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<thead>
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**Summer 2015**

**Research Posters 2015**

Spelman College G-STEM

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ABSTRACT
Sustainable tourism is an environmentally centered approach to travel. However, few studies discuss the effect it has on local communities from the perspective of community members. In Monteverde, Costa Rica local conservation efforts helped promote economic growth. In this project, the impacts of ecotourism on Monteverde were examined and the perspectives of residents were documented using video interviews and questionnaires. Ninety percent of participants agreed that ecotourism had positively impacted their lives. However, residents voiced a concern about the upsurge in trash and sought government programs to help offset the increase in litter and encourage recycling. Concern over loss of community and culture was recorded in 89% percent of surveys and the residents expressed interest in donating to conservation programs if they received certification for their participation.

BACKGROUND
Ecotourism is intended to minimally impact communities by contributing to an increase in economic infrastructure and development; biodiversity and natural resources; while promoting local involvement in the generation of capital and environmental appreciation. Monteverde is a small town located in Puntarenas, Costa Rica. With a population size of approx. 6,750 people. Conservation in Monteverde is linked to the Quakers.

RESULTS

<table>
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<tbody>
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<tr>
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<tr>
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</tr>
<tr>
<td>Average Eco-friendly activities</td>
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<td>2.26</td>
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</table>

CONCLUSION
Ecotourism in Monteverde impacted community members and encouraged sustainable living. However, the loss of culture and community were expressed in a large percentage of interviews.

METHODS
Questionnaires was given to residents of Monteverde in two groups: those living in Monteverde longer than 30 years who knew the community before ecotourism (n = 21), and those who knew Monteverde only after ecotourism (n = 15). Some of those interviewed also owned local businesses and answered additional related questions (n = 8). Individuals living and working in Monteverde (including residents of contiguous Cerro Plano and Santa Elena) were given surveys to complete. Questionnaires were intended to quantify and translate the perspective of the Spanish speaking residents. Each question were categorized and statistically compared. This project was approved by CIEE IRB.

ACKNOWLEDGMENTS
I would like to thank Alan Masters for helping me with the framework and structure. I would like to thank Kathy Rockwell for giving me a list of people to interview and a descriptive map for finding them. I would like to thank Aditi Pai my GSTEM mentor from Spelman College for advisement and guidance. Thank you for visiting and taking pictures during all of the interviews. I would like to thank Jose “Moncho” Calderon for translating my questionnaire and printing them for me. I would like to thank Spelman College and CIEE for sending me here. I would like to thank all of the amazing people of Monteverde and the businesses that were respectful and helpful. Finally, I would like to thank all of the amazing CIEE students and staff for all of the support and love. ¡Gracias!

LITERATURE CITED
The Development of an Eye-Tracking Program to Examine Working Memory During Gameplay

Jett Bagley
Dr. Po-Lei Lee, Dr. Yolanda Rankin
Computer Science

Introduction

In this experiment we work to examine brain activity and cognitive resources, by using a visual resource (virtual game of Mahjong) to study human working memory. Working memory is the process used to manipulate and maintain information so that the information can be used to carry out tasks (Baddeley, 1974). Many studies have shown that performance on working memory tasks are able to be correlated with performance on reading comprehension, intellectual aptitude tests, general intelligence, reasoning ability factors, and even moral judgments (Deman, C., & Carpentier, 1980; Oberauer, W., Schulze & Sub, 2005; Kane & Engle, 2001; Kihlstrom & Christal, 1990; DeCarlo, Thomas & Bellock, 2000; Moore, Clark & Kane, 2008). Furthermore, poor visual working memory, the small amount of visual information held in the mind to carry out cognitive tasks, has been connected to disorders like Attention-deficit/hyperactivity disorder (Castellanos & Tannock, 2002; Rapport, Alderson, Kofler, Sarver, Balden, & Stimpson, 2008).

It is possible that cognitive differences influence individual eye movement differences. For example, differences in intelligence, speed of processing, or working memory can influence the speed and direction of the eye during tasks.

Eye coordinates, or gaze information, informs visualization. Eye tracking is the process of measuring the relative motion of the eye or the point of gaze of the subject. Eye tracking technologies are used in video games, from camera operation to military weapon operation. In scientific research eye trackers, devices used for measuring eye positions, are used in study of the visual system. Previously research has used eye tracking to gain information on the cognitive resources of a subject. For example, tracking the eyes during a PowerPoint presentation to study correlations between information retention and the gaze of the subject (Slykhuis, Welb, Annetta 2005). In this study we’ve created an eye tracking system to study the working memory and cognitive differences with the purpose of provided insight into the reasoning behind individual working memory performance differences.

Materials and Methods

Materials

We used a Shaddi room, 12-Channel EEG System, Eye Tribe Eye Tracker, Dell P Series 22 inch 1680 x 1050 Monitor, 2 Toshiba Satellite 15.6 inch Notebooks, and Standard Computer Mouse to complete the experiment.

Methods

In creation of the eye-tracking program, the coordinates are passed from the Eye Tribe Gaze API. They are then filtered to account for off-screen gazing, blinks and other user disengagement with the screen on which the game is being played. Each coordinate is time stamped for later use when it is being matched with the screen capturing of the game and EEG signal being recorded.

Results

At start time, the program verifies its connection to the Eye Tribe Tracker system. The program then sets constraints of the eye coordinates it will receive based upon the size of the display. The red dot coordinates of the participant’s individual eyes are captured, as well as the overlap between the two eyes that represents the participant’s point of gaze. The gaze coordinate along with a timestamp are stored every 1/45 seconds. Below is a sample of the correlating code to these functions.

Summary & Conclusion

The study sought to determine if a relationship exists between individual differences in working memory, eye movement measures, and EEG signals. To determine if a correlation could be found, a working memory game was administered to participants while their eye movement and brain activity was monitored. My specific role was to create the code used in the eye-tracking program.

Overall, the program efficiently and accurately stored the gaze data of the participant. The program was able to capture only eye movements across a standard desktop monitor screen, incapable of recording coordinates beyond the screen. In result, further iterations of this experiment require faster capturing and larger monitoring capabilities to produce relevant results. The program produced could also be used for other studies in which eye movements need to be captured from participants. For example, in research for the development of tools to be used by patients with limited head and eye movement, able-bodied people are often used for testing. This program could be used to ensure testing participants stay within the limited eye movements that replicate patients with disabilities.

The fluxuation in Alpha and Beta neural oscillations and the cognitive abilities of participants were investigated in correlation to eye movements during gameplay to study the relationship between working memory, brain activity and game performance. The purpose of this experiment is give insight into the causes of differences in individual working memory performance. The subjects sat in a shielded room with Electromyography (EMG) electrodes placed along the frontal bone to target occipital lobe activity. The subjects’ Alpha and Beta waves were monitored during a three-minute gameplay session using an original program paired with the Eye Tribe Eye Tracker monitoring device. The program was written in C++ and developed in Visual Studio.

The program received and stored gaze coordinate data during two, three minute gameplay sessions. My specific role was to create the code used in the eye-tracking program. The code effectively captured the participant’s eye position up to 45 frames/second.

Acknowledgments

The program received and stored gaze coordinate data from participants. For example, in research for the development of tools to be used by patients with limited head and eye movement, able-bodied people are often used for testing. This program could be used to ensure testing participants stay within the limited eye movements that replicate patients with disabilities.

Part F). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the U.S. Department of Education. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.
Quantum Confinement is a relatively new subject matter in quantum mechanics. Although the principle has existed for some time, the problem of quantum confinement has raised numerous issues pertaining to boundary conditions in elementary quantum mechanics and how they should apply to real problems. Quantum confinement traps the atom in a cavity whose dimensions are small enough to alter its properties. Sommerfeld and Welker were the first to take notice that a hydrogen atom confined in a sphere with infinite non-penetrable walls problem can be solved exactly. In previous works, physicist used the time-independent Schrodinger equation with boundary conditions to obtain exact results. The Schrodinger equation is a partial differential equation that describes how the quantum state of a physical system changes with time. There is the time-dependent equation and the time-independent equation. The time-dependent equation, the most general equation, gives a description of a system evolving with time while the time-independent equation describes stationary states. In real situations, the cavity the atom or molecule is being held in is never fully impenetrable. Henceforth, this research focuses on what happens when the hydrogen atom leaves captivity.

Methods and Material

Materials used for this research program comprised the program Eclipse that was used for the computer programming language C++. This project studied the effects after a hydrogen atom is released out of a container using a very simple model of confinement that describes the reality of a hydrogen atom in captivity. The following definitions and descriptions are essential to understanding the results presented in this paper. Schrodinger equation is used as a method of determining wave functions systematically. The wave function \( \psi(\mathbf{r},t) \) can be calculated from a partial differential equation called the Schrodinger wave equation where \( r \) relates to space coordinates and \( t \) relates to time. The time independent Schrodinger equation gives a description of a system evolving with time while the time independent Schrodinger equation predicts that wave functions can form standing waves. The general solution of the time-dependent Schrodinger equation can be expressed as a sum of separable solutions.

Acknowledgments

This research was based upon work supported by the National Science Foundation under Grant #HRD-0963629. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. This research was performed at the University of Cordoba located in Cordoba, Spain during June 1 – July 31 under the mentorship of Antonio Sarsa and Jeffrey Ehme. I would like to thank my mentors for their hard work and guidance throughout my research experience.
**Introduction**

Today there are so many products that exist in our society due to our capitalist economy that prides itself on the consumer’s next purchase, but the processes used to create and dispose of these products are not as sophisticated as they should be. This creates a problem because the corporations that are producing these goods are not thinking about the environmental impact that they are having. We use raw materials as though this earth contains an infinite amount to sustain our business, but unfortunately this mindset is depleting and destroying our natural resources through the extraction of raw materials, pollution, energy consumption, and improper waste management. In order to regulate how much our resources are going towards consumer goods, these businesses need to understand and be held accountable for how much they are using and make changes in order to sustain the earth and its resources for future generations. Both the Oikos and TRANSOL prototypes have the potential to decrease any excessive use of energy by utilizing the sun which is the best natural resource.

Doing a life cycle assessment (LCA) will show where less amounts of raw materials can be used in order to assess the potential environmental impacts that they could have.

**Materials**

**Oikos:**
- Aluminum infrastructure: The following materials were used to build the aluminum structure of the track that TRANSOL operates on: torches, 76x76x3 mm square units, 200 mm M12 aluminum screws.
- Solar infrastructure: The following materials were used to build the solar infrastructure that generated energy for the TRANSOL to travel on the track. The materials include: Topsola TSM-160M solar panels, a Regulatory Outback Flexmax 80, 12V 130Ah battery, 76 mm PUR wheels, 72 mm track roller steel, IP 55 waterproof cases, SC drive motor braking system, Arduino and X-bee control system, numerous electrical copper wires, 3000x1500x2 mm iron and thermal energy from the hybrid solar panels that are located on the roof of the house. The top of the photovoltaic panel that is exposed to the sun is where the electricity is captured, but underneath the panel there is a steel structure where water flows and absorbs the heat by conduction (thermal collector), thus creating thermal energy.

The TRANSOL prototype is on a small scale for testing and research purposes, but the CSIC lab has plans to make this locomotive bigger and able to function as a replacement to traditional trains. The Oikos prototype is a house that is able to capture electricity and thermal energy from the hybrid solar panels that are located on the roof of the house. The top of the photovoltaic panel that is exposed to the sun is where the electricity is captured, but underneath the panel there is a steel structure where water flows and absorbs the heat by conduction (thermal collector), thus creating thermal energy.

**TRANSOL**
- Solar Infrastructure: The following materials were used in the construction of the TRANSOL locomotive and it includes: 36, 1700x240x120 mm base pillars, 7000x200x100 mm beams, 4200 x200x100 mm beams, square aluminum 6063 extruded T5 bars, square aluminum 6063 extruded T5 tube, rectangular steel tube, 80x80x1 mm triangular steel plates, steel M8 screws, steel M8 nuts, M8 washers, M8 lock washers, 1500x1000 mm plates of honeycomb Polyurethane (PUR), 76 mm PUR wheels, 72 mm track roller steel, IP 55 waterproof cases, SC drive motor braking system, Arduino and X-bee control system, numerous electrical copper wires, 3000x1500x2 mm iron and thermal energy from the hybrid solar panels that are located on the roof of the house. The top of the photovoltaic panel that is exposed to the sun is where the electricity is captured, but underneath the panel there is a steel structure where water flows and absorbs the heat by conduction (thermal collector), thus creating thermal energy.

**Objectives**

- For this project, the goal is to identify any environmental impacts that might have been present during the construction and operation of TRANSOL and Oikos prototypes.
- These prototypes were created and built by researchers and engineers in the Consejo Superior de Investigaciones Científicas Lab, Centro de Automática y Robótica (CAR) in Madrid, Spain.
- The Oikos prototype is a house that is able to capture electricity and thermal energy from the hybrid solar panels that are located on the roof of the house. The top of the photovoltaic panel that is exposed to the sun is where the electricity is captured, but underneath the panel there is a steel structure where water flows and absorbs the heat by conduction (thermal collector), thus creating thermal energy.

**The TRANSOL prototype is on a small scale for testing and research purposes, but the CSIC lab has plans to make this locomotive bigger and able to function as a replacement to traditional trains that are present in today’s society.**

**Life Cycle Analysis**

To conduct an LCA, the first task is to create a goal which is based on what needs to be assessed and achieved so that there will be an understanding of how the process is to be completed and evaluated. After the goal has been established, a scope and specific parameters will need to be set to help focus on what particular environmental impacts the company or individual want to look at during the project. The next step is to conduct a Life Cycle Inventory Analysis (LCIA), which is done by inputting the data needed to correctly determine the impact of these decisions. LCIA includes atmospheric emissions, raw materials acquisition, and aquatic pollution just to name a few. Making sure to stay within the scope, it is important that all data impacts would be seen and considered during every stage in the process. There will be material extraction to disposal, in order to accurately capture the impacts on the environment (Finninv, R.K., Toh, D.A., Camodeca, B.K., Latham, H.C., 2018). After the data is collected, it should be used to create graphs, tables, and any other visual representation that will help in making the necessary changes and decreasing the impacts in the operation and development stages of the product.

**Results**

- These graph show the amount of CO₂ that has been added to the atmosphere as a result of the extraction and manufacturing of the materials listed, and therefore adding to the overall Global Warming Potential (GWP). The global warming potential (GWP) is defined as the likelihood that the emitted greenhouse gas (GHG), which is CO₂, will remain in the atmosphere for a period of time. For this report, the GWP was examined for 100 years.
- Oikos’ largest impact is seen in the emissions that come from turbines, and as a result this is very harmful to the ecosystem in the water due to the extremely high temperatures in which the water is deposited back into nature.
- The TRANSOL prototype captured 14,000 kWh/year in electric energy and there can also be comparisons done to show the noticeable differences that the analyzed product has compared to another similar product. The desired models of the data should be presented to executives so that there can be a plan created to make the necessary changes and decrease the impacts in the operation and development stages of the product.

**Conclusion**

- In conclusion, this research project that shows there are quite a few outliers that could be taken if these prototypes are to eventually be approved for mass production. For Oikos, there are more sustainable materials, such as ceramic tiles (Saravia and Huybrechts, 2004) that can be used for the outer facade, and concrete or recycled brick for the base units. This would allow the house to capture more energy from the sun with less emissions, the use of wood to construct a home is much better than using other materials such as concrete and has been researched. For TRANSOL, it is better that solar powered railway transportation is being pursued and that there are many plans in place that can be put into place and regulated to avoid unexpected energy usage (Jaffery, S. H. I., Khan, M., Ali, L., Khan, H. A., Mufti, R.A., Khan, A., Khan, N., Jaffery, S. M., 2013). Overall, it would be useful to decrease the amount of polyurethane that was used in TRANSOL and substitute it with steel that was used in Oikos because they had large environmental impacts.
An Aptitude for Attitude  
Neural Bases of Multisensory Perception Correlate to Variations in Human Personality Type  
Jasmin A. Eatman1; Mary Jane Spiller, Ph.D2  
1Spelman College, Atlanta, GA; 2University of East London, London, England

Abstract

A synesthetic experience is characterized by the automatic stimulation of several divisions of cognitive processing by an inducer, followed by unique cognizance of an imagined object that incorporates multiple qualities. This study included participants who self-identified as synesthetes as well as those who did not report any subtype of synesthetic experience. Survey research included the Bergen questionnaire, and further identified personality traits using the Big Five Personality Inventory, Creative Experience evaluation, and Conscientiousness subscale. This 139 question, twenty-minute survey, was administered through the online survey platform, Qualtrics. Step 1: Development of comprehensive modified synesthesia survey. Step 2: Administrator survey via Qualtrics. Step 3: Review of survey results and grouping of synesthesia subtypes. Step 4: Multiple linear regression analysis.

Methods and Materials

Survey research included the Bergen questionnaire, and further identified personality traits using the Big Five Personality Inventory, Creative Experience evaluation, and Conscientiousness subscale. In order to conduct a comparative examination of self-reported personality qualities and synesthestis type, Pearson’s correlation and hierarchical regression analyses were utilized in multilevel liner analysis. Statistical comparisons revealed that Openness, and Industriousness are the strongest predictors of time-space synesthesia. Consistently frequent reporting of openness and industriousness by number-space synesthetes point to several advantages of multisensory perception. In view of the correlations between synesthesia and personality, there are implications for synesthesia research in monitoring neuropsychological health throughout human development.

Introduction

Figure 1. Hierarchy of specialization in grapheme recognition. Synesthetic experiences are considered to be a product of both genetic differences and experiential biases.

Research Question and Hypothesis

Are there differences in personality predictors of various synesthesia subtypes?

If grapheme-color synesthetes are identified using the Bergen questionnaire, then the personality predictors that will be exhibited most often by these participants are extraversion and fantasy proneness whereas industriousness, and task planning will be the strongest personality predictors of time-space synesthesia. There will be a strong correlation between openness and both of these synesthesia subtypes.

A significantly positive correlation between number-space synesthesia and openness (r=.20, p<0.01) clearly point to a tendency for number space synesthetes to exhibit transparency and amiability in establishing new interpersonal relationships.

Results

Figure 2. Positive correlation between number-space synesthesia and openness.

Figure 3. Positive correlation between grapheme-color synesthesia and fantasy proneness.

Table 1: Comparison of number-space synesthesia subscales, task planning, and creative experience (broadly interpreted).

Results (continued)

- Openness (r=.17 p<.002), and Industriousness (r=.14 p<0.02) are the strongest personality predictors of time-space synesthesia.
- Task Planning (r=-.12 p<.03) is negatively correlated to number-space synesthesia.
- Frequent reporting of industriousness by number and time-space synesthetes.

Conclusions and Future Considerations

Many different forms of synesthesia have been discovered, and many are yet to be identified. There also exists a wide range of variability within synesthesia subtypes. Future Considerations: In an analysis of personality characteristics that are predictive of specific synesthesia subtypes, future implications for these findings include longitudinal studies of synesthetes’ patterns of behavior in social spaces including higher education and competitive work environments.

Clinical Implications: An understanding of multisensory perception is important to the development of social services in the area of mental healthcare and medicine because health services ought to consider the unique needs and experiences of those who are receiving care.

References


Acknowledgements

I would like to thank Spelman College, The University of East London, Dr. Rosalind Gregory-Bass, and the Spelman College GSTEM Program.
Establishing a robust protocol for viral nucleic acid extraction from food products using an internal control

Ebony Gaillard, Abroad Advisor: Dr. Felicity D’Mello - University of London Royal Veterinary College
Spelman Faculty Advisor: Dr. Nripendra Bose – Department of Chemistry and Biochemistry

Abstract

Food products can potentially be hosts of food-borne viruses such as single-strand RNA viruses. The contamination of food products potentially cause viruses such as Hepatitis B and E to spread throughout populations. The purpose of this study is to create a robust protocol for the detection of viral RNA in food products. In this study, we studied the presence of viral RNA in canine liver tissue samples spiked with Feline Calicivirus (FCV). The three methods used to break up the liver tissue are as followed: dicing with a scalpel, shredding utilizing the QIAshredder, and mashing with a pestle-like instrument. These methods were evaluated to find the best way to recover viral RNA from the canine liver tissue. By completing downstream applications such as polymerase chain reaction (PCR) and gel electrophoresis, it was found that each method successfully recovered viral RNA. A Nanodrop spectrometer was used to measure the concentration of recovered RNA in each spiked liver sample and it was concluded that mashing via the pestle instrument was the most efficient method to recover the most RNA.

Background

Enteric diseases can be caused by viral contamination of food products. These food products can be found in grocery stores, farmer’s markets, and restaurants. It has been difficult to determine which food products pose a health risk to consumers due to most viruses having low infectious dose and virus’ inability to multiply outside its host (Mattison et al. 2009). Methods are being evaluated currently on the RNA extraction and amplification of the viruses from food sources. As these methods are performed, a sample control virus is needed to ensure the process of RNA extraction is working. In this study, Feline Calicivirus is used as the process control for the methods used.

Feline Calicivirus (FCV) is a single-strand RNA virus that infects the respiratory tract of the feline species. FCV is a part of the Caliciviridae virus family in which Hepatitis B and E and Norwalk virus are also members. Unlike the other viruses listed FCV does not infect humans. The viruses’ close relation to these viruses allow for FCV to be a sample process for viral RNA extraction from food products. It is the goal in future studies to use the protocols from this experiment to conduct viral RNA extractions with virus Hepatitis B.

Materials/Methods

- TRizol® Plus RNA Purification Kit was used for extraction.
- Three sample processing techniques are used in this study. After these respective procedures are conducted, 0.2 mL of chloroform are pipetted into each tube. The tube is inverted for 15 seconds then incubated at room temperature for 2-3 minutes. Furtherly, the sample is centrifuged at 12,000 g for 15 minutes at 4°C. The addition of chloroform separates the solution into the lower red phase, the interphase and the upper aqueous phase. For this study, the upper aqueous phase containing RNA is pipetted out and transferred to another tube.
- Conventional RT-PCR reactions were performed in a total volume of 50 µl. The 50 µl volumes contained 5 µl of sample, 25 µl of 2x PCR Bio Ultra Mix, 1 µl each of Forward Primer (CBK1) and Reverse primer (CBK2) and 18 µl of deionized water.

Results

Gel Electrophoresis

Table 2: Nanodrop Spectrometer results for the concentration of recovered RNA per mg of liver tissue. The mashing technique yielded the most recovered viral RNA.

Conclusions

By completing downstream applications such as polymerase chain reaction (PCR) and gel electrophoresis, it was found that each method successfully recovered viral RNA. A Nanodrop spectrometer was used to measure the concentration of recovered RNA in each spiked liver sample and it was concluded that mashing via the pestle instrument was the most efficient method to recover the most RNA. This study gives potential options for FCV to be used as a process control for the extraction of viral RNA from food products. Further experimentation using the mashing technique at an increased sample size will allow for a better analysis of the results.

Acknowledgements

This research was based upon work supported by the National Science Foundation under Grant #HRD-0963629 (G-STEM) and the U.S. Department of Education; Student Aid and Fiscal Responsibility Act; Title III Grant (SAFRA, Part F). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the U.S. Department of Education.
This research explores the nature of the parametric Bezier Curves and its application in determining the path trajectory of an autonomous vehicle using Bezier curves. The research uses the MATLAB scripting language to find the optimal distance between control points of a fifth degree Bezier curve. This was found by finding the integral of the second derivative of the Bezier curve's curvature. The results of this research indicate an increasing linear dependency between the distance of the six control points and the length of the vehicle's trajectory, assuming that the width remains constant. The approximated correlation derived from the generated program will assist in finding a precise relationship between the two variables and will reduce the time in which the autonomous vehicles plans its path.

The focus of this research is to determine a relationship between the distance between the 6 control points of the Bezier curve, with minimum curvature, and the length and width of the path.

Mathematically, a Bezier curve is a parametric curve of degree $n$, expressed as:

$$ B(t) = \sum_{i=0}^{n} \binom{n}{i} (1-t)^{n-i} t^i P_i $$

In the scope of this research, the Bezier curve, of fifth degree, represents the path trajectory, with certain length, $l$, and width, $w$, of an autonomous vehicle during the overtaking procedure as seen in the image.

Two programs were created to find the ideal Bezier curve for a given length and width. The first assumed that all distances between control points were equal, save $|P_4 - P_3|$. The second follows the assumptions above. Both calculated an ideal Bezier curve that corroborated each other.

### Assumptions

- It is assumed that the path is being planned on a straight road with no curves.
- The width of the path is fixed to resemble the standard width of the road, approximately 3.2 meters.
- The distance between the following control points are assumed equal:
  $$ |P_2 - P_1| = |P_6 - P_5| $$
  $$ |P_3 - P_2| = |P_5 - P_4| $$

### Materials

All programs were generated using the MATLAB scripting language.

### Method

$$ K = \sqrt{(x''y' - x'y'')^2 + (x''y - x'y')^2} $$

The curvature of a Bezier is calculated using the above equation. The Bezier curve with the smallest variation in the curvature's integral is the ideal curve for the given length and width.

The time that it takes for the program to determine the ideal Bezier curve is not yet at an acceptable time interval for the autonomous vehicle to plan its path in practical situations. Future applications of this research will focus on finding a faster methodology to determine the ideal Bezier curve and then to mathematically prove it. The culmination of this and further research will be applied to the overall path planning logic and controller of an autonomous vehicle during the overtaking procedure. This research may also serve as the basis of research in determining the path trajectory of an autonomous vehicle during an overtaking procedure on a curved road.

**References**

INTRODUCTION
Image segmentation is the partitioning of an image to multiple regions based on similarities in color, texture, contrast, intensity, etc where each region is internally homogeneous and the union of two adjacent regions is nonhomogeneous.

This research implements a method of segmentation using graphical analysis based on texture and color.

OBJECTIVES
The goal of our method in this research is to ensure the program's ability to recognize when a group of segments makes up one object.

Ideally, the program created from this research will segment in the way a human eye would.

METHODS
The approach in this research applies local binary codes from local binary patterns (LBP) to each pixel to measure texture in a 3 x 3 neighborhood. Each pixel is then assigned a four dimensional vector with its texture feature and RGB color space as parameters. The euclidean distance between vectors measures their dissimilarity. Regions are created based on dissimilarity of points.

RESULTS
This graph based segmentation yields a segmentation with the intended results. For the 100 x 100 images with 2 distinct textures, the parameters with sigma values 0 to .25 with k=550 and min_size = 2100 produced the best results. Larger images with larger textures pose an issue to the program.

In the future, this program can be altered to yield an accurate segmentation of larger images with more complex textures.

ACKNOWLEDGMENTS
This research was based upon work supported by the National Science Foundation under Grant #HRD-0963629 (G-STEM) and the U.S. Department of Education; Student Aid and Fiscal Responsibility Act; Title III Grant (SAFRA, Part F). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the U.S. Department of Education. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

This research was performed at L’Institut Nationale des Sciences Appliquées located in Strasbourg, France during June 1st to July 31st under the mentorship of Dr. Cecilia Zanni Merk, Dr. François De Beuvron, and Dr. Stella. I would like to thank my mentors.
Introduction

In plant physiology, when a phloem group is attached to a plant, it is used in living organisms as an outlet for information using cell signaling circuits. The protein phosphorylation switch consists of a target protein that exhibits characteristics dependent on phosphorylation status, a protein phosphatase, and a protein kinase. Protein kinases and phosphatases are responsible for the strength of the signal.

This experiment focuses on protein phosphatases 2A (PP2A), which are enzymes that catalytically remove the phosphate group from the target protein. PP2A contains a regulatory subunit that acts as a catalytic subunit (PP2A-C) and is regulated by the binding of two regulatory subunits (I and II). The subunit I is responsible for modulating the target before it bonds to the core dimer that was created by the catalytic subunit PP2A-C bound to PP2A-A.

Brassinosteroids are steroidal hormones that promote growth and regulate physiological responses crucial to plant development. They encourage cell division and expansion, regulate senescence, modulate fertility, pollen development, and final flowering and influence the plant’s capacity to transmit environmental signals. As shown in Figure 1, brassinosteroids are produced by transduction, activating a signal transduction pathway leading to irreversible changes in the primary protein of the receptor kinase BAK1 on cell surface. This experiment focused on mutations in the phyto-hormone in Arabidopsis thaliana because this mutation allows brassinosteroid-related phenotypes of the plants. They are similar to ones compared in wild-type Arabidopsis, produce less seeds, and have altered growth patterns. The mutation in the PP2A-C gene alters the expression of BRIRGp-BR2R1-CFP or BRIRGp-BES1-GFP. Arabidopsis genomes contain five PP2A subunits, which are the A and B subunits, and one of the PP2A subunits share 15% sequence identity in a single subfamily and 80% between two subfamilies. Mutations in PP2A-A and B subunits then result in reduced resistance to apoptosis, cell surface receptor kinases to nuclear transcription factors. Nature Cell Biology, October 2009, 1254–1260.

Materials

Arabidopsis thaliana seedlings containing mutations in the PP2A C2-and C4 subunits and mutation in the B’ were used in this experiment to visually analyze the effects of mutations in BR signaling components. The Arabidopsis gene in a green house that produces optimum conditions for growth of the plants. A forward primer was used to amplify the region of the DNA that was being examined. T.A cloning was used to carry out the polymerase chain reactions (PCR).

Methods

1. Sterilization of Seeds
2. Fertilization
3. DNA extraction
4. Polymerase Chain Reaction

Results

Discussion

The Arabidopsis plants with the double mutations in the experiment exemplified a dwarf appearance. This data confirms that PP2A-C2 and C4 affect brassinosteroid signaling. As stated before brassinosteroid promote plant growth. The double mutants of the mutants provide a visual evidence of the brassinosteroid being altered due to the mutation in the protein phosphatases, PP2A-C2 and C4. PP2A works against BRs to determine the strength of the transcription signal cascade. The transcription signal followed by the binding of brassinosteroid activates transcription. Because PP2A is believed to be involved in BR-like nucleic acid binding which results in the expression of genes activated by BR (Zhang et al., 2014). The mutation in the PP2A catalytic subunits are thought to be responsible for the altered phenotypes in the dwarf.

The triple mutant had yet to be examined before this experiment. Two Arabidopsis plants exemplified the triple mutation. The small number of triple mutants that survived soil transfer could suggest that the mutation puts a strain on cell growth. The triple mutation Arabidopsis looked similar to the wild type Arabidopsis. It is an example of a wild type Arabidopsis plant. The triple mutant somatic is slightly shorter than the wild type Arabidopsis thaliana. This stem is under a dwarf plant but the leaves are similar to dwarf leaves, being that they are small in comparison to a wild type Arabidopsis.

Conclusion

It is possible that the mutation in the B subunit slightly reduced the function of PP2A as activity of different enzymes and phosphatase to BR-like signaling. Allowing for signal transduction in some as it would in a wild-type Arabidopsis thaliana, resulting in transduction and the function-related signal gene be expressed. It is hard to visualize determine the exact cellular process that occurred as a result of the triple mutations. The 3B subunits have a great deal of genetic similarity, completely absorbing the 3B subunits would allow for a better analysis of the use of B subunit play in Brassinosteroid signaling in Arabidopsis plants.

References

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A Choice to Change the World

Brassinosteroid Signaling In Arabidopsis PP2A-C Mutants

Objective

The goal of the research presented was to obtain a Arabidopsis plant with a mutation in the PP2A-C2-and C4 and B’ subunits. This was accomplished by introducing mutations in B’ regulatory subunit into the pp2a-c2 pp2a-c4 mutant already available. Result analysis showed that the triple mutation had little effect on the BR-related phenotype of the plant.
Introduction
A Voronoi Diagram is a set of ‘sites’ (points) and a collection of regions that divide the space containing the sites. Each region corresponds to one of the sites, and all the points in one region are closer to the corresponding site than to any other site. Voronoi diagrams in 1D, the n-Post Office Problem, Image Compression: an Application of Lloyd’s Algorithm, and Voronoi Diagrams in 2D are studied. Use of the Applications of Voronoi Diagrams and known relationships between integration, derivatives, and computational math allow researchers to determine and achieve the minimum cost required for the sites at the center of mass of the Voronoi cells (regions).

Objectives
The goal of this project is to compute Voronoi Diagrams: Properties and Applications.
• Voronoi Diagrams in 1D
• The n-Post Office Problem in 1D
• Image Compressions: an application of Lloyd’s Algorithm
• Voronoi Diagrams in 2D

This project researches the applications of Voronoi Diagrams, their properties and algorithms for their calculation. This research enables the use of the relationship between integration, derivatives, and computational math to determine the site’s optimal location. Furthering our research, using each material and method learned to take a grey-scale image with 256 shades of grey and produce a much compressed image, creating a new way to save pixels on your computer device. Provisions are made for materials and methods on Voronoi Diagrams including definitions, various equations, and examples. Results are provided from MATLAB, implementing the use of Lloyd’s Algorithm.

Materials and Methods
• Voronoi Diagrams in 1D: Knuth’s Post Office Problem in 1D; theoretically having a line where the sites (points) are fixed is important. The sites represent different post offices in a city.

• Voronoi Diagrams in 2D: Partitioning a plane, using perpendicular bisectors to evenly divide the sites on the plane. The end result is the division of the sites to find the closest post office to a given house in the city.

• The n-Post Office Problem in 1D: To prove that the critical points are where the post offices locations lie at the center of mass of their Voronoi cells, consider the n-post office problem in 1D.

• Image Compression: an Application of Lloyd’s Algorithm: Lloyd’s algorithm generates a sequence that converges to a local minimum. MATLAB is implemented to help run the system, until it finds the best optimal location for each point.

Results
In conclusion, running Lloyd’s Algorithm in MATLAB compressed the image, Figure 5M, successfully finding the optimal location for each of the four shades of grey.

Summary & Conclusion
A Voronoi Diagram is a set of ‘sites’ (points) and a collection of regions that divide the space containing the sites. Each region corresponds to one of the sites, and all the points in one region are closer to the corresponding site than to any other site. Using the Voronoi diagrams in 1-dimension or 2-dimension assists in finding the closest post office to a given house. The results allow findings of local minimum cost.

The goal of this project was to compute Voronoi Diagrams: Properties and Applications, focusing mainly on, Voronoi Diagrams in 1D, the n-Post Office Problem in 1D, Image Compressions: and application of Lloyd’s Algorithm, and Voronoi Diagrams in 2D. This project studied the Applications of Voronoi diagrams, their properties and algorithms for their calculation. Research enabled the use relationships between integration derivatives and computational math to determine the site’s optimal location. The results are that calculating the Cost is determined by finding the optimal location. The minimum cost must have the post offices at the center of mass of their Voronoi cell. Implementing the use of Image Compression through MATLAB, produced a code to run Lloyd’s Algorithm. In running Lloyd’s Algorithm multiple times, the best optimal location is determined.

Acknowledgements
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Protein Purification and Crystallization of AKT1

Krista Montgomery
Tiffany Oliver, PhD
Chemistry

Introduction
AKT1, also known as Arabidopsis thaliana 1, is a protein transporter that plays an essential role in the uptake of potassium in plant channels. Although this protein has been identified its structure and function has not been directly defined. By purifying this protein and using crystallization we are hoping to be able find the cyclic nucleotide binding which will help us to understand the structure and function of the transporter protein AKT1. Crystalizing the AKT1 Protein will help us to understand the binding type for AKT1. Purification is used to determine the amino acid sequence of a particular group of protein, and to enhance medical studies and in genetic applications. Crystallization of these constructs would allow us to understand the different structures and functions of AKT. Understanding the structure for AKT1 will allow us to understand its purpose in the plants channels.

Objective
The purpose of this research is to take the Protein AKT1 and see if different constructs on this protein could be purified which would allow for crystallization. Crystallization of these constructs would allow us to understand the different structures and functions of AKT1

Materials
The stock solution of Tris Ph 8.0, of 5 Mole NaCl, Imidazole pH 8.0. To prepare these buffers supplies such as Falcon tubes, pipets and beakers were used. The HIS-tag is prepared as a nickel column to capture the AKT1 protein. Prepared pellet with AKT1 construct(varies).B.M.E, D.N.A ase were used for breaking down D.N.ae Bioslock Vibra Cell 75043 was used to stir the solution of protein and B.M.E and D.N.A. A centrifuge or Sorvall was used to centrifuge the protein. A syringe was used for filtration. A P-1 pump for putting protein into HIS tag. Lastly a supper loop machine was used for gradient washing of column (AKATA). Nano drop and SDS pages to quantify and detect the amount of protein obtained respectively.

Experimental Methods

2.2 Methods
For this type of purification a HIS- nickel Column was used. The transporter protein AKT1 is hydrophobic and knowing this Buffer plays an important role in the methods for this purification because it changes the pH of the protein and it also washed the column containing protein. The lysis buffer contained only 2ml of Imidazole, and the Elution buffer contained 25ml of Imidazole. Gradient purification was used which gradually increased the concentration of Imidazole so that the amount of protein could be identified. The super loop AKTA machine was used to do this gradient concentration method. The Nanodrop was used to quantify the amount of protein present and SDS gel electrophoresis was used to visualize the protein extracted.

2.3 Test Protocals
The protein pellet was previously prepared. 30ml of lysis buffer was added to the pellet along with deoxyribonuclease and 2-Mercaptoethanol (B.M.E) after the solution was mixed it was allowed to mix on the 10 cycles on/off 10 seconds in Lysis buffer. The pellet and Lysis buffer was mixed well after this step. After this step the centrifuge was used for thirty minutes. A P-1 pump was then used to load the nickel column with protein. The P-1 pump was first washed with water and then Lysis buffer. A minimum of 10ml of both solutions was needed. Before running the pellet solution through the P-1 pump a syringe was used to filter and capture any excess agents. Once the solution of protein was collected the wash and flow through were collected and saved. The next step was washing the freshly loaded column with the AKTA Superloop machines. The AKTA was first watched with H2O with at least 40ml. Then each tubings A and B were placed into Lysis(B) buffer and Elution(A) buffer. Once both tubing had been cleared of waste connect the column and fill the rack with at least 40 tubes that will collect the protein below. Collect data on computer program and observe to see if any protein was collected. Lastly use electrophoresis to see how pure the protein you obtain

Summary and Conclusions
Five constructs of AKT1 were constructed and tested but only three were successful. Although the AKT1 construct eight and eleven were successful only a small portion of AKTI was collected, which means there was not enough for crystallization this is shown in figure 7. Construct 2, 8 and, 11 and were successfully purified and construct two was used to set a crystallization plate, which was unsuccessful. The reason what construct 2, 8 and eleven were successful was because they had the cyclic nuclide binding at the end these results are seen in figure 8. Finally using sequence analysis the binding type of AKTI was identified as cyclic nucleotide binding.

Literature cited

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The Interaction of CIS-Acting Replication Element with Host Cell Influences
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ABSTRACT
The genomic RNA of the hepatitis C virus (HCV) is a good model for investigating about conserved structural units using current methodologies. The genomic RNA of the hepatitis C virus (HCV) contains functional domains, defined by highly conserved structural RNA motifs, mostly located in the 5′-untranslated regions (5′UTR) and 3′UTR, but also occupying long stretches of the coding sequence. Subsequent RNA replication strongly depends on the 3′UTR folding and is also influenced by the 5′-end of the HCV RNA. This review summarizes current knowledge about functional RNA domains within the HCV RNA genome and provides an overview of the control exerted by direct, long-range RNA-RNA contacts for the execution of the viral cycle. Advances in novel bioinformatic tools have allowed for the existence of search for evolutionarily conserved RNA domains, resulting in the identification of domains distinct from those present in the UTRs. Analysis of numerous HCV isolates sequences revealed an unusual conservation in the 5′-end of the core protein coding sequence. Interestingly, this conservation could not be explained only by the preservation of the amino acid sequence since synonymous substitutions were suppressed. The current methodologies used will undoubtedly improve the identification and validation of functional RNA domains in the near future.

INTRODUCTION
Hepatitis C virus (HCV) is a positive-strand RNA virus belonging to the Flaviviridae family. It is a 6.9 to 7.4-kilobase viral genome flanked by 5′-untranslated regions at its 5′ and 3′ ends and contains a single open reading frame that encodes a polyprotein of approximately 3000 amino acids (Romero-López et al., 2014). The polyprotein is cleaved into 10 single proteins by a host signal peptidase in the structural region and by viral-encoded proteases in the nonstructural region (Romero-López et al., 2012). HCV belongs to the Flaviviridae family, which includes yellow fever virus, bovine diarrhea virus and dengue virus. The HCV genome shows such variability that it is able to evolve at different rates, with some subtypes and isolates having been identified. Viral genotype clearly affects the success of interferon therapy, although no clear correlation with virulence exists. The HCV genotype population infecting a patient is structured in terms of quasi-species (Romero-López et al., 2009). The identification of conserved therapeutic targets and the search for fully effective antiviral compounds is a major goal of HCV research (Fang et al., 2000). The identification of conserved structural regions identified in the near future, thus extending our knowledge of RNA-mediated regulation not only in viral systems, but also in many cellular processes.

METHODS
2.1 Isolating Plasmid RNA containing CRE
When isolating Plasmid RNA containing CRE, 5 µl of LB medium, 5 µl of ampicillin was pipetted into a 2 ml centrifuge tube, which was incubated overnight at a temperature of thirty-five degrees Celsius. For plasmid isolation five microliters of LB medium, bacteria, and ampicillin were pipetted together into a 2 ml tube, which was incubated overnight at a temperature of thirty-five degrees Celsius.

2.2 Performing Polymerase Chain Reaction
In our experiment we used primer 1 (5′-TCGCG-TTGTGCAGAAGTGCTGC-3′) and primer 2 (5′-ACTATTCTGCGCTGACATTC-3′) which were pipetted into three of the centrifuge tubes labeled positive (+), positive (+), and negative (no plasmid). Next ten microliters of a dNTP mix contained a mix of ten microliters of dATP, dTTP, dCTP, dGTP, and sixty microliters of water (SDS). Three microliters of MgCl2, ten microliters of complex polymerases were pipetted into all three tubes to make a final volume of a hundred microliters with water added. Finally twenty nanograms of the plasmid PGLI+acu was added to both the positive centrifuge tubes, while the negative centrifuge tube had twenty microliters of water.

2.3 Purifying DNA
When purifying DNA 100 µl of positive PCR products was pipetted by adding, 100 µl of D2H2O, 200 µl of Phenol was added to a centrifuge tube. Then 200 µl of Chloroform (isompropyl alcohol 24:1) was added to the centrifuge tubes along with 5 µl of Na acetate and 150 µl of 99% ethanol. Then the mix was centrifuged at 13,000 rpm for 20 minutes. After centrifuging the aqueous phase of the phenol and the PCR was removed, the solution was used to add the rest of the mix, which was vortexed for 10 seconds and centrifuged at Ethernet-thousand rpm for 5 minutes. The aqueous portion of the chisam and the sample were removed, the 5 µl of Na acetate plus 150 µl of 100% ethanol was added. The mix was then vortexed and stored in the freezer at minus 20 degrees Celsius for 2 hours. The mix was then used to add DNAse at minus 20 degrees Celsius. The Thermo cycler was set to ninety-five degrees Celsius at two minutes for annealing, ninety-five degrees Celsius for thirty seconds, fifty-five degrees Celsius at thirty seconds, seventy two degrees Celsius at thirty minutes, and seventy two degrees Celsius at ten minutes to help denature the PCR product.

2.4 Performing Transcription to obtain RNA
The components used in this protocol were in the Transcript Aid T7 High Yield Transcription Kit. Transcript Aid T7 High Yield Transcription Kit. Transcription 5x buffer 4 µl (dNTPs mix (dATP, dTTP, dCTP, dGTP) and Transcriptase Aid Enzyme mix) 2 µl were used to thoroughly mix into a centrifuge tube. Next twenty nanograms of the plasmid was added along with 150 µl of ethanol and 150 µl of 100% ethanol, and 150 µl of DNAse was added. Then the mixture was centrifuged at 13,000 rpm for 20 minutes.

2.5 Precipitate RNA and Gel Electrophoresis
The components used were 80% ethanol (200 ul) from the previous protocol (2.4) in order to clean the pellet.

RESULTS

Figure 1. Integrity of Plasmid Isolation

Figure 2. Purification of DNA

Figure 3. RNA Reverse Transcription

Figure 4. Purified Sample of hnRNP A1 and TIA1

Figure 5. Digestion of hnRNP A1 with EcoRI

CONCLUSION
These structurally conserved RNA elements interact with protein factors and other RNA domains in order to direct and regulate essential viral functions as well as switching between different steps of the viral cycle. The interference with the functioning of these structural domains offers a potential means of treating viral infections, such as that caused by the HCV. Further implementations of these results will undoubtedly improve the identification and validation of functional RNA domains in the near future, thus extending our knowledge of RNA-mediated regulation not only in viral systems, but also in many cellular processes.

REFERENCES

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ABSTRACT
These structurally conserved RNA elements interact with protein factors and other RNA domains in order to direct and regulate essential viral functions as well as switching between different steps of the viral cycle. The interference with the functioning of these structural domains offers a potential means of treating viral infections, such as that caused by the HCV. Further implementations of these results will undoubtedly improve the identification and validation of functional RNA domains in the near future, thus extending our knowledge of RNA-mediated regulation not only in viral systems, but also in many cellular processes.

Figure 1. Integrity of Plasmid Isolation

Figure 2. Purification of DNA

Figure 3. RNA Reverse Transcription

Figure 4. Purified Sample of hnRNP A1 and TIA1

Figure 5. Digestion of hnRNP A1 with EcoRI
Hepatitis C virus (HCV) is a member of the Flaviviridae family. The Flaviviridae family is characterized by a single-stranded positive-sense RNA genome. HCV affects almost 200 million individuals and can result in liver cirrhosis, and even death. Current treatment methods for the disease or infection arising from the virus include pegylated interferon alpha and ribavirin. These two methods of treatment however only yield about 40%-50% success rate (Heathcote and Mann, 2005). One structural element that participates in replication is the cis-acting replicating element (CRE) (Romero-Lopez et al., 2014). Studies have shown that this specific domain of the HCV genome negatively regulates viral translation and serves as a regulatory element of the IRES (internal ribosome entry site) function. The IRES serves as an internal entry site for ribosomes to aid in the process of translation and protein synthesis because translation is dependent upon the presence of the IRES. The purpose of this research is to determine any interaction between a eukaryotic 40S subunit and the CRE element of the HCV and to clone a host cell factor in E.coli.

**Methods**

**Isolate plasmid DNA corresponding to CRE element of HCV viral RNA**

**Transcription and purification of PCR fragment of CRE element**

**SHAPE modifications of CRE element and precipitation**

**Reverse transcription of RNA of CRE element with fluorescent primer 4 NED**

**Amplification and purification of cDNA for TIAR and hnRNPA1 and purify DNA**

**Transformation of host cell factors into E.coli**

**Insert DNA of host cell factors into E.coli for further cloning**

**Transformation of hnRNPA1 in E.coli with pGEM-T vector**

**RESULTS**

**Figure 1** shows a gel electrophoresis from the pGEM-T plasmid that contains DNA corresponding to the HCV viral RNA genome. Samples were run on 1% agarose gel. Lanes 1-3 contain 200 ng of two independent samples from plasmid isolation experiment. The concentration of the sample in lane 2 is 179 ng/uL.

**RNA of ac+HV**

**PCR fragment of ac+HV**

**Figure 2** shows a gel electrophoresis of PCR fragment from 0025-04-14 (ac+HV). 250 ng of each sample was loaded and run on 1% agarose gel. The concentration of the sample in lane 2 is 186 ng/uL. A diluted sample in lane 3 was loaded for comparison of area.

**Figure 3** Plasmids carrying hnRNPA1 insert from E.coli. 5 uL of each clone was loaded and run on 1% agarose gel.

**Figure 4** Gel electrophorases of RNA samples of PCR fragments obtained from transcription of CRE element (ac+HV). 250 ng of sample was loaded per lane and run on 1% agarose gel. Lane 6 contains the Riboladder high-range RNA ladder. Lanes 1-5 contain various samples from the PCR reactions. PCR fragments are between 500 nt and 200 nt from the standard. It was determined that the concentration of the sample in lane 3 is 75.7 ng/uL, 73.9 ng/uL for the sample in lane 2, and 68.5 ng/uL for the sample in lane 1.

**REFERENCES**


Mass Balance Change at Engabreen

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Abstract

The purpose of this research is to identify trends in ablation and accumulation in Engabreen, a glacier in the Svartisen Ice cap in Norway. While glaciers worldwide are retreating at an alarming rate, some glaciers are advancing. This research looks at what factors have contributed to Engabreen having a positive mass balance most years since 1970. Looking at data compiled from 1970-2005 it is clear that while the glacier Engabreen is indeed still advancing, the rate of accumulation is decreasing with each year and shall eventually cease to advance. Data has been collected on overall mass balance, annual and seasonal precipitation, and summer temperatures. The data collected has shown that precipitation over Engabreen has increased overtime and that the mass balance of Engabreen has gotten less positive over the past 40 years. Though Engabreen is growing, as temperatures continue to rise they will cause an increasing amount of ablation. Although Engabreen is likely to see more precipitation in the coming years, increased temperatures will likely cause more ablation than accumulation and Engabreen will retreat like many glaciers around the world.

Method

Data was acquired through the use of several resources. In particular, the mass balance data was acquired from several journals from Glaciological Investigations in Norway found through the Norwegian Water Resources and Energy Directorate. Precipitation and summer and winter temperature data were acquired through the Norwegian Meteorological Institute and the Norwegian Broadcasting Company. Data was entered into Microsoft Excel and used to create charts.

Conclusion

Engabreen’s mass balance has been mostly positive since 1970, however, the mass balance has become less positive over the past 40 years. Temperatures at Engabreen are increasing steadily and precipitation has had a slight increase as well. While the glacier Engabreen is indeed still advancing, the rate of accumulation is decreasing with every year since 1970. Looking at data compiled from 1970-2005 it is clear that the annual mass balance will eventually become negative and the glacier will retreat.

Background

Since 1980 glaciers worldwide have suffered increasingly rapid retreat to the point that many of them are disappearing (Polito). This trend of melting is not uniform. From 1980-2000 European glaciers saw an increase in mass balance while the rest of the world’s glaciers suffered a steep decrease (Kattenhorn et al.). Post 2000 the majority of Europe’s glaciers have been retreating as well. The only region seemingly benefiting from the warming climate has been Norway, and as even these glaciers begin to retreat, one of the few glaciers not retreating, but growing is Engabreen, a glacier in the Svartisen Ice Cap. Global temperature rise does not necessarily mean an immediate increase in glacier retreat everywhere. Global temperatures have risen about 0.8 degrees Centigrade since 1880. Two-thirds of this warming has occurred post 1975 (Cafaro). There is a direct influence of warming on precipitation. In essence, wet areas get wetter and dry areas get drier (Trenberth). Increases in global temperature increase the air’s ability to hold water. There is an increase of 7% to every 1 degree Celsius. This results in an increase in land precipitation in high latitudes like North America and Eurasia (Trenberth). Norway and many of Europe’s glaciers had been enjoying a season of growing but as global temperatures continued to increase however, even with extra rainfall these glaciers retreated under increasingly warm summers.

Results

Precipitation has had a slight increase over the past 40 years as well. Winter temperatures have increased steadily at an incline over the past 40 years. Summer temperatures continue to increase, however, winter temperatures are increasing at a steeper rate than summer temperatures. Engabreen relies on winter accumulation and thus will suffer from a steep rise in winter temperatures. As this trend continues, the annual mass balance will eventually become negative and the glacier will retreat.

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