic part). a) Male patient; b) Female patient.

Discussion/ Conclusion

Although the first class of phantom images look similar, they are different, which was verified from the differences in the volumes of lungs and heart. The second class of phantom images show more anatomical differences since the underlying patient data are different. Combining the both strategies in two classes, we will be able to generate thousands of phantoms for deep learning purposes.

Future Work

In future, we will generate a sufficient number of phantoms for use in CBCT Monte Carlo simulation as indicated in Fig. 4. Meanwhile, the generated phantoms can also be used for testing new methods in other medical imaging modalities.

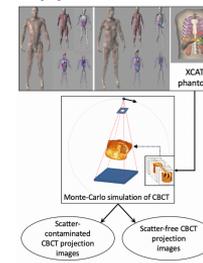


Fig. 4. Workflow of deep learning-based scatter correction for CBCT. (Part of the figure is from [2] and [3])

References

- Qian J, et al. Dose reconstruction for volumetric ... *Phys Med Biol* 2010;55:3597-3610.
- Lee H, Lee J. A Deep Learning-Based Scatter Correction ... *Electronics*. 2019 Sep;8(9):944.
- Segars W, et al. 4D XCAT phantom for multimodality ... *Med. Phys.* 2010;37(9):4902-4915.
- C. Zhao, ..., and M. Jin, Robust moving-blocker ... *PLoS ONE* 2017, 12(12): e0189620

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*Segmentation of Cardiomyocytes
using the Laplacian Pyramid*

Toluwani Ijaseun,

Undergraduate Research
Fellowships, Honors College

Biomedical Engineering

Faculty Mentor: Juhyun Lee, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON





Segmentation of Cardiomyocytes using the Laplacian Pyramid

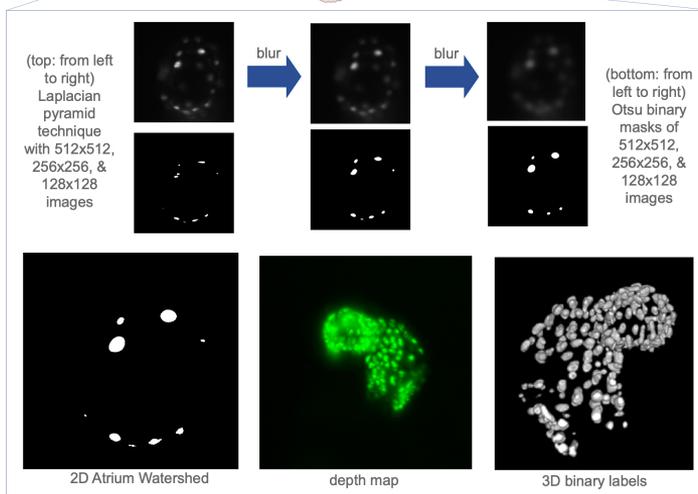
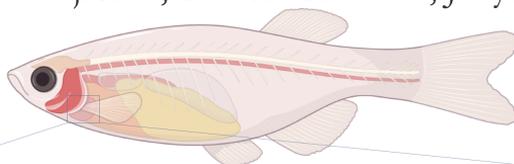
Toluwani Ijaseun, Tanveer Teranikar, Juhyun Lee, Ph.D.

Introduction

There are many components and techniques needed to successfully practice image processing. Since every image contains noise, image processing helps make the image clearer and easier to segment. For our research, these images will help identify fluorescence blobs in our zebrafish and study the effects of changing gene expression. Eventually, we believe this will help alter the genes for people with heart diseases.

Methods

- Image slices are taken into MATLAB and turned into depth map images to get a clearer view of the z-dimension.
- Depth map images are taken into Fiji and segmented using the 3D ImageJ plugins. These are the features used:
 - Gaussian blur
 - Image Scaling
 - Bilateral Filter
 - Image Subtraction
 - Background Subtraction
 - Binary Mask
 - Gray Morphology
 - Watershed
- Segmented images are taken into Amira to get a better look at 4D segmentation.



Discussion

- The Laplacian method allowed the downscaled images (256x256 & 128x128) to detect cardiomyocytes that were not spotted by the original image (512x512).
- Gray Morphology was used to 'open' the images and get rid of 'false' blobs that were detected during binary masking.
- The Gaussian blurring also helped Fiji better segment the cardiomyocytes, and the image subtraction helped reduce the noise from the depth map images.

Future Work

In the future, we plan to incorporate the Hessian Blob Algorithm in our segmentation process. This will allow us to:

- Pinpoint exact locations of cardiomyocytes (local max, local min, saddle points)
- Show clear change in intensity in images
- Set a more accurate threshold for intensity values

Acknowledgements & Contacts

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References

- Bhavna R, Uriu K, Valentin G, Tinevez J-Y, Oates AC (2016) Correction: Object Segmentation and Ground Truth in 3D Embryonic Imaging. *PLoS ONE* 11(8): e0161550. <https://doi.org/10.1371/journal.pone.0161550>
- Marsh, B.P., Chada, N., Sanganna Gari, R.R., et al. The Hessian Blob Algorithm: Precise Particle Detection in Atomic Force Microscopy Imagery. *Sci Rep* 8, 978 (2018). <https://doi.org/10.1038/s41598-018-19379-x>
- Wang, C., & Chang, F. (2011). A Multi-focus Image Fusion Method Based on Laplacian Pyramid. *Journal of Computers*, 6(12), 2559-2566. <https://doi.org/10.4304/jcp.6.12.2559-2566>



*Evaluating Physics-Based
Atmosphere Dispersal Model for
Quantifying Methane (CH₄)
Emission Rates from Natural Gas
(NG) Pipelines*

Nathaniel Steadman,

**Undergraduate Research
Opportunity Program,
Office of Undergraduate Research**

Civil Engineering

Faculty Mentor: Kathleen Smits, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Evaluating Physics-Based Atmosphere Dispersal Model for Quantifying Methane (CH₄) Emission Rates from Natural Gas (NG) Pipelines

Nathaniel Steadman¹, Dr. Kathleen M. Smits¹, and Shanru Tian¹

¹ University of Texas at Arlington, Department of Civil Engineering



Introduction

- Currently the EPA estimates the leak rate to be around 1.4% but after recent studies, the leak rate was found to be closer to 2.3%
- There are several models to determine CH₄ emission rates, but dispersal models are simpler, more accurate, and flexible.

Objective

- What is the effect of atmospheric pressure, wind, atmospheric stability and surface roughness on predicted emission rates?
- How do these effects that you quantify in the model agree/disagree with emission rates for similar conditions in the field?

Materials and Methods

Field data was collected on June 1, 2020 at Methane Emissions Technology Evaluation Center (METEC) where CH₄ concentration and atmospheric conditions were observed over a 20-hour period after gas reached a steady state in the subsurface. The controlled rate was 0.08 kg/hr from 12pm – 8am. The data is from the downwind direction at a single observation point.

The model uses an inverse modeling technique that tracks the methane particle from the sensor to the source to predict the emission rate based on the observed data of concentration and atmospheric conditions.

* <https://energy.cotstate.edu/metec/>

L = Monin-Obkhov Length (m)

u* = friction velocity (m/s)

θ_v = virtual temperature (°C)

k = von Karman's constant

H = kinematic surface flux (K-m/s)

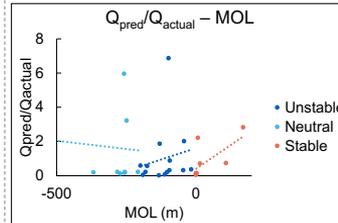
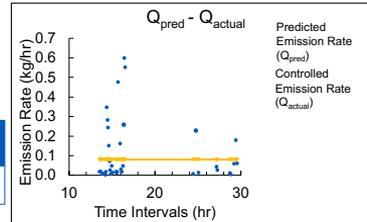
$$L = -\frac{u_*^2 \theta_v}{kgH}$$

Results

1. Comparison of Model Prediction and Controlled Emission Rate, Q

- The average ratio for $Q_{pred}/Q_{actual} = 1.39$, meaning that on average the model **overpredicted Q by 39%**

| Data Points | Average Emission Rate (kg/hr) | Standard Deviation | Prediction Accuracy |
|-------------|-------------------------------|--------------------|---------------------|
| 36 | 0.11 | 0.16 | 1.39 |



2. Comparing Atmospheric Stabilities

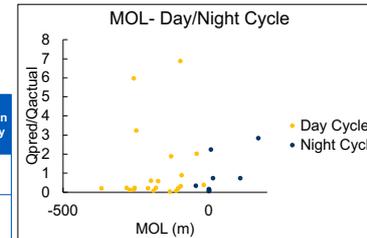
| Atmospheric Stability | Data Points | Average Emission Rate (kg/hr) | Standard Deviation | Prediction Accuracy |
|-----------------------|-------------|-------------------------------|--------------------|---------------------|
| Neutral | 8 | 0.101 | 0.173 | 1.27 |
| Stable | 8 | 0.0676 | 0.0861 | 0.64 |
| Unstable | 14 | 0.0807 | 0.144 | 1.01 |

- When the atmosphere was **unstable**, on average the model **overpredicted Q by 1%**

3. Comparing Day/Night Cycle

- Atmospheric stability changes as the day progresses with transitional changes during sunrise and sunset.

| Time Cycle | Data Points | Average Emission Rate (kg/hr) | Standard Deviation | Prediction Accuracy |
|------------|-------------|-------------------------------|--------------------|---------------------|
| Day | 21 | 0.0913 | 0.1543 | 1.14 |
| Night | 10 | 0.0605 | 0.07749 | 0.756 |



Conclusion

- In general, the model overpredicts Q by 39% which is not a bad average for model predictions
- Atmospheric stabilities has a big effect on the accuracy of the model with the unstable condition having the best accuracy by overpredicting by 1%
- The model has the best accuracy during the daytime when the atmosphere shares neutral and unstable stabilities.

Future Implications

- Collect more data at field site with more accurate sensors to measure atmospheric conditions
- Determine a better way to classify stabilities
- Compare the different ways to calculate Monin-Obkhov Length and its effect on the prediction of Q
- Complete coupled modeling of the subsurface and the atmosphere for a more realistic understanding of natural gas leak emission rate

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References

- Flesch, T. K., et al. "Deducing Ground-to-Air Emissions from Observed Trace Gas Concentrations: A Field Trial." *Journal of Applied Meteorology*, vol. 43, no. 3, 2004, pp. 487-502., doi:10.1175/1520-0450(2004)043<0487.0.co;2.
- Flesch, Thomas K., et al. "Backward-Time Lagrangian Stochastic Dispersion Models and Their Application to Estimate Gaseous Emissions." *Journal of Applied Meteorology*, vol. 34, no. 6, 1995, pp. 1320-1332., doi:10.1175/1520-0450(1995)0342.0.co;2.

*Localized Neutral Density Maxima
in the Upper Atmosphere*

Bidur Kaphle,

Undergraduate Research
Fellowships, Honors College

Physics

Faculty Mentor: Yue Deng, Ph.D.

UNIVERSITY OF TEXAS  ARLINGTON



Localized Neutral Density Maxima in the Upper Atmosphere

Bidur Kaphle¹ (bidur.kaphle@mavs.uta.edu), Yue Deng¹, and Cheng Sheng¹

¹Department of Physics, University of Texas at Arlington, Arlington, Texas, USA



Introduction

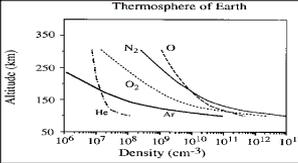


Fig: Neutral atmospheric densities for various molecular and atomic species [Cravens, 1997].

As we launch satellites in the atmosphere, they experience drag force exerted by neutral particles presenting in the atmosphere. This drag force is called satellite drag.

We still have no satisfactory explanation to the origin of localized neutral density maxima in the upper atmosphere. The work of our project is to explain the importance and effects of energy deposition and momentum exchange at different scales so as to describe the Ionosphere-Thermosphere system. The clear explanation of neutral density maxima is a path to explaining energy dissipation in the upper atmosphere, which we believe will be helpful to effectively and efficiently launch new satellites and run new missions.

Objectives

Though for many years, it was widely accepted that the majority of solar wind energy injection and dissipation in the geospace system occurred in the form of ring current and auroral precipitation, it was not only recently proven that the majority of solar wind energy enters Ionosphere-Thermosphere (IT) system (aka Upper Atmosphere) in the form of Poynting flux. [Dessler and Parker, 1959; Akasofu, 1981; Knipp et al., 2005; Huang et al., 2014]. Magnetic storms result in the heating of the IT system, and the precise spatial distribution of Poynting flux is still not completely well explained and understood [Thayer and Semeter, 2004; Deng et al., 2011; Huang et al., 2016]. The heating causes increase in ion temperature, neutral mass density and neutral temperature.

Previous studies have used percentage perturbations of neutral density to categorize active-time local neutral density variations and found most of the local neutral density maxima locate in the cusp and polar cap [e.g. Huang et al., 2014, 2016, 2017; Deng et al., 2013; Sheng et al., 2015]. Less attention has been paid to the absolute perturbations and the background neutral density. It is our interest to investigate the absolute perturbations in neutral density and further explore the causes of localized neutral density maxima in the upper atmosphere.

Methodology

For our research, we mostly focused on literature review and data analysis. We reviewed several articles to build the necessary theoretical argument to support our claim before working on data analysis to prove our point. We used data from GOCE, CHAMP, GRACE, and Swarm Satellites, and used absolute perturbations to describe neutral density maxima. We focused on comparing our results with previous studies, further discussing the possible significance of our research to better understand neutral density maxima and upper atmospheric response to solar and geomagnetic activities.

Previous work

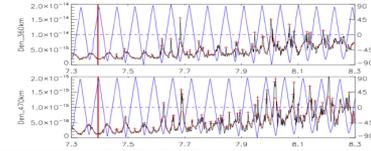


Fig: Neutral mass density (g/cm3) peaks over the northern hemisphere measured by CHAMP and GRACE for the storm event on January 7, 2005. Here, blue line denotes the Magnetic Latitude of the satellite, black line denotes the neutral density measurement, and red line denotes the moving average. (Huang, 2016)

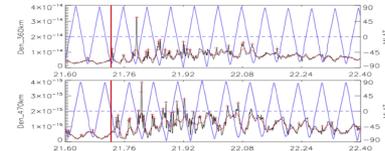


Fig: Neutral mass density (g/cm3) peaks over the northern hemisphere measured by CHAMP and GRACE for the storm event on January 21, 2005. Here, blue line denotes the Magnetic Latitude of the satellite, black line denotes the neutral density measurement, and red line denotes the moving average. (Huang, 2016)

Summary of Huang et al., [2016]

- Clear Poynting flux enhancements were seen in the polar cap while enhancements from all the neutral measurements were observed at high latitude pole ward of 80° MLAT suggesting that substantial heating was supplied to the polar cap during storms.
- The simulation of TIE-GCM shows less energy input in the polar cap than the observation.
- The comparison of neutral temperature enhancements at Resolute Bay between FPI measurement and TIE-GCM simulation shows a consistent underestimation of the neutral temperature in the model results. The simulated temperature increases by about 260° and 280 °K for the two storm events, respectively, which are much smaller than the observed changes (750° and 900 °K). This might result from the underestimation of Joule heating at high latitudes in the model as discussed in Huang et al. [2013].

Progress

```

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import os

# Load data from files
def load_data(directory):
    data = {}
    for file in os.listdir(directory):
        if file.endswith('.csv'):
            data[file] = pd.read_csv(os.path.join(directory, file))
    return data

# Example usage
data = load_data('data/')
# ... (rest of the code)
    
```

Python code

Working Progress

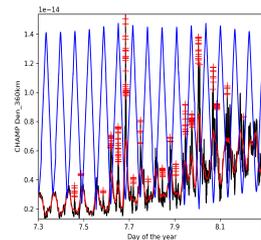


Fig: Modified version of Huang et al. [2016]

Here, Blue line denotes the latitude of CHAMP at 360km above the earth, black line denotes the neutral density at that point, red line is 23-minute moving average and “+” sign denotes the point where difference between neutral density and moving average is greater than 30%.

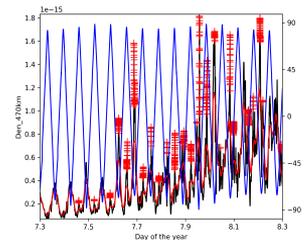


Fig: Modified version of Huang et al. [2016]

Here, Blue line denotes the latitude of GRACE Satellite at 470 km above the earth, black line denotes the neutral density at that point, red line is 23-minute moving average and “+” sign denotes the point where difference between neutral density and moving average is greater than 30%.

Difference from Huang et al, 2016

The difference in the number of local neutral density maxima (plus marks in the figures) between Huang et al. [2016] and our results might be due to different temporal resolution of the data. We believe our data have a higher temporal resolution than the data used by Huang et al. [2016].

Future work

We plan to use data from GOCE, CHAMP, GRACE, and Swarm Satellites and use absolute perturbations to describe localized neutral density maxima. We will plot the data, analyze the relation by comparing our finding to previous studies and further review the literature of previous findings to clearly interpret our results. We believe that this will give us new results on absolute changes which are necessary to draw the conclusions on localized neutral density maxima. This will help us explore the mechanisms of localized neutral density maxima and upper atmospheric response to solar and geomagnetic activities.

Our work will help us explore the mechanisms of localized neutral density maxima and upper atmospheric response to solar and geomagnetic activities. After getting all necessary information and obtaining results, the next step will be organizing the results and reporting them in a research paper.

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Citations

- Akasofu SI (1981) Energy coupling between the solar wind and the magnetosphere. Space Sci Rev 28:121–190
- Deng Y, T. Fuller-Rowell, A. Ridley, D. Knipp, R. Lopez (2013). Theoretical study: Influence of different energy sources on the cusp neutral density enhancement, J. Geophys. Res., 118 (5), doi:10.1002/jgra.50197
- Huang, C. Y., Huang, Y., Su, Y. J., Sutton, E. K., & Sutton, E. K. (2017). High-latitude neutral mass density maxima. Journal of Geophysical Research: Space Physics, 122(10), 10.694.
- Huang, C. Y., Huang, Y., Su, Y. J., Sutton, E. K., Hairston, M. R., & Coley, W. R. (2016). Ionosphere-thermosphere (IT) response to solar wind forcing during magnetic storms. Journal of Space Weather and Space Climate, 6, A4.
- Sheng, C., Y. Deng, Q. Wu, A. Ridley (2015), Thermospheric winds around the cusp region, J. Geophys. Res., 120: 1248–1255. doi: 10.1002/2014JA020028.

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- Nathaniel Steadman

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- Dominique Lange

Concluding Remarks

Thank You & Your Welcome!



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time to
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...& prep for Fall 2020!

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