HISTORY
Central State University was established on March 19, 1887 by the Ohio General Assembly in an act that created a Combined Normal and Industrial Department at Wilberforce University. The older institution was founded by the African Methodist Episcopal Church in 1856 and named in honor of the great abolitionist, William Wilberforce. The new Department was considered to be a separate school and had its own Board of Trustees.

In 1941, the General Assembly expanded the Department, which offered two-year courses, into a College of Education and Industrial Arts, which provided four-year college programs. In 1947, the College began operating independently from Wilberforce, continuing its programs in teacher education, industrial arts and business, and adding a four-year liberal arts program under the name Wilberforce State College. In 1951, the legislature provided the name Central State College, and in November 1965, Central State was granted university status.

Today’s CSU is Ohio’s only predominantly African American public institution of higher education. The enacting legislation of 1887, however, stipulated that the institution be “open to all persons of good moral character.” This remains true today as Central State actively promotes ethnic diversity in its student body, faculty and staff in order to enrich the university experience, even as the institution maintains its core historical responsibility to educate African American youth for success, leadership, and service on state, national and global levels.

The University offers 38 academic majors in 10 departments, located in the Colleges of Arts and Sciences, Business and Industry, and Education, as well as a Master’s Degree in Education.
Message from the President:

I am pleased that the vision of an undergraduate journal dedicated to the celebration of student intellect through research has become a reality at Central State University. This inaugural issue sets the stage for future collaboration between students and faculty, and enhances opportunities for students to explore areas of interest and grow in intellectual maturity.

I commend the students and faculty mentors who worked together for many hours to bring together this excellent collection of articles and original work. The faculty, who worked tirelessly on this endeavor, on a volunteer basis, build on a tradition at Central State of excellence in teaching and enhance the University’s ability to serve all students who wish to enrich their personal and professional lives through research and creative endeavors. At Central State University we strive to ignite in students a passion for learning that will last a lifetime.

The Undergraduate Research Journal is produced in connection with the Center for Allaying Health Disparities through Research and Education (CADRE). Funded by the National Institute on Minority Health and Health Disparities (NIMHD), CADRE is aimed at increasing and improving Central State’s capacity to conduct research that will reduce disparities in health among minority populations. This journal reflects our commitment to student involvement in this important project.

I invite you to review the journal and share my enthusiasm about our students’ research and scholarly success.

John W. Garland
President
Principal Investigator, CADRE
Greetings!

I am elated to introduce the inaugural issue of the *CSU Undergraduate Research Journal*. Continuing in the theme that “Change is Central”, we are greatly expanding the ability and capacity of our faculty and students to conduct research. As a predominantly undergraduate institution, Central State University recognizes that research is critical to our students’ ability to further their studies and to compete in an increasingly global market. The *CSU Undergraduate Research Journal* is part of our effort to make research and scholarly activities an essential component of the intellectual climate and the undergraduate experience at CSU.

I congratulate Dr. Denise Huggins, editor of the journal, and all of the faculty who mentored and assisted our students throughout this first production of the journal. We hope that other students will be inspired as they review the works of their peers and will become contributors to this new scholarly tradition at Central State University.

*Change is Central! Research is Central! Academics are Central!*

Juliette B. Bell, Ph.D.
Provost and Vice President for Academic Affairs
A little over two years ago, the idea of a CSU Undergraduate Research Journal was just being developed. Contemplation of this type of journal was exciting because of its ability to be an instrument for increasing interest in undergraduate research as well as its ability to be a method for showcasing the outstanding work of undergraduate students at the university.

The ideas regarding an undergraduate research journal at Central State University (CSU) became part of the RIMI proposal funded by NIH, National Center on Minority Health and Health Disparity. As a result of this funding the Center for Allaying Health Disparities through Research and Education (CADRE) was established and this made publishing this collection of work by our students possible.

Special thanks should go to President John Garland (P.I. for CADRE), Dr. Greta Winbush (Project Director of CADRE), Mr. Morakinyo Kuti (Director of CSU’s Office of Sponsored Programs and Research) as well as the CADRE Advisory Committee whom have given us continued support and have played an important role in helping to bring this journal to our faculty, students, and the university as a whole.

In this first issue, you will find research articles from various disciplines across our campus. Each article was researched and written by an undergraduate student, under the direction of one of our faculty mentors. We hope that through these articles, you will gain a greater understanding and appreciation of the undergraduate work being conducted on our campus.

We are very proud of this issue and all of the hard work that it took to create this compilation of undergraduate research. Though we are a new publication, we are confident that we are embarking upon a journey that holds great opportunity for the future of our students. We look forward to expanding opportunities for undergraduate research and continued recognition of the students and their results.

Dr. Denise W. Huggins, Editor-in-Chief
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A special thanks to Ivy Ray, Project Coordinator, for all the outstanding work she has done and whose help made the publishing of this journal possible. In addition, the editing faculty – Dr. Ertel and Ms. Lorenzo- did a great job and on such short notice. We also need to thank Lee Hoffman and Dwayne Daniels for their help with the Music and Fine Arts students and the work seen in this journal.

A thanks also goes out to Dr. Greta Winbush and Mr. Morakinyo Kuti who both were instrumental in helping to keep the journal on track.
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In Memory of

Dr. David Shevin
1951 - 2010

A Colleague, A Teacher, A Friend
We Miss You!

“Hope’ is the Thing with Whiskers”

By
Higginson
(Emily Dickinson’s hamster)

“Hope” is the thing with whiskers
And pouches in its cheeks
That runs within the running wheels
And almost silent—squeaks

And lovely—in the pantry sat
So busy with the oats
Who can combat the nasty Cat
And rip its stupid throat

I’ve seen it in its little cage
So tiny yet so brave
I had with me a BLT
It asked a leaf—I gave.

This poem originally appeared in the volume Growl, a collection of humorous poetry written and edited by Dr. David Shevin.
View of the Tower on the Campus of Central State University
Distribution of a Human RFLP In The ACTG2 (ACTA3) Gene Among The CSU African American Population

Kaleef Williams and Tiffany Cummings

Mentor: Dr. Anthony R. Arment
Department of Natural Sciences

Abstract

Restriction fragment length polymorphisms (RFLPs) are DNA mutations that create or destroy restriction sites. Restriction enzymes recognize and cleave specific sequences (sites) wherever they occur within DNA. RFLPs are used as linkage markers to study genetic conditions as well as variation and evolution within populations. This study focuses on a RFLP within the human ACTG2 gene. The gene encodes γ-actin, a cytoskeletal element specifically expressed in mammalian (e.g. human) enteric muscle. The RFLP occurs within the first intron (non-coding region) of ACTG2, and while not causing any genetic condition, it is a marker to study human evolution. The RFLP was discovered by Ueyama et al. (1995) and studied within Japanese and Caucasian populations. The Japanese population demonstrated equilibrium, while the Caucasian population was skewed 1:21 (RFLP absent vs. present). Both populations split east-west from a common ancestor after migration out of Africa. So did the RFLP occur before or after the split? This study examined RFLP frequencies in African Americans in an effort to study the “root” of the tree prior to the east-west split. Data demonstrated the RFLP was in equilibrium and the RFLP was present in human ancestors prior to the east-west split.

Introduction

The genomes of all species demonstrate genetic variability. Whether caused by environmental forces or replication errors during cell division, the average human genome contains one mutation per 100,000 base pairs (Booker, 2009). The human genome contains roughly 3.4 billion base pairs and between 20-25,000 genes. If a particular point mutation occurs in greater than 1% of the population, it is referred to as a SNP (single nucleotide polymorphism). The accumulations of mutations over time in Homo sapiens currently place a SNP within every 100-300 base pairs of the genome (www.ornl.gov); yet for all this variation, human DNA remains 99% identical.
SNPs are used with increasing frequency in medical genomics to pinpoint genes contributing to both single gene (e.g. sickle cell anemia or cystic fibrosis) and complex human diseases (e.g. diabetes and asthma). Determination of a patient’s genotype is an important first step towards individualizing treatments based upon a patient’s response to drug reactions and metabolism before a prescription is even written. The sequencing of a personal genome is becoming less expensive as technology improves. The current cost to have an individual genome sequenced is roughly $48,000 (which is 1/50,000 of the cost a decade ago). It is estimated that within the next 4 years, the cost will be 1/1000 of today’s cost. The cost will soon be low enough to become an affordable medical option at the individual level (Anderson, 2010).

A RFLP (restriction fragment length polymorphism) occurs when genetic mutation creates or destroys a restriction site. These sites are the targets of a family of enzymes called restriction enzymes (RE). RE has the ability to cleave DNA into fragments when the enzyme’s specific sequence (site) occurs. Thus, a region of DNA containing a variable RFLP will either cut or not cut depending upon the inherited sequences. Once a RFLP is identified in DNA, it becomes possible to amplify that region of DNA using PCR (the polymerase chain reaction), expose it to the target restriction enzyme, and resolve the fragment(s) into bands by electrophoresis. By determining the number and sizes of these bands, the genotype of an individual can be determined. See Figure 1.

![Inheritance of RFLP markers](www.ncbi.nlm.nih.gov/projects/genome/probe/IMG/RFLP_genotyping.gif)

Typically, RFLPs involve a single base mutation; ACTG2 (ACTA3) is a notable exception. In 1995, Ueyama et al. published a paper describing an RFLP occurring within the ACTG2 gene. The RFLP occurs
within the first intron (non-coding region) of the gene and is created by the variable presence of a
24bp insertion containing a Hind3 site. See Figure 2.

![Diagram of the Human ACTG2 Gene](image)

**Figure 2. The Human ACTG2 Gene.** (above) Coding and noncoding regions of ACTG2 gene; the
arrow indicates the location of the RFLP. (below) Sequence of the region flanking the 24bp
insertion with Hind III RFLP.

ACTG2 codes for one isoform of the protein actin. Actin is a ubiquitous eukaryotic protein responsible
for a variety of cellular functions including muscle contraction, vesicle movement, organelle movement
and cytokinesis following mitosis. Actins are divided into three families (α, β, and γ) according to
cellular function and expression patterns. The γ-actins are parts of the cytoskeleton; the isoform
ACTG2 is specifically expressed in enteric muscle. Traditionally, RFLPs have been used as markers to
pinpoint human disease genes. Laasanen et al. (2008) investigated the ACTG2 Hind III RFLP as a marker
for fetal cholestasis or preeclampsia, but found no linkage.

Ueyama et al. (1995) conducted a population genetics survey on the frequency of this RFLP in
Caucasian and Japanese populations. Results indicated that the RFLP was present in a 45:55 (- vs. +)
ratio in the Japanese population (n = 312 alleles) but was highly skewed 1:21 (- vs. +) in the Caucasian
population (n = 44 alleles). This suggested there must be some selection pressure to maintain the RFLP
in one population and not the other. However, mutations within introns are seldom selected for, only
exons are.

No study was conducted to determine the variation of the RFLP within African American populations.
Additionally, no study has been done to examine the variation within African DNA, which forms the
“root” of the tree from which the other populations arose. This study examines the variance of the ACTA2 Hind III RFLP within African American DNA sampled on the CSU campus.

Materials & Methods

Study Design

A human study protocol was developed in conjunction with CSU’s Internal Review Board (IRB) to gain participation in this study through volunteer DNA samples. Students were asked to self-declare their ethnicity for purposes of data sorting for statistical analysis.

Cell Isolation and DNA Extraction

Epithelial cheek cells were collected by oral swab or saline rinse. Cells were pelleted by centrifugation and resuspended in 0.5 mL of a 10% Chelex solution. The suspension was boiled for 10 minutes in a water bath with occasional shaking. Cellular debris was pelleted by centrifugation for 5 minutes. Three hundred microliters of the supernatant were moved to a fresh tube for freezer storage until PCR was performed.

Primers and PCR Conditions

PCR primers were adapted from Ueyama et al. (1995) as described below. A correction was made to the upper primer to include a cytosine listed in Genbank Accession D006564 not listed in the source paper. Primers were synthesized by SeqWright (Houston, TX).

Upper (5’): TCT TTC CCC TTG TTC ATT CT
Lower (3’): GCA GCC CCT TCA ACA GAT AC

PCR was conducted using a Thermo Scientific Hybaid PCR Thermocycler (Fisher Scientific, Pittsburgh, PA). Reaction conditions used were 1 cycle at 5 min 95°C followed by 35 cycles of 94°C 30s denaturation, 51°C 30s anneal and 30s extension at 72°C. A final extension of 5 min was performed followed by a 4°C soak. Ten microliters of each human sample were used as template for each reaction. All reactions were done in a total 50 µL volume.
Restriction Analysis

Thirty microliters of the PCR reaction were diluted to a final volume of 50 μL with 10x buffer and water and digested with 6U of Hind III for at least one hour. DNA fragments were resolved by electrophoresis through a 2% TBE agarose gel and stained with ethidium bromide. Gel images were documented with the DocIT®LS Image Acquisition Software (UVP, Ltd., Cambridge, UK).

Results

![Gel Image]

Figure 3. Typical Gel Results of ACTA3 RFLP PCR After Hind3 Digestion. Lane 1 is a 100bp ladder (marker). Samples are grouped by number and displayed as (C)ut and (U)ncut. The uncut PCR product is either 463 or 439bp. Restricted products are 254bp and 186bp in size. An individual inheriting no RFLP from either parent (homozygous -/-) will demonstrate the same band (439bp) before and after digestion. (e.g. Sample 1). An individual who is heterozygous (+/-) will demonstrate 3 bands after digestion (463, 254 and 186bp; e.g. Sample 2). A homozygous (+/+ )individual will demonstrate only 2 bands (254 and 186bp; e.g. Sample 5).

Statistical Analysis

Analysis for Hardy-Weinberg Equilibrium was conducted and results compared using the chi-square ($\chi^2$) test.

Hardy-Weinberg Equilibrium Calculations

\[ p^2 + 2pq + q^2 = 1; p + q = 1 \]

\[ p = \text{frequency of Allele } 1 (-) \text{ and } q = \text{frequency of Allele } 2 (+); p+q = 1 \]
Table 1. Population Genetics Data for the RFLP Among Three Populations

<table>
<thead>
<tr>
<th></th>
<th>Ind. Tested</th>
<th>p</th>
<th>q</th>
<th>p²</th>
<th>2pq</th>
<th>q²</th>
<th>p²</th>
<th>2pq</th>
<th>q²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Japanese</strong></td>
<td>156</td>
<td>0.550</td>
<td>0.450</td>
<td>0.300</td>
<td>0.500</td>
<td>0.200</td>
<td>0.250</td>
<td>0.500</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Individuals</strong></td>
<td></td>
<td>47</td>
<td>78</td>
<td>31</td>
<td>39</td>
<td>78</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Caucasian</strong></td>
<td>22</td>
<td>0.500</td>
<td>0.950</td>
<td>2.5x 10⁻³</td>
<td>0.095</td>
<td>0.925</td>
<td>0.250</td>
<td>0.500</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Individuals</strong></td>
<td></td>
<td>0</td>
<td>2</td>
<td>20</td>
<td>5.5</td>
<td>11</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>African American</strong></td>
<td>52</td>
<td>0.570</td>
<td>0.430</td>
<td>0.325</td>
<td>0.490</td>
<td>0.185</td>
<td>0.250</td>
<td>0.500</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Individuals</strong></td>
<td></td>
<td>17</td>
<td>25</td>
<td>10</td>
<td>13</td>
<td>26</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-square ($\chi^2$) Tests $df = n-1$ where $n =$ # of categories $\sum \left( \frac{(\text{observed}-\text{expected})^2}{\text{expected}} \right)$

Table 2. Chi-square Results. The null hypothesis in each case is that the population is in equilibrium.

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$ value</th>
<th>P value</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese</td>
<td>0.020</td>
<td>0.90</td>
<td>Accept</td>
</tr>
<tr>
<td>Caucasian</td>
<td>4.20</td>
<td>0.30</td>
<td>Accept</td>
</tr>
<tr>
<td>African American</td>
<td>0.037</td>
<td>0.84</td>
<td>Accept</td>
</tr>
</tbody>
</table>

Discussion

The RFLP was present in 43% of the CSU African American gene pool tested. Statistically, this data is in Hardy-Weinberg Equilibrium. The CSU African American sample gave $\chi^2 = 0.037$; at one degree of freedom, $P = 0.84$, accepting the hypothesis that the CSU dataset is in equilibrium. The Japanese population gave $\chi^2 = 0.020$; at one degree of freedom, $P = 0.90$, accepting the hypothesis that the Japanese population data is also in Hardy-Weinberg Equilibrium. Despite the observed 1:21 difference in allelic frequencies, the Caucasian samples collected by Ueyama et al. (1995) are still within acceptable values ($\chi^2 = 0.037$, $P = 0.30$) to have been generated by chance and not be a selecting force.
The simplest explanation for the large variation between the Caucasian population and both African American and Japanese populations is sampling error. Small sample sizes can vary substantially; in this case, only 22 individuals were genotyped. A second sampling project is underway to analyze the same RFLP in Caucasian populations using a larger data set. For greater confidence, the CSU dataset also needs to be larger.

The ACTG2 RFLP sits in an intron, a non-coding nucleotide sequence. Introns are typically not under selection pressure from environmental factors, so greater genetic variation is tolerated without deleterious effect. Thus, having values which approach a 50:50 equilibrium would be expected. Genbank was searched for other organisms with known or predicted ACTG2 genes. All examples were mammalian with the exception of chicken. Sequence comparisons of the intron region turned out to be impossible, as none of the other organisms had an intron with sequence similarity to the human gene (data not shown). This is additional evidence that introns are not typically under any selection pressure.

The defining test for the occurrence of this RFLP within humans will need to come from African DNA sampling. By comparing Japanese versus Caucasian populations, Ueyama et al. (1995) were effectively comparing branches of the tree without looking at the root. The composition of African American samples contains ancestry from regions outside Africa, making comparisons in the current study better but not definite. Recently, Tishkoff et al. (2009) conducted an extensive study of over 1300 human markers and their variation among nearly 200 different global, human populations. From this dataset, Tishkoff et al. (2009) were able to statistically predict the average composition of African American DNA. The results suggest the following composition: ~71% Niger-Kordofanian, ~13% European and ~8% other African populations. Given these numbers, it should be possible to use jackknife analysis to extrapolate African values from our current data. This work is ongoing, as a larger dataset is necessary to improve the accuracy of the calculations.

**Acknowledgments**

The authors gratefully acknowledge the support of CSU through a 2008-09 Research Challenge grant as well as support from Dept. of Education MSEIP Grant PR120A040020. Thanks also to Les Prether, who is currently collecting more data to generate a more robust comparison.
References


Biographical Information:

Kaleef O. Williams is a CSU Senior Biology Major. Kaleef is moving towards medical school. He is currently a member of the Beta BetaBeta (Tribeta), the CSU Lambda Iota Chapter. Tribeta is a national honor society for biology majors.

Tiffany L. Cummings is also a CSU Senior Biology Major. Tiffany has plans to go to graduate school in hopes of studying molecular biology and bioinformatics. She is a member of the Beta BetaBeta (Tribeta), the CSU Lambda Iota Chapter
Dr. Anthony R. Arment received his Ph.D. in Biomedical Sciences (Molecular Biology) from Wright State University in 1995. His B.S. was from Urbana University in 1988. He has been a faculty member of Central State University since 2003 and teaches within the Department of Natural Sciences. Undergraduate research is a central part of all the projects in which he is currently involved.
Using COMSOL to Simulate the Effect of Atherosclerosis

Edward Wilson

Mentors: Dr. Yu Liang, Dr. Asit Saha and Dr. S.I. Sretharan

Department of Mathematics and Computer Science
Water Resource Department

Abstract

This paper simulates the effect of atherosclerosis, a chronic and progressive disease where an artery wall thickens as the result of a build-up of fatty materials such as cholesterol. Atherosclerosis leads to many serious diseases such as coronary artery disease, carotid (ka-ROT-id) artery disease, and peripheral arterial disease. In order to find out the causes of atherosclerosis and the effective remedy strategy, this paper uses COMSOL multiphysics software to [Gobbert, 2008] simulate the mechanical configuration (e.g., the stress, displacement of blood vessel, the pressure exerted by blood, etc.) of the plaque blockage and artery, suffered from atherosclerosis. The effect of blood flow over the plaque blockage is discussed in detail.

Introduction

Atherosclerosis is where plaque, consisting of deposits of cholesterol and other lipids, calcium and inflammatory cells called macrophages, builds up within the walls of the arteries. This material clot can cause severe problems. The first is that plaque can protrude into the artery, which eventually leads to a partial or complete blockage of blood flow. Second, plaque can suddenly rupture the artery, leading to the formation of a blood clot. Lastly, the fatty material can weaken the wall of the artery causing a balloon like effect, and if the artery were to rupture, it would cause intense internal bleeding. COMSOL multiphysics software, which is based on finite element method, was used to simulate the effect of atherosclerosis, in this paper.

There are a number of literatures available in this field. Wong (2009) used COMSOL to represent a composite model of the artery, in which the artery was represented into three sub-domains similar to this work. As well, the three sub-domains were meshed together treating it as one complex object; this technique allowed for the author to assign different material properties for the artery,
plaque, and stent. El Khatib (2008) the author explores an interesting way to represent the plaque or fatty material in which he leaves it unfixed and fixed the vessel walls. This technique explores the fluid-structure interaction which expresses kinematic and mechanic equilibrium between the fluid and the solid. Lorenzini (2008) explored the effect that plaque had on the artery walls with different variables including length and shape of arteries and different masses of fatty material. Sun (2006) investigated the accumulation of low-density lipoprotein (LDL), and the influences of wall shear stress and transmural pressure in the arterial wall.

Compared to previous work such as [El Khatib, 2008], which discussed the fluid-structure interaction within a general blood vessel, this paper mainly investigates the mechanical configuration of artery suffered from atherosclerosis. In order to disclose the remedy for atherosclerosis, the effect of blood flow over plaque blockage is especially discussed.

Like all other studies, his work accomplished finite element method (FEM), simulation according to the following flow chart.

![Flow Chart of Finite Element Method](chart1.png)

The remainder of this paper is organized in the following way: Section 2 discusses the pre-processing of simulation; Section 3 is the solution to the problem; Section 4 focuses on the post-processing of simulation; Section 5 draws a conclusion for this paper.
Pre-Processing

2.1 Geometry Configuration

Figure 1 shows a geometric configuration of a blood vessel created by native CAD tools included in COMSOL. The figure consists of three sub-domains. The first outer sub-domain, denoted as EXT 3, is the muscle surrounding the blood vessel. The second sub-domain, denoted as EXT 2, represents the boundary within the tissue which is our artery wall. The third sub domain, denoted as EXT 1, shows the plaque built-up inside the artery. A more realistic, complicated blood vessel geometric configuration has to be generated using commercial CAD software such as AUTOCAD.

![Geometry Configuration](image)

Figure 1: Geometry Configuration of the Artery

2.2 Material Definition

Table 1 shows the material definitions associated with each sub domain. The properties of materials defined within the table such as Fluid and Hyper-Elastic are obtained from the book Multiphysics Modeling using COMSOL [Pryor, 2011].

<table>
<thead>
<tr>
<th>Material</th>
<th>Type of Material</th>
<th>Required Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood inside Blood Vessel</td>
<td>Fluid</td>
<td>Density and Viscosity</td>
</tr>
<tr>
<td>Fat clot</td>
<td>Hyper-elastic</td>
<td>Poisson ratio and bulk modulus</td>
</tr>
<tr>
<td>Artery</td>
<td>Hyper-elastic</td>
<td>Poisson ratio and bulk modulus</td>
</tr>
<tr>
<td>Muscle</td>
<td>Hyper-elastic</td>
<td>Poisson ratio and bulk modulus</td>
</tr>
</tbody>
</table>

Table1: Material Properties of Blood Flow, Plaque, Artery and Muscle
2.3 Boundary Conditions

Boundary conditions are used to represent each sub domain to help us solve the differential equations. The conditions allow us to simulate and accurately display how the muscle, tissue and clot components react within the COMSOL software. Table 2 represents the boundary conditions of each sub domain.

<table>
<thead>
<tr>
<th>Muscle component</th>
<th>Artery component</th>
<th>Fat clot component</th>
<th>Blood component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside layer: fixed displacement</td>
<td>Inside layer: fluid pressure</td>
<td>Fluid pressure</td>
<td>Inlet and outlet pressure, which depend on heart-beat</td>
</tr>
<tr>
<td>Inside layer: roller</td>
<td>Outside layer: roller</td>
<td>No-Slip wall</td>
<td>Lagrange multipliers are used to “ZIP” the neighboring structure components</td>
</tr>
</tbody>
</table>

Table 2: Boundary condition for blood flow

2.4 Meshing

Figure 2 represents the meshing of the model; Meshing is a critical process that discretizes the model so that finite elements method can be applied near the blood vessel and fat clot, especially around the fat clot because it suffers large deformation.

![Figure 2: Mesh Generation](image)

3. Solver

As a multi-physics model, this work involves fluid-structure interaction (i.e., blood-flow and blood vessel) and structure-structure interaction (i.e., blood vessel and plaque blockage) problems. Fluid-
structure interaction shows the interaction of some moveable or deformable structure and usually has an internal or external fluid flow, while structure-structure interaction shows the interaction of two non-stationery structures.

As demonstrated in Figure 3, the interactions between blood and blood-vessel or blood and fat clot belong to the structure-fluid interaction as shown by Figure (3a) fluid exerts external force over the structure (vessel or clot) via pressure. Any deformation of the structure will cause changes of boundary conditions for the blood within the artery flowing against the artery walls.

The second diagram represents structure to structure interaction which is illustrated by the plaque resting against the artery wall. COMSOL also uses conventional physics-based user-interfaces; it allows for entering coupled systems or partial differential equations (PDEs), as well as multi-body interactions, such as structure to structure interaction and fluid-structure interaction. COMSOL multiphysics couples physically heterogeneous components modeled at similar space/time scales and support both stationary and transient cases.

![Diagram showing fluid-structure interaction]

Figure 3: (a) fluid-structure interaction; (b) structure-structure interaction

4. Post-Processing

Figure 4 shows the velocity of blood flow within the blood vessel. As the blood nears the clot its velocity begins to speed up as represented by the darker blue near the mass. This observation matches the Bernoulli’s principle, which states that for an in viscid flow, or a fluid assumed to have no viscosity, an
increase in speed of the fluid occurs at the same time with a decrease in pressure or a decrease in the fluid’s potential energy.

![Figure 4: Velocity of Blood Flow Within the Artery](image1)

**4.1 Stresses Over Fat Clot**

Figure 5 illustrates the stress over the blood vessel and fat clot. The stress is applied by the blood vessel.

![Figure 5: Stress Over Fat Clot Within the Artery](image2)
4.2 Deformation of Blood Vessel

Figure 6 illustrates the higher concentration represented by the dark orange, where the clot is located causing the higher deformation of the blood vessel.

![Figure 6: Deformation of Blood Vessel](image)

4.3 Streamline of Blood Flow

Figure 7 illustrates the flow of blood around the clot. The darker orange shows a steady flow of blood until reaching the clot, where it begins to become restricted which is represented by a light green color.

![Figure 7: Stream-line of Blood Flow](image)
Conclusion

Overall, the use of COMSOL helped our project to break this complex problem into three sub-domains, which then allowed us to mesh the sub-domains into one complete object. After meshing the object, we should assign the mechanical properties (derived from standard material library) to each layer. The outer layer is composed of the muscle and was a variable mix of fixed displacement and roller, while the inner layer is composed of fluid pressure and its surrounding outside layer was roller. Finally, the plaque was represented using fluid pressure while the blood component was a mix of inlet and outlet pressure, which depended on the heart-beat. Through our research we were able to successfully model the deformation of the artery wall due to the mass of plaque located in the simulated artery. In the future, a more complicated and real world geometric model about blood vessel will be formulated, where the artery will be split into multiple chambers. Furthermore, the growth of plaque or fat clot will be introduced in the simulation model.

Acknowledgments

The author wishes to express his gratitude to his mentors in the Department of Mathematics and Computer Science, and the Water Resource Department, in Central State University. Special thanks also goes to the Center for Allaying Health Disparities through Research and Education (CADRE) of Central State University for providing the COMSOL software and support. This project is funded by CADRE Summer Research Scholarship (2010) of Central State University and U.S. Air Force Minority Leader Program with contract number FA8650-05-D-1912.
References


Biographical Information

Mr. Edward Wilson is a junior student and a straight-A holder at the Department of Mathematics and Computer Science, Central State University. Mr. Edward Wilson joined Dr. Liang’s research team in fall of 2009. His current research projects are “Predict Enemy's Intention according to Infrared Persistent Surveillance Data” (sponsored by U.S. Air Force Minority Leader Program with contract number FA8650-05-D-1912) and “Three-Dimensional Multiphysics Modeling of Blood Vessel” (sponsored by RIMI Summer Research Award 2010 with contract number 1P20MD003350-01).
Dr. Yu Liang got his first Ph.D. degree (Computer Science) from Chinese Academy of Sciences in 1998 and got his second Ph.D. degree (Applied Mathematics) from University of Ulster (United Kingdom) in 2005. Since August 2007, Dr. Liang has been working as an Assistant Professor in the Department of Mathematics and Computer Science, Central State University. The ongoing research projects of Dr. Liang are sponsored by U.S. Air Force and National Institutes of Health. Currently, there are six students (one master student and five undergraduate students) working in Dr. Liang’s team.

Dr. Asit K. Saha, PhD (Applied Mathematics), PhD (Tissue Engineering) is Assistant Professor in Mathematics at Central State University, Ohio. Dr. Saha’s research field is System Biology that includes Embryonic Stem Cell Research, Tissue Engineering and Cartilage Biology, Human Immune System and HIV, Brian Dynamics under Stress and Epidemiology. Dr. Saha won the Best Journal Paper award two times from University of South Australia, Australia. He has been awarded with 2010 Professor of Excellence Award from Southern Ohio Council of Higher Education (SOCHE). Dr. Saha’s research in Tissue Engineering is funded by National Institutes of Health (NIH) as a Research Infrastructure for Minority Institutions (RIMI) Exploratory Program Grant. Dr. Saha is in the review board of many international research journals.

Dr. Sritharan’s background includes research in the fields of hydraulics, water resources management, environmental engineering and applications of geospatial technologies. He has carried out research and educational projects for national agencies such as National Nuclear Security Administration (NNSA), NASA, National Science Foundation, US EPA, US Army Corps of Engineers, Department of Interior, and has worked internationally in Costa Rica, Ghana and Egypt, and Zambia. He has led a number of STEM educational projects at CSU and is the leader of the team of directors coordinating the Center for Excellence in Emerging Technologies at Central State University established by the State of Ohio. Dr. Sritharan is leading the effort on setting up a geospatial data base center (GDBC) at CSU under the Center for Allaying Health Disparities through Research and Education (CADRE) Project funded by National Institute of Health.
The Influence of Personal Habits and Extra Curricular Activity on GPA

Matthew Murphy

Mentor: Dr. Denise W. Huggins
Department of Social and Behavioral Sciences

Abstract

Previous research has examined the influence of extracurricular activities on students’ grade point average (GPA). Numerous variables, under the label of “extracurricular activities,” have been included in these studies. Most of the variables focus on school related activities, such as sports and campus social organizations (fraternities and sororities). However, this study also includes students’ study habits, personal relationships, health, and personal time spent outside of the classroom to further understand how various factors may affect a student’s GPA. With this in mind, students at Central State University—a historically black college, answered numerous questions to explore the relationship between extracurricular activities and GPA. While this study produced some predictable outcomes, it also yielded some surprising results. Variables such as living off-campus and having a job actually had a positive influence on GPA, while study in groups instead of independently impacted GPA negatively.

Introduction

In this study, the researcher examined the relationship between extracurricular activities and students’ GPAs to determine if these activities had either a positive or negative influence on one’s GPA. It is often assumed that if students spend time away from their studies it will produce negative consequences on their GPA. Therefore, the researcher focused on those types of variables to examine what role they play on a student’s overall GPA. The variables are: hours slept, time spent with a significant other, family encouragement, hours of study, employment status, personal health, time spent watching TV or playing computer games, fraternity or sorority membership, and how often a student attended parties were all included. By examining these particular variables, the researcher hoped to have a better understanding of the type of activities that caused either a negative or positive effect on students’ GPA.

Upon completion of this study, the researcher discovered that some extracurricular activities as well as personal habits do, in fact, contribute to a positive effect on student’s GPA, while others played a negative role.
Literature Review

Numerous studies have examined factors and behaviors that influence or affect academic performance (GPA). Many of the studies focus on only one or two variables, despite there being a variety of variables connected to this issue.

One of the more prevalent factors that keeps coming up in research and not too surprisingly, is the influence of sports related activities. Some might assume that participation in sports might impact student’s learning or GPA negatively. However, Trudeau and Shephard (2008) found that the opposite was true. In their research, school sports did not seem to have adverse effects on academic performance, and instead, pointed to a more positive relationship between physical activity and intellectual performance. One of the reasons the researchers gave for such a positive result was that physical exercise has an overall positive physiological effect on the brain and thus stimulates learning.

In several studies (Trudeau and Shephard, 2008; Fox, Barr-Anderson, Neumark-Sztainer, and Wall, 2010), college student participation in school related clubs was a factor that has been shown to influence student’s academic performance. Whether its sports or school organizations the quality, rather than quantity, of extracurricular activity was found to have positive effects on educational attainment (Peck, Roeser, Zarrett, and Eccles, 2008).

However, various studies have found just the opposite to be true and point to differing methodology as well as theoretical assumptions to account for the contradicting results (Hunt, 2005). According to Baker (2007), it often came down to the type of organization as well as race and gender of the participating students that made a difference.

Beyond the sports and school related activities, personal habits and responsibility may also factor into how well a student performs academically. Course effort (hours of study time) and outside activities such as employment, social activity, and family responsibility are other variables that have been studied (Svanum & Bigatti, 2006). Personal and family responsibility, which may include caring for or supporting a child as well as being employed, are necessary parts of life that may influence a student’s GPA.

Diligence (Arthur, Shepherd, Sumo, 2006) and intelligence (George, Dixon, Stansal, Gelb, and Pheri, 2008) are two of the many predictors of academic performance. While intelligence has a more direct correlation to academic performance, it is also a challenge to measure. Other predictors of academic and personal success may include, “Time management skills, time spent studying, computer ownership, less time spent in passive leisure, and a healthy diet” (George et al., 2008 p. 706).
Health, which correlates with personal habits, also influences academic performance. Variables such as diet (Kobayashi, 2009) and sleep (Kelly, Kelly, and Clanton, 2001) have been shown to impact academic achievement. Kobayashi (2009) examined the relationship between GPA, Body Mass Index (BMI) and fast food intake. The study focused on American as well as Japanese university students. The study found that “GPA and BMI were negatively correlated among American students” (Kobayashi, 2009, p. 559).

The study conducted by Kelly et al. (2001) explored how many hours of sleep students usually received in order to see how sleep affected their GPAs. Their study investigated the presumption that students who sleep fewer hours would report a lower GPA, than students who got more sleep. Therefore, the number of hours students sleep may be a factor used to determine academic performance.

Several health studies have focused on how both mental and physical aspects can affect academic performance. For example, studies have investigated how eating disorders and body image relate to college students’ GPA (Yanover and Thompson, 2008). These variables might only affect a small percentage of students on a college campus, but are valid research considerations when exploring how certain variables affect the student’s academic success.

A study conducted by Schwanz, Palm, and Brallier (2007), explored how attention deficiency and hyperactivity predicted college GPA scores. It was found that self reported attention deficiency accounted for a 7 percent increase in GPA prediction, while self reported hyperactivity gave a 2 percent increase in predictability power. The researchers called the percentages small but statistically significant (Schwanz et al., 2007).

Outside factors such as the personal, academic, or social environment should also be considered in this type of study. Previous studies have found that “student academic success was linked to the feeling of belonging and campus resources” (Thompson, Thompson, Orr, and Grover 2007, p.642). It was also found that the low success rates among minority students were linked to a negative view of campus climate (Gloria, Hird, and Navarro, 2001).

Race/ethnicity has been shown to influence a student’s GPA. In a study to see whether “ethnic differences in perceptions of college climate” were in any way associated with academic success, Edman and Brazil (2007) found that there were differences. They observed “ethnic differences in the relationship between the students’ perceptions and GPA” (p. 371). Furthermore, they found that African American and Caucasian students had higher levels of cultural congruity and academic self efficacy than Asian students. This indicates that the African American and Caucasian students had higher personal “confidence in performing various academic tasks” than did the Asian students (p.373).
Family and social contexts (Spitzer, 2000) have always been sources of support or strife when it comes to encouraging academic success in students. The influence of family and the environment, or social context, cannot be ignored as both can have an impact on academics (Isreal, Beaulieu, & Hartless, 2001). Beyond family, it is also necessary to mention the influence a romantic relationship might have on how well a student performs in school. In a study conducted by Jimenez and Tatem (2007) they found that “…college females who are in a supportive committed relationship have a significantly higher GPA than students who are in an unsupportive committed relationship” (Jimenez and Tatem, p.17).

Gender is an additional factor that can influence a student’s GPA (Sellers, 1992). It has been found that overall, females earn higher GPAs than males in all levels of education (Mau and Lyn, 2001). However, gender alone may not account for the difference. In an in-depth study of gender and GPA, researchers explored how personality traits that relate to gender (non-cognitive individual differences) affect GPA scores (Hicks, Johnson, Iacono and McGue, 2008). Some of the personality traits examined included achievement striving, self control and aggression. The study found that “each personality trait was a significant predictor of GPA, with sex differences in aggression accounting for one-half the sex difference in GPA” (Hicks et al. p. 247).

**Methodology**

**Measurement**

The key variables for this study were Grade Point Average (GPA) and factors associated with extracurricular activities. Extracurricular activities were defined as study habits, personal relationships, health, and social life. Other activities included time sleeping, time dedicated to relationships, job status, drug use, campus organization membership and its requirements.

**Subjects for Study**

The subjects for this study were Central State University students who attended classes at the main campus. There were 42 students who participated in this study on a voluntary basis. Participants were selected based on an availability sample. Permission to conduct the survey in a particular class was obtained from the instructor prior to distribution of the questionnaire. Participants in the study were assured that confidentiality would be kept and at no point during the study were the subjects asked to give any identifying information.

**Data Collection Method**

The measurement device for this study was a questionnaire. Once institutional review board (IRB) approval was obtained, a 43 item questionnaire was given to students while in a classroom setting. Students were asked to voluntarily complete the questionnaire. Students were informed that they would
not be penalized for not completing the questionnaire or by not answering certain questions. The researcher gathered the completed questionnaires and proceeded to input the information into the Statistical Package for Social Sciences (SPSS) program for analysis. Since the sample was based on availability, only descriptive statistics and measures of association were used to analyze the data. Once the information was completely analyzed, the questionnaires were destroyed.

**Results**

The questionnaire was divided into the following categories of questions; demographic, personal study habits, personal health, and questions about school related and/or personal extracurricular activities.

<table>
<thead>
<tr>
<th>Table 1 – Basic Characteristics of the Sample by Percent</th>
<th>N= 42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>36%</td>
</tr>
<tr>
<td>Female</td>
<td>64</td>
</tr>
<tr>
<td>Age of subjects (Avg. 21.85 years old)</td>
<td></td>
</tr>
<tr>
<td>18-21</td>
<td>37%</td>
</tr>
<tr>
<td>22-23</td>
<td>51</td>
</tr>
<tr>
<td>24-26</td>
<td>07</td>
</tr>
<tr>
<td>&gt;26</td>
<td>05</td>
</tr>
<tr>
<td>In-State Students</td>
<td>44%</td>
</tr>
<tr>
<td>Out-of-State Students</td>
<td>56%</td>
</tr>
<tr>
<td>Live on campus</td>
<td>52%</td>
</tr>
<tr>
<td>Live off campus</td>
<td>48%</td>
</tr>
<tr>
<td>Own Transportation</td>
<td>62%</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>52%</td>
</tr>
<tr>
<td>Part-Time</td>
<td>82%</td>
</tr>
<tr>
<td>Classification</td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>07%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>17</td>
</tr>
<tr>
<td>Junior</td>
<td>36</td>
</tr>
<tr>
<td>Senior</td>
<td>40</td>
</tr>
<tr>
<td>Typical hrs taken each semester</td>
<td></td>
</tr>
<tr>
<td>&lt; 11 hrs</td>
<td>02%</td>
</tr>
<tr>
<td>12-14</td>
<td>22</td>
</tr>
<tr>
<td>15-17</td>
<td>44</td>
</tr>
<tr>
<td>18-20</td>
<td>27</td>
</tr>
<tr>
<td>&gt;20</td>
<td>05</td>
</tr>
<tr>
<td>Grade Point Average (Avg. 2.9 GPA)</td>
<td></td>
</tr>
<tr>
<td>&lt;2.0</td>
<td>05%</td>
</tr>
<tr>
<td>2.1-2.5</td>
<td>26</td>
</tr>
<tr>
<td>2.6-3.0</td>
<td>44</td>
</tr>
<tr>
<td>3.1-3.5</td>
<td>15</td>
</tr>
<tr>
<td>3.6-4.0</td>
<td>10</td>
</tr>
</tbody>
</table>
The demographic information on the participants can be viewed in Table 1 – Basic Characteristics of the Sample. Of the 42 subjects, 64 percent were females and 88 percent were between the ages of 18-23, the majority (40.5%) were college seniors. Almost all (97.6%) of the respondents were full time students with 44 percent typically taking between 15 and 17 hours a semester. A little less than half of the students (44%) had a GPA of 2.6 to 3.0, with 31 percent who had GPA’s below 2.6. It should be noted that according to the Director of Assessment at Central State University, the average GPA of CSU students is 2.4. However, subjects in this study indicated that their GPAs were on the average 2.9. Seniors represented approximately 40 percent of the subjects and they often have higher GPAs than those in lower classifications. Over half of the respondents were from out-of-state (56%) and lived off campus (52%). Approximately, half of the students (51%) reported that they were in a dating relationship and 62 percent had their own transportation. And finally, 52 percent of participants were employed with 82 percent of those working part time.

After the data were analyzed, the researcher found predictable as well as unexpected outcomes. One unexpected result was the majority of students who were dating had a GPA between 2.6 and 3.0. It was also interesting that of the dating students (57.1%), those who spent over 41 hours a week with their boy/girlfriend had the same GPA as those who spent only 21-40 hours with their significant other each week. The researcher predicted that the dating students would have a lower GPA due to the time students would spend on their relationships. However, the dating students had a higher GPA than the average student at CSU. The result indicates that dating may not be the greatest distraction that students may encounter.

Another unexpected result was that students who reported never eating breakfast had an overall higher GPA than those who reported eating breakfast sometimes. One could draw the conclusion that never eating breakfast has a positive influence on GPA however, this may not be true for everybody.

Also concerning health, the majority of students with GPAs of between 3.1 and 4.0 responded that they felt their health had a positive influence on their GPA, while the majority of students with lower GPAs of between 2.1 and 3.0 reported just the opposite.

The majority of respondents who reported attending on or off-campus parties on a regular basis had a GPA of between 2.1 and 3.0, which indicates that regular party goers have the average GPA (2.85) for this study. The students were also asked about their use of recreational drugs. Those students who reported using drugs and/or alcohol had a GPA between 2.1 and 2.9; those who reported not using at all had GPAs of 2.5 to 4.0.
Another noteworthy finding was the amount of credit hours students took did not adversely affect the GPA they earned. In fact 10.5 percent of respondents were taking 15 or more credit hours at the time of the survey and they all had GPAs of between 3.6 and 4.0. In addition, the researcher believed that not having a job would allow more study time and result in better grades. However, the 21 percent of the employed students had a GPA between 3.6 and 4.0, compared to unemployed students (55%) who had GPAs between 2.6 and 3.0.

As far as personal study habits, the researcher found that 55 percent of the subjects reported studying for 0-8 hours per week, with more than half of those studying for less than 4 hours per week. The majority of these students had a GPA of 2.6-3.0, which was the average GPA in this study.

There were also several predictable findings such as; more TV watching negatively influences academic success as 45 percent of respondents who reported watching 0-3 hours of TV weekly had a GPA of between 2.6 and 3.0, and those who watched 4-7 hours weekly (42%) had a GPA of 2.1 to 2.5.

When asked about studying in a group, students who indicated that they prefer to study in groups had a lower GPA than those studying independently. It was also found that when family or friends of the students encouraged them in their studies the result was also an overall higher GPA. In addition, students were asked if they felt that the overall campus had a positive or negative climate. In this study “climate” was defined as the prevailing attitudes, standards, or environmental conditions of the university. Those who responded that the campus had a negative climate (49%) wrote that there was a lack of motivation and encouragement on the part of the instructors, that not enough study groups or opportunities were available, that there was a lack of academic resources, and many students had a negative attitude toward the University and their own academic achievements.

Other, more expected outcomes included: students who lived off-campus had higher GPAs, and the more sleep students got, the better their health and the higher their GPAs. Also, as students obtain a higher classification the better their GPA became.

Conclusion

When the researcher of this project set out to study the relationship between extracurricular activity and GPA, the expectation was to find that most non-academic activities would have a negative influence on GPA. While for certain activities this was true, the researcher found that common knowledge, or assumptions are not always correct. Overall, this study helped to identify which variables would result in a positive or a negative influence on students’ GPAs at CSU.
One conclusion that can definitely be drawn is the more time a student spends on non academic activities, in the majority of the cases, the more average (2.85) their GPA becomes. One cannot conclude that if these students spent more time on academic endeavors that their GPAs would necessarily go up, but there is some indication that students who spend a great deal of time on non-academic extracurricular activities are doing just enough on the academic side to get by. Also, it seems that for students who do not have obligations outside of school, such as a job or children, their free time is still filled with other activities that are not always academic in nature.

It should be noted here that one variable alone is not necessarily the cause for a drop in academic performance; it can be a combination of a few, or a composite of variables mentioned in this study and personal circumstances.

Students should know, however, that according to this study several factors contribute to a better GPA. These include getting adequate sleep, getting encouragement from family and friends, spending less time playing computer games or being involved in social networking sites, and being more physically active.

Now that the study is complete, there are some changes the researcher would make if conducting this study again. One change would be to have a larger target sample size in order to get a better representation of the student body. The majority of respondents were seniors and students not involved in school sports. A larger sample may have produced a better hybrid of upper and lower classmen as well as student athletes. In addition, a more detailed questionnaire could have pin pointed more precisely how certain variables contribute to positive or negative GPAs. Omitting some questions and adding others may have given additional information that was not obtained in this version of the questionnaire. Overall, the study could have offered more useable conclusions if a larger random sample had been obtained.

References


Biographical Information:

Matthew Murphy was born in Grand Rapids, Michigan, but grew up in the Netherlands. After graduating high school, he moved back to the United States. While working full time, he earned his associate’s degree in social work. He has worked in the social service field for seven years with various populations including autistic adults, refugees, and homeless veterans. Currently, Matthew is pursuing a bachelor’s degree in social work at Central State University where he is in his senior year. Matthew lives in Dayton, Ohio with his wife and daughter.

Dr. Denise Huggins is an Associate Professor of Criminal Justice in the Department of Social and Behavioral Sciences. She received her PhD. at Texas Woman’s University in 2001. She has taught at Texas Christian University and the University of Arkansas. She has been at Central State University since 2004 and teaches statistics and research methods as well as criminal justice courses. The majority of Dr. Huggins’ research has been in the area of issues women face in prison.
An Improved Optimal, Scalable Parallel Algorithm for Controlling Steady State Heat Flow through a Metal Sheet

Christopher Burts

Mentor: Robert L. Marcus
Department of Mathematics and Computer Science

Abstract

The objective of this research project is to develop a scalable parallel algorithm for a computer cluster that simulates the control of steady-state heat flow through a rectangular metal sheet which determines an optimal technique for cooling the sheet. The simulation sets initial boundary conditions of heat of 100°C applied to three edges and an ice bath of 0°C applied to the other edge. In past research it was determined that when the hot edges (100°C) were lowered, relative maxima would occur along certain rows and columns of the sheet. The locations of these hottest rows were identified and the temperatures along these rows were cooled to determine if that method of cooling would provide an efficient cooling of the metal sheet. It did not effectively cool the entire sheet. This phase of the research will also apply cooling to every 50th column and every 50th row of the sheet to determine how effective this cooling scheme is. MATLAB surface plots will be used to display the topologies of the heat and MATLAB function plots will be used to display the speed-up graphs.

The present algorithm requires that the number of tasks in the partition evenly divide the number of rows of the metal sheet. The project will be extended to modify the algorithm so that it will execute for a partition with any number of tasks to help further determine maximum speed-up partition sizes. This study was supported by an NNSA grant from the Office of Sponsored Research, Central State University and a Classroom Grant from the Ohio Supercomputer Center, Columbus, Ohio.

Introduction

This project is a continuation of several previous projects on the development of a scalable parallel algorithm for simulating and analyzing steady-state heat flow through a rectangular metal sheet. The objective of this phase of the project is to determine an optimal technique for cooling internal cells of the sheet after the hot edges have been cooled.
The first phase of this project [Marcus & King, 2007] was done several years ago wherein the simulation set initial boundary conditions of heat of 100 °C applied to three edges of the sheet and an ice bath of 0 °C applied to the fourth edge. The parallel algorithm uses a row-wise decomposition of the metal sheet which consists of 400 rows and 400 columns (400x400). The simulation distributes a section of rows to each task in the parallel partition, computes the steady-state heat flow condition in parallel, and then collects the sections of rows back on the root task of the partition. The first speed-up graph in Figure 7 shows that the steady-state heat flow algorithm displayed near linear speed-up for a partition size up to 10 tasks.

In the second phase of this project, the boundary conditions of the hot edges were lowered from 100 °C to 50 °C in decrements of 5 °C. For each setting the steady-state heat flow conditions were determined and the heat topology and scalability were analyzed. In past research [Marcus & Porche’, 2009] and [Marcus & King, 2007] it was determined that when the hot edges (100 °C) were lowered relative maxima would occur along certain rows and columns of the sheet. The maximum temperature of these maxima was 78 °C as shown in the Figure 10 “Resetting Hot Edges: 100 °C to 50 °C.” The locations of the hottest rows were identified and the temperatures along these rows were cooled to determine if this method of cooling would provide an efficient method of cooling the metal sheet. This method did not effectively cool the entire sheet and the topology of the heat remained virtually the same as shown in the Figure 10. The speed-up graphs in Figure 11 show that the algorithm was near linear for partitions with up to 10 tasks.

Last year the third phase of this project [Burts, King & Marcus, 2009] included a technique for cooling every 50th row of the sheet. The heat topology in Figure 13 shows that the sheet was more effectively cooled without cooling every cell. The topology below in Figure 13 shows rows of relative maxima heat values and the maximum of these maxima was 59 °C. The speed-up graph shows that the algorithm displayed better than linear speed-up for partition sizes of two through ten tasks. This phenomenon is called super-linear speed-up which may be due in part to the installations of new computer clusters at the Ohio Supercomputer Center where the project was done.

This year we continued this project into its fourth phase with an improved optimum cooling technique wherein the cooling is applied to every 50th row and every 50th column of the sheet. The simulation was expanded to include test runs with partitions of up to 16 tasks so that the most optimum scalable size partition could be determined. The heat topology in Figure 15 shows that relative maxima heat values occurred on a series of rectangular areas within the interior of the sheet and that the maximum of these maxima was 55 °C. The speed-up graph in Figure 16 shows that the algorithm displayed
super-linear speed-up when using partition sizes of four and five tasks and almost linear speed-up when using partitions of two and eight tasks. Speed-up did not increase when the number of tasks exceeded eight.

Theoretical Basis

The theoretical basis for this problem is the Poisson partial differential equation (pde) which is:

1) \[ u_{xx} + u_{yy} = f(x, y) \]

where \( 0 \leq x \leq a \) and \( 0 \leq y \leq b \)

and \( u_{xx} = \partial^2_{xx} u \)

\( u_{xx} \) is the second partial of the function \( u \) at some point \((x_i, y_j)\) on the metal sheet and represents the acceleration of the heat in the \( x \) direction, and \( u_{yy} \) is the second partial of the function \( u \) at \((x_i, y_j)\) on the metal sheet which represents the acceleration of the heat in the \( y \) direction. The boundary conditions for this problem are given by the equations:

\[ u(x,0) = G_1(x) \quad \text{and} \quad u(x,b) = G_2(x) \]

\[ u(0,y) = G_3(y) \quad \text{and} \quad u(a,y) = G_4(x) \]

where \( G_1 = G_2 = G_3 = 100.00 \) and \( G_4 = 0.0 \)

Since the metal sheet is insulated with no loss of heat except at the boundaries, \( f(x_i,y_j) = 0 \). These boundary conditions lead to a simplified solution [Quinn, pp. 329-330] of this problem which can be approximated by the equation:

2) \[ u_{ij} = \frac{u_{i+1,j} + u_{i-1,j} + u_{i,j+1} + u_{i,j-1}}{4} \]

where: \( u_{ij} = u(x_i, y_j) \) the value of a steady state solution for the heat at some point \((x_i, y_j)\) on the metal sheet.

The Parallel Algorithm

The following flow-chart in Figure 1 shows the parallel algorithm used to compute steady-state heat flow through the metal sheet. This is the algorithm outlined by Michael J. Quinn [Quinn]. In the first phase of this project we designed a C++ program to implement this algorithm in a manner which ensured scalability (see the first speed-up graphs below). As we continued with extensions to this algorithm in the later phases of this project, we performed additional computations in parallel to ensure that the modified algorithms were also scalable.
Sheet Initialization:
The initial conditions of the sheet are shown in Figure 2 where the interior points or cells are $75^\circ C$ and the boundaries are initialized as described above.

Equation (2) above leads to iterative procedure for determining steady-state heat flow wherein the expression on the right-hand side of the equation represents the heat at a given instant in time and the functional value on the left-hand side of the equation represents the heat for $(x_i, y_j)$ at the next instant in time.

A diagrammatic view of equation (2) which represents the steady-state heat flow conditions is shown in Figure 3:
Equation (2) can be written iteratively as:

\[
3) \quad w_{ij} = \frac{u_{i+1,j} + u_{i-1,j} + u_{i,j+1} + u_{i,j-1}}{4}
\]

where: \( u_{ij} \) is the value of the heat at some point \((x_i, y_j)\) an instant in time, and

\( w_{ij} \) is the value of the heat at the next instant in time.

The iterative equation (3) is a simplification of the solution to the Poisson pde in equation (1). Figure 3 shows that the heat value \( w_{ij} \) conforms to the natural flow of heat in an insulated metal sheet: wherein the next heat value for \( w_{ij} \), is the average of the current heat values of the surrounding cells.

**Distribution of Initialized Sheet**

Figure 4 shows the simulation of a metal sheet that is represented by a matrix \( u \) with 400 rows and 400 columns (400x400). The iteration equation (3) requires access to the neighboring cells above and below the middle cell. That requires that the bottom row (the 100th row) on a task be sent to the neighboring task below it so that it is above its 1st row, and the top row (the 1st row) of a task be sent to the row below the last row of the neighboring task above it (see right-hand-side of Figure 4).

This process is referred to as exchanging neighboring rows between adjacent tasks. The rows being exchanged are called ghost rows because an exchange must occur before each re-computation of heat values on the metal sheet.
Computation of Stead-State Heat Flow

The iteration equation (3) is used for computing values in the matrix $u$. The diagram in Figure 4 shows the decomposition of a 400x400 matrix $u$ and the distribution of its rows to 4 tasks. The number of rows of $u$ sent to each task is determined by dividing the number of rows of $u$ (400) by the number of tasks in the parallel partition (4). Consequently, the portion (slice) of matrix $u$ sent to each task is a 100x400 section of heat values.

The flow-chart for the parallel algorithm in Figure 1 shows that before calculating new heat values which are stored in the 100x400 matrix, $w$, there is an exchange of ghost rows between neighboring tasks using MPI_Isend and MPI_Recv message passing commands [Gropp, Lusk & Skjellum] and [Lin & Snyder]. Figure 5 shows how we implemented the parallel algorithm in Figure 1. The absolute value of the difference between the new heat value, $w_{i,j}$, and the current heat value, $u_{i,j}$, is calculated so that the maximum difference, $\text{diff}_k$, (where $k$ is the number of the task) between the heat values is computed. The MPI_Reduce command [Gropp, Lusk, & Skjellum] is used to collect the difference ($\text{diff}_k$) from each task, determine the maximum difference of these values, and then store it in $\text{maxdiff}$. The MPI_Bcast command [Gropp, Lusk, & Skjellum is used to broadcast $\text{maxdiff}$ to all tasks. Each task will test $\text{maxdiff}$ and if $\text{maxdiff} < 0.01$ is true, then steady-state heat flow has been achieved, otherwise the loop shown in the flow-chart in Figure 1 is repeated. The results showed that the loop was repeated on the average 800 times before steady-state heat flow was achieved. The total number of calculations of heat values to determine steady-state conditions is about: $800 \times 400 \times 400 = 128,000,000$. Since the calculation of each heat value requires 4 floating-point operations, it takes about 512 million floating-point operations to determine steady-state heat conditions for a 400x400 matrix $u$. 

![Diagram of Computations](image)
Figure 6 shows the topology of the heat after steady-state heat flow is achieved. The graph in Figure 7 shows that the speed-up analysis. Speed-up is defined by the following formula [Gropp, Lusk & Skejellum]:

\[
\text{speed-up} = \frac{\text{run-time for 1 task}}{\text{run-time for n tasks}}
\]

where:

\[
\text{run-time} = \text{wall-clock time for executing a program}
\]

Steady-state Heat Flow Topology and Speed-up Analysis

The topology of the steady-state heat flow was done using MATLAB surface plots [Herniter]. The analysis was done using three sizes of the matrix \(u\): 100x100 (green), 200x200 (red), and 400x400 (blue). For each instance of the matrix the analysis was done for partition sizes of 1, 2, 4, 5, and 10 tasks. The graph for matrix \(u\) with size 200x200 and 400x400 showed close to linear speed-up. The graph for matrix \(u\) with size 100x100 showed close to linear speed-up for partition sizes only up to 4 tasks.

Parallel Algorithm for Lowering Hot Edges Temperature

The main objective of this phase of the project was to analyze the steady-state conditions for lowering the hot edges of the sheet from 100°C to 50°C. The parallel algorithm is shown in the flow-chart in Figure 8. The “while loop” below is repeated for each setting of the hot edges from 100°C down to 50°C in 5°C decrements. The “repeat loop” in the algorithm may be repeated more than one time wherein the change in temperature may increase from 50°C back up to 100°C. The decreasing and raising of the edge temperatures may be done as often as desired.
Heat Topology After Lowering Hot Edges Temperature

Figure 10 shows that after reducing the hot edges to 50°C the interior hot cells had a maximum value of 78°C. Relative maxima values were found at several locations of the matrix $u_{i,j}$ and using the following method:

The method for determining whether a cell is a local maximum or a local minimum requires the use of the ghost cells (see Figure 9) as needed for computing a new heat value for the cell $w_{i,j}$ as shown in the iterative equation (3) above (see Figure 3). As a result the computations were done in parallel which improved the scalability of the algorithm. The speed-up analysis on the right shows that this algorithm was almost linear as indicated by the graph in green labeled “Lower Hot” in Figure 11.
The objective of this phase of the project was to determine an efficient method for cooling the heat build-up on the interior cells of the metal sheet. In spring 2009 after reducing the hot edges to $50^\circ C$ we determined the locations of the relative maxima values of $u_{i,j}$ as shown in the preceding flow-chart in Figure 8 and cooled the row and the column where these values were located. The determination of the relative maxima values were done in parallel. As shown in Figure 12 that method did not effectively lower the heat on the interior of the metal sheet.

We then implemented the method wherein we cooled every $50^{th}$ row to $50^\circ C$ and then determined the steady-state heat conditions. Figure 12 shows the topology of heat. This method reduced the maximum heat temperature from $78^\circ C$ to $59^\circ C$. The speed-up analysis to the right shows a relatively surprising result. The speed-up graph for a matrix $u$ of size $400\times400$ using partition sizes of 1, 2, 4, 5, 8, and 10 tasks shows super-linear speed-up. This performance of better than linear speed-up is probably due to the size of the cpu cache unit.
An Improved Optimal Method for Lowering Temperature of Internal Heat

The objective of the current phase of the project which was done this year was to determine a more optimal method for cooling the interior cells of the metal sheet. In spring 2010 after reducing the hot edges to 50°C we cooled every 50th row and every 50th column to 50°C and then determined the steady-state heat conditions. Figure 16 to the left shows that we were able to further reduce the maximum heat from 59°C to 55°C. The speed-up analysis in Figure 16 shows that super-linear speed-up was still achieved when using partition sizes of four or five tasks. The speed-up was close to linear for two tasks and eight tasks but for 10 or more tasks the speed-up was not linear but constant. As mentioned above the super-linear speed-up is probably due to the increased size of cpu cache. For the matrix 400x400 matrix u, the row-wise decomposition method distributes a 100x400 slice of matrix u to each task for a partition size of 4 tasks and it distributes an 80x400 slice of matrix u to each task for a partition size of five tasks. This may allow the parallel computations to be done from high speed cache with infrequent references to slower main memory. For a partition size of one task the 400x400 matrix u may require many more references to main memory. However, when using partition sizes of 10 or more tasks, the increased communications between tasks apparently offset the time savings from the parallel computations and the speed-up remained constant.

<table>
<thead>
<tr>
<th>Re-set Every 50th Row and Column to 50°C</th>
<th>Speed-up Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image15.jpg" alt="Figure 15" /></td>
<td><img src="image16.jpg" alt="Figure 16" /></td>
</tr>
</tbody>
</table>
Computational Requirements

In the prior section on “Computation of Steady-state Heat Flow”, we noted that it took approximately 512 million floating-point calculations to compute steady state conditions. The method used to lower the temperature of the hot edges reduced the heat in decrements of 5°C from 100°C to 50°C which required 10 calculations of steady-state conditions. Every 50th row and column was reset to 50°C and steady state conditions were calculated again. Therefore, this project requires over 5 billion (11*512 million) floating-point operations. The wall clock time for the work we did in this phase of the project is shown in the Figure 17.

![Figure 17](image)

Using a partition with 1 task (i.e. a single processor desktop PC) the simulation for this project will take about 17 seconds as noted in Figure 17 above. Simulating the hot edges being raised in a similar manner from 50°C to 100°C would take another 17 seconds. This project could be used to simulate the heating and cooling cycle (34 seconds per cycle) hundreds of times. Simulating the cycle 1000 times would take 34000 seconds or about 9.5 hours. The near linear speed-up for doing such a simulation with a partition of eight tasks would only take about 1 hour.

Conclusion:

As in the phase of the project done this year, after lowering the temperature of the hot edges, an improved optimal cooling method was used wherein every 50th row and every 50th column were cooled and steady-state heat conditions were determined while the sheet remained distributed. This method was more effective in cooling the sheet and the algorithm continued to be scalable. The maximum of the relative maxima temperatures was reduced from 59°C (from the previous phase of the project) to 55°C in this phase of the project. It is quite reasonable that we may effectively reduce the heat build-up on the internal cells of the metal sheet by lowering the heat on more than every 50th row and column. The
algorithm displayed super-linear speed-up when using partitions of four or five tasks, almost linear speed-up when using two or eight tasks, and no speed-up when using more than 8 tasks. The super-linear scalability achieved was better than expected since it exceeded the expected linear speed-up which occurs in most parallel algorithms.

**Future Research Directions:**

The present algorithm requires that the number of tasks in the partition evenly divide the number of rows of the metal sheet. The project will be extended to modify the algorithm so that it will execute for a partition with any number of tasks. This will allow for a better determination of the number of tasks that will provide the maximum speed-up and efficiency for this simulation.

**Acknowledgements**

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Christopher Burts is from Chicago, IL. He graduated from Central State University this past May with a degree in Computer Science. This past summer he interned at AVETEC (Advanced Virtual Engine Test Cell, Inc.) in Springfield, OH. While at AVETEC, he worked with another group of students from Clark State Community College and helped to build two High Performance Computing Clusters (HPCC). Christopher is now attending Wright State University and is working towards a Masters in Computer Science with a focus on network security.

Mr. Robert L. Marcus is Emeritus Professor of Computer Science and the Acting Chair, Department of Mathematics and Computer Science. Mr. Marcus received his Masters at the University of California and has been at Central State University for 40 years. His research interest is in High Performance Computing and the Design of Scalable Parallel Algorithms. He is an active member of the Association of Computing Machinery, and the Statewide User’s Group of the Ohio Supercomputer Center.
Effect of Stress on Neurotransmitter in the Brain

Nabil Ali and Chiedozie Onianwa

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Abstract

The basic components of a neuron (brain cell) are axon and dendrite. Axon is sending information and dendrite is receiving the information. The communication between different neurons is carried out via neurotransmitter (\(N_\tau\)). There are many different types of neurotransmitters that may have possible relevance to developmental disorders. Such neurotransmitters include: serotonin (5-HT), which is involved in sensory perception, mood control, depression, impulsivity, aggression, and other behavior problems; dopamine, which may cause problems in cognition, and in diseases such as Parkinson’s disease, mood disorders, and schizophrenia; acetycholine, which is involved in muscle contractions and in diseases such as myasthenia gravis; norepinephrine, which controls stimulation and moods, incites gastrointestinal activity, and amends endocrine function (e.g., insulin secretion); The amino acids gamma-aminobutyric acid (GABA) and glutamate also act as neurotransmitters. GABA is the main inhibitory neurotransmitter reducing anxiety; on the other hand glutamate is the main excitatory neurotransmitter and is involved in memory formation and in Amyotrophic lateral sclerosis (ALS) or Lou Gehrig’s disease.

The present study is based upon the dynamics of neurotransmitter. A mathematical model has been constructed to understand this complex mechanism. The main objective of this research is to understand the effect of stress on the dynamics of this complex mechanism of neuron-to-neuron communication. Model analysis has been performed with the aid of computer simulation.

Introduction

A neuron is an excitable nerve cell that is the basic building block of the nervous system that processes and transmits information by electrochemical signaling. They are similar to other cells in the human body in a number of ways, but there is one key difference between neurons and other cells. Neurons are specialized to transmit information throughout the entire body. A schematic diagram of a neuron is shown in figure 1.
There are three basic types of neurons that include sensory neurons, motor neurons and interneurons. Sensory neurons are nerve cells within the nervous system responsible for converting external stimuli from the organism’s environment into internal electrical impulses. They are the ones with specific receptors that the brain interprets as sensory information. Motor neurons are neurons that are responsible for sending electrical signals from the brain to the muscle neurons. They have axons that travel to all parts of the body.

Inter-neurons are neurons in the central nervous system (CNS) that connect neurons to each other and which can be found in the brain and spinal cord [1].

Neurotransmitters are endogenous chemicals which relay, amplify, and modulate signals between a neuron and another cell. Release of neurotransmitters from one area of a neuron and the recognition of the chemicals by a receptor site on the adjacent neuron causes an electrical reaction that facilitates the release of the neurotransmitter and its movement across the gap. An Austrian scientist named Otto Loewi discovered the first neurotransmitter in 1921 [2]. He named the compound "vagusstoff," as he was experimenting with the vagus nerve of frog hearts. Now, this compound is known as acetylcholine.

Neurotransmitters are manufactured in a particular part of a neuron known as the cell body from which they are transported to the terminal part of the neuron where they are enclosed in small membrane-bound bags called vesicles. In response to an action potential signal being received, the neurotransmitters are then released from the terminal area when the vesicle membrane fuses with the neuron membrane. The neurotransmitter chemical then diffuses across the synapse. Figure 2 shows the details of the neurotransmitter dynamics.
Stress develops due to the emotional and physical strain caused by our response to pressure from things in our day to day activities. The effect of stress includes tension, irritability, inability to concentrate, and a variety of physical symptoms that include headache and a fast heartbeat. Stress symptoms may be affecting health, even though one might not immediately realize it. We blame illness for that nagging headache, frequent forgetfulness, or decreased productivity at work. However, sometimes stress is to blame. Indeed, stress symptoms can affect the human body, thoughts and feelings, as well as behavior.

The effect of stress on neurotransmitters is very complex and at the same time it is extremely important for human health. We are trying to come up with an understanding on why certain group of people under stress or pressure act, and react differently than if they were completely calm and relaxed. Thus far we have been unable to arrive at hard scientific evidence to prove or deter this theory. In this paper we are developing a simple system dynamical model which explains the functional irregularities related to stress. Figure 3 shows two different scenarios of the human brain in stressed and relaxed moods.
In neurons there is a very sophisticated mechanism called, “re-uptake mechanism”. The re-uptake process is a complex mechanism by which it re-cycles the deactivated neurotransmitter to the host neuron. The key here is the recycling of the neurotransmitters after they have completed transmitting a neural impulse (as shown in figure 2).

An overstressed person may produce excessive neurotransmitter that may not be accepted by corresponding dendrites of the adjacent neurons. Eventually, if the re-uptake mechanism is not recycling the excess neurotransmitters at the rate they are being produced, then there is significant blockage in the gap junction between two adjacent neurons. If the stress continues for a longtime, due to cumulative blockage of the gap junction, no neurotransmitter can transmit signals from one neuron to other.

This paper demonstrates the development of a mathematical model to understand the disorder of re-uptake mechanism due to stress. Model analysis is performed analytically and numerically. Our investigation is based on the phenomenological concept of the neurotransmitter in the brain cell.
Mathematical Model

The schematic diagram,

![Schematic Diagram of Brain Cells and the Transition of Neurotransmitter](image)

*Figure 4. The Schematic Diagram of Brain Cells and the Transition of Neurotransmitter*

Based on the schematic diagram [figure 4] our mathematical model is as follows:

\[
\frac{d}{dT}(N_T) = (\alpha N_T)(\gamma N_T)\left\{1 - \frac{N_T}{\Omega}\right\} - \beta N_T
\]

[1]

We assume that at any current time \( T \) the concentration of the neurotransmitter is denoted by \( N_T \).

\( \alpha \) = natural intrinsic growth rate of the neurotransmitter
\( \beta \) = rate at which the neurotransmitter being deactivated by receptors of other neurons
\( \gamma \) = rate at which re-uptake mechanism occurs
\( \Omega \) = carrying capacity of the neuron to produce maximum amount of neurotransmitters

Steady State Analysis

The system [1] has three different steady states:

\[ N_T^{s1} = 0 \]

[2]

\[ N_T^{s2} = \frac{\Omega + \sqrt{\Omega^2 - 4\frac{\beta \Omega}{\alpha \gamma}}}{2} \]

[3]

\[ N_T^{s3} = \frac{\Omega - \sqrt{\Omega^2 - 4\frac{\beta \Omega}{\alpha \gamma}}}{2} \]

[4]

Subject to \( \Omega \geq \frac{4\beta}{\alpha \gamma} \)

[5]
The steady state given in [2] is trivial; therefore we are not considering this one. Our interest is focused on steady state given in [3] and [4].

The general solution of the above system can be obtained from:

\[
\frac{1}{\beta} \ln\left(\frac{1}{N_T}\right) + \frac{\left(\frac{1}{2}\right)}{\beta \ln(\alpha \gamma N_T^2 - \alpha \gamma N_T + \beta \Omega)} + \frac{\left(\frac{\alpha \gamma \Omega}{\beta}\right)}{\sqrt{\alpha^2 \gamma^2 \Omega^2 - 4 \alpha \gamma \beta \Omega}} \tanh\left(\frac{2 \alpha \gamma N_T - \alpha \gamma \Omega}{\sqrt{\alpha^2 \gamma^2 \Omega^2 - 4 \alpha \gamma \beta \Omega}}\right) = T + C
\]

[6]

The constant \(C\) will be obtained from the initial concentration of \(N_T\).

**Computer Simulation**

MATLAB 7.0 has been used to do the simulation part. We use ODE45 solver to solve our problem given in [1].

It is observed from our numerical simulation that the system [1] can reach the steady state very quickly as seen in the figure 5.

![Figure 5](image)

*Figure 5. Dimensionless Concentration of the Neurotransmitter is heading towards steady state with respect to dimensionless time very fast. Where, \(\alpha = 4, \beta = 1, \gamma = 3, \Omega = 5\). The initial concentration of \(N_T\) chosen as 4.*
The system is oscillating once it attains the steady state as observed in figure 6.

Figure 6. The steady state behavior of the system, where, x-axis is the dimensionless time and y axis is the dimensionless concentration of NT. Where, $\alpha = 4, \beta = 1, \gamma = 3, \Omega = 5$.
The initial concentration of NT is chosen as 4.

If the re-uptake mechanism is not functioning to its maximum potential, then we have the different scenario where the system [1] is trying to attain another steady state as shown in figure 7.

Figure 7. System [1] attains a different steady state due to the faulty re-uptake mechanism. The steady state behavior of the system, where x-axis is dimensionless time and y-axis is dimensionless concentration of NT. Where, $\alpha = 4, \beta = 1, \gamma = 0.3, \Omega = 5$. The initial concentration of NT is chosen as 4.

The system [1] will collapse if the re-uptake mechanism is severely faulty and cannot function properly, at that stage the parameter $\gamma \approx 0.03$ (very low) [figure 8].
Figure 8. The concentration of the Neurotransmitter is heading towards the trivial steady state ($N_f = 0$) when the re-uptake mechanism is severely faulty. Where, $\alpha = 4, \beta = 1, \gamma = 0.03, \Omega = 5$. The initial concentration is chosen as 4.

Conclusion

A hypothetical model has been constructed on neurotransmitter re-uptake mechanism. Model simulation has been performed by the software Matlab 7.0. Model outcomes are shown in figures 5-8.

Using our systems we generated a number of scenarios which yielded a total of three steady states. The first solution shows that neurotransmitter’s concentration approaches its steady state very fast, and is a proven biological scenario. The second solution shows the neurotransmitters as it maintains its steady state without the interference of stress (with a healthy / functioning re-uptake mechanism). Here, a periodicity in the neurotransmitter dynamics was observed. The third solution shows the neurotransmitters as they approach their steady state; however, the evidence of partial damage is present in the re-uptake mechanism as seen in the erratic oscillatory behavior. The final solution showed the residual damage due to the effects of stress on the re-uptake mechanism.

From the outcomes of the model system it is now clear that of equations have shown us the drastic change between a re-uptake mechanism that is not under constant stress, in comparison to a damaged re-uptake mechanism under the effects of stress. Our model is one of the simplest approaches to investigate this complex mechanism. In the future we want to develop a more in depth systemic biological model to unfold these complex traits.
REFERENCES


Biographical Information:

Mr. Nabil Ali is a graduating senior from Central State University. Over the last few years he has amassed knowledge through various internships and educational works. His freshman year he participated in a supercomputing summer workshop with members from the Computer Science Department along with Wright-Patterson Air Force Base and the Ohio Supercomputing Center. During his sophomore year, he worked with his current department chair studying heat flow through parallel computing. His junior year he worked with the NNSA in works with remote sensing and GIS and also again with Wright Patterson Air Force Base doing Image Processing for IED detection. Now entering his senior year he is currently working in Dr. Yu Liang’s research team to use hyperspectral imaging techniques to solve geographic problems.

Dr. Asit K. Saha, PhD (Applied Mathematics), PhD (Tissue Engineering) is Assistant Professor in Mathematics at Central State University, Ohio. Dr. Saha’s research field is System Biology that includes Embryonic Stem Cell Research, Tissue Engineering and Cartilage Biology, Human Immune System and HIV, Brain Dynamics under Stress and Epidemiology. Dr. Saha won the Best Journal Paper award two times from University of South Australia, Australia. He has been awarded with 2010 Professor of Excellence Award from Southern Ohio Council of Higher Education (SOCHE). Dr. Saha’s research in Tissue Engineering is funded by National Institutes of Health (NIH) as a Research Infrastructure for Minority Institutions (RIMI) Exploratory Program Grant. Dr. Saha is in the review board of many international research journals.
Real Time Detection of Targets Using Hyperspectral Image Analysis

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Abstract

It is known detecting and recognizing targets (wanted personnel or objects) play significant roles in human society. In this work the authors employ hyperspectral imaging techniques to detect targets, which are blended with complicated real-world environments such as mud, grass, or sand. This toolkit requires following three steps: (1) Acquisition of hyperspectral sensory data using various remote sensors. (2) Detection of the discontinuities or irregularities of hyperspectral sensory data using appropriate signal processing method such as wavelet and fast Fourier transform (FFT); once any discontinuity is observed, the sensory data will be manipulated using hyperspectral image processing methods, such as image enhancement, spectral match, clustering, classification and band-reduction. (3) Analysis of the image so that the susceptible target will be identified by shape and size. The timing cost of each step is critically accessed. All the processes are discussed in detail through appropriate diagrams and charts.

Keywords: hyperspectral, target, signal processing, image analysis, discontinuity.

Introduction

Detecting and recognizing targets play a tremendous role in human society. For example, they are employed in searching and rescuing the miners who were trapped 2,300 ft below ground (Chile, August 5-October 12, 2010); it is also largely employed by fishers to track and locate fish under the water. In this paper, an instrumentation based detection-method using hyperspectral imaging strategy is presented. The purpose of this method is to detect targets in real time.

Hyperspectral imaging based remote sensing has been used in many investigations. For example, Ravn (2008) investigated a near-infrared chemical imaging (NIR-CI) method, which is actually a fusion of near-infrared spectroscopy and image analysis. Subramanian (1997) proposed a methodology for
hyperspectral image classification using novel neural network technique. Bakker (2002) investigated hyperspectral edge filtering for measuring homogeneity of surface cover types; the corresponding work can be directly applied in the discontinuity detection. Plaza (2008) discussed the parallel algorithms for hyperspectral analysis based on heterogeneous and homogeneous networks of workstations. ISL (web media source 2010) investigated target detection and logistics infrastructure security. Compared to the above work, this paper is distinguished by the method of real-time response to potential threat. These processes will involve Fast Fourier Transform (FFT)-based irregularity/discontinuity detection and black and white image analysis.

The remainder of this paper is organized in the following way: Section 2 presents the flow chart of process implementation; Section 3 consists of time performance of each step/operation; and Section 4 draws a conclusion of the entire work.

Implementation

2.1 Flow Chart

Figure 1 shows the flow chart of the hyperspectral imaging toolkit that is used for the purpose of real time detection of targets. The flow chart will be broken down and discussed in each of the following sections:

- Section 2.2 will discuss the method of acquisition of a hyperspectral image;
- Section 2.3 will discuss the image enhancement process, image classifications and band width reductions for edge detection;
- Section 2.4 will discuss analyzing black and white images used in sensing. It will also cover zooming in and detecting the edges, then removing the noise and segment in order to determine the geometric configuration of the target.

The processes described in sections 2.3-2.4 will use MATLAB to analyze the discontinuities. These discontinuities eventually give the tentative idea of the level of potential threats. Once the discontinuity of a potential risk is established, acquisition of the appropriate image should be identified. The process of enhancing the image starts by setting the regions of interest (ROI). Once the enhancement of the image is complete, processing of the image in black and white will start, and then geometrical configuration of the object as a potential threat is determined.
Chart 1: Flow chart shows the three consecutive steps in the process; each sub process within the process is discussed.

2.2 Acquisition and Detection of Discontinuity

Acquisition of a hyperspectral image using remote sensing using various sensors is the first step. It is conventional to use the three basic colors red, green, and blue (RGB) to capture a standard image. These three basic colors of light with three different wavelengths can be absorbed by any surface to create an image.

Hyperspectral images use a broad range spectrum by using a hyperspectral camera and other remote variant tools to enhance the image. Pixels examined in a hyperspectral images use the whole spectrum of 256 bands, where as a standard image only represents the RGB bands. Hyperspectral images being made of large band numbers (greater than three) will be stacked based on their ROI in the image. When the ROI’s are acquired, the image will be represented with a 2-dimensional coordinate axis of X * Y and then each band will be stacked one over another in the Y-axis (Figure 1). In this figure, X*Y represents the number of pixels, and is the number of bands/wavelengths stacked up to 256 bands. The resolution (4657 × 3105) in the XY-plane is the number of pixels of the image. The Greek letter is the number of bands/wavelengths of the same image layered based on its ROI.
Lowering the band widths and classifying the homogeneous elements will speed up the computational process despite the huge amount of data generated within the hyperspectral cube.

Both wavelet and FFT analysis techniques can be used to detect the discontinuity of the sensory data. In this particular study, we used the FFT analysis. If the discontinuity is observed, then there is a possibility to detect target there. There are various software (such as Python, MATLAB) that can detect the discontinuity. Here, MATLAB is used to identify the discontinuity in real time as shown in Figure 2. The dark blue region represents less or no discontinuity whereas the red domain represents the highest amount of discontinuity.

Once discontinuity region (or regions) is identified, the geographical information system (GIS) software toolkits will be used to get the pixel signature data of the threat based on reflective/wavelength values.
(see Figure 3). The areas of discontinuity are shown by square blocks as roads, trees, and grass. These three spots are recognized as ROI.

![Image of discontinuities](image.jpg)

**Figure 3: (a) Identification of ROI  (b) The Graph of the Reflective Values and Potential Variant Changes.**

Once the discontinuity of sensory signal is detected, the hyperspectral image needs to be formulated and then verified, as illustrated in Figure 1. Figure 4 demonstrates the verified images of ROIs. Figure 4b classifies targets based on color spectrum ranging from 218 to 256, using the Microspec software tool kit. Figure 4c indicates the effect of lowering the color spectrum band.

![Verified images of ROIs](image2.jpg)

**Figure 4a: Verified Image of Potential Target Based on Discontinuities in ROI  
Figure 4b: Classifications of Target Based on Color Spectrum**

### 2.3 Hyperspectral Image Process

The task in Step 2 is to enhance the quality of the hyperspectral images based on ROI. The ROI is analyzed by comparing with reference spectrum about tree, grass, metal, and rock. Spectral un-mixing is required when an image in ROI has mixed pixels. Spectral un-mixing can also be used to separate minerals and elements.
Once the above initial steps are done, the homogeneous makers for classification of different objects within the target are ready for analysis. After the classification of the image is set, the bands of the image will need to be lowered as seen in Figure 5.

![Figure 5: Effect of Bandwidth on ROI Image](image)

Figure 5 depicts the effect of decreasing the bandwidth on the image of a given ROI. As the bandwidth reduces, the background noise increases, eventually deteriorating the image quality. This technique is used for critical edge detection of the target.

Choosing the optimal subset of features while lowering the bands width will ensure integrity of the image. Once the optimal features have been met in the analysis of the image, it is ready for edge detection.

### 2.4 Analysis of Spectral Image in Lab Simulated Results

Figure 6 shows the original four-band (whose spectrum spans red, green, blue and infrared) hyperspectral image, which is taken by Canon digital camera. Using this hyperspectral image as benchmark, the framework described in this paper is assessed step-by-step.

![Figure 6: Original Hyperspectral Image About Potential Targets](image)
Next the image will be converted in black and white format using a sequence of hyperspectral image processing techniques such as enhancement, classification, band-reduction. In order to implement this conversion, zooming in on the ROI in order to cut the background noise is needed. Figure 7 is the converted image of an ROI in black and white format.

![Figure 7: Black and White Image of ROI.](image)

Figure 8 demonstrates that the edges of the simulated shapes within the ROI are having irregular boundaries. This is due to lowering the band width. The need to use de-noising algorithm to overcome these irregular boundaries are needed in order to smoothing the edges. MATLAB software is used to de-noise it as shown in Figure 8.

![Figure 8: De-noises Image of ROI Using MATLAB.](image)

Geometric configuration will be the last processes in the analysis of the spectral image. The purpose of geometrical configuring is to make a one-to-one relation between the pixels and the plotted ROI to determine the geometric shape and size of the target. Images in Figure 9 are set as metric, because most targets are composed of round or approximately spherical shaped objects.
Computing the associated digital reference number, of the geometrical shapes, is based on the pixel signatures compared to values from the library of object shapes that have been pre-established.

Adopting this technique, would develop ordinal numbers with regard to the shape of suspect objects compared to objects from the library containing a data base of known shapes of harmful devices. Figure 10 shows the areas of the different objects in the ROI, giving an idea of how big a target will be. In this case the comparison of the objects in the ROI with a spherical device is rendered as a circle in 2D. Each shape is given a value based on its roundness and how the pattern could potentially match up to devices in a known data base.

In most cases, a reference database (about geometry properties) of known objects is usual to identify the target.
Time Performance

Timing is a critical issue for any target detection. Table-1 shows the corresponding time-cost of each operation (given in flow chart). It is observed that wavelet transformation and image analysis are the most time-consuming operations.

Table 1 - Processing Times of Different Steps

<table>
<thead>
<tr>
<th>Steps and Processes</th>
<th>Operation</th>
<th>Dimension (pixels)</th>
<th>Time Cost (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acquisition of image</td>
<td>2304x3072x3</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Read the data</td>
<td>2304x3072x3</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>Wavelet transform</td>
<td>2304x3072x3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Zoom in</td>
<td>1001x1151x3</td>
<td>0.003</td>
</tr>
<tr>
<td>5</td>
<td>Format conversion</td>
<td>1001x1151</td>
<td>0.002</td>
</tr>
<tr>
<td>6</td>
<td>De-noising</td>
<td>1001x1151</td>
<td>0.5</td>
</tr>
<tr>
<td>7</td>
<td>FFT</td>
<td>1001x1151</td>
<td>0.9</td>
</tr>
<tr>
<td>8</td>
<td>Image analysis</td>
<td>1001x1151</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Conclusion

This experiment is a joint task that includes both computational laboratory and field work. A cost analysis can be performed based on time performance for each individual sub step within the process. The use of multiple programs slows down the entire process. Other software with open software development kits (SDK) will be needed to decrease the time constraint on real time detection of target. Currently work is underway to develop an SDK that will allow interaction between software with minimal time constraints.

In the future, this work will be extended for real scenarios, where potential bomb threats are laid underneath sand, bushes or any other random debris. The process will involve the creation of hyperspectral images taken from various camera angles. Work to be done yet is to integrate the heterogeneous sensory data and detect the discontinuity using Short Term Fourier Transformation (STFT) or wavelet.
Other future goal is to develop processes that involve data from an Unmanned Air Vehicle (UAV) and ground deployment. A low flying UAV or camera on top of a Humvee would seem ideal for the next step in the real time detection process. Other possibilities would be fusing infrared and GPS technologies with hyperspectral imaging to form a more accurate picture after the time constraints are met.

Acknowledgments

The authors would like to thank Central State University and the CSU Department of Mathematics & Computer Science and the CSU Department of Water Resources Management. The authors would like to thank their mentors Dr. Yu Liang and Dr. S. I. Sritharan for the guidance given. The authors would like to particularly thank the Department of Water Resources Management for the use of their tools and software. The authors are grateful to Dr. Huggins and the reviewers for their time on reviewing this paper. The reference papers on hyperspectral imaging and other valuable information from the mentors were extremely helpful. This project is funded by the U.S. Air Force Minority Leaders Program with contract number FA8650-05-D-1912.
References


Biographical Information:

Mr. Shane Fernandes, a student at Central State University, is a freshman majoring in Computer Science. He currently has a 4.0 GPA, and plans to take a second major in Geo Physics. He joined the Minority Leadership Program (MLP) of U.S. Air Force in January of 2010. Under Dr. Yu Liang’s supervision, Shane is involved in the following research projects: real time detection of improvised explosive devices (IEDs), multiphysics modeling of biomedical problems, and hyperspectral imaging analysis tools for geographic information system. His future goals are to develop technologies to reform agriculture of farmlands in war torn countries through hyperspectral imaging and analysis.

Mr. Nabil Ali is a graduating senior from Central State University. Over the last few years he has amassed knowledge through various internships and educational works. His freshman year he participated in a supercomputing summer workshop with members from the Computer Science Department along with Wright-Paterson Air Force Base and the Ohio Supercomputing Center. During his sophomore year, he worked with his current department chair studying heat flow through parallel computing. His junior year he worked with the NNSA in works with remote sensing and GIS and also again with Wright Patterson Air Force Base doing Image Processing for IED detection. Now entering his senior year he is currently working in Dr. Yu Liang’s research team to use hyperspectral imaging techniques to solve geographic problems.

Dr. Yu Liang got his first Ph.D. degree (Computer Science) from Chinese Academy of Sciences in 1998 and got his second Ph.D. degree (Applied Mathematics) from University of Ulster (United Kingdom) in 2005. Since August 2007, Dr. Liang has been working as an Assistant Professor in the Department of Mathematics and Computer Science, Central State University. The ongoing research projects of Dr. Liang are sponsored by U.S. Air Force and National Institutes of Health. Currently, there are six students (one master student and five undergraduate students) working in Dr. Liang’s team.
Dr. Sritharan’s background includes research in the fields of hydraulics, water resources management, environmental engineering and applications of geospatial technologies. He has carried out research and educational projects for national agencies such as National Nuclear Security Administration (NNSA), NASA, National Science Foundation, US EPA, US Army Corps of Engineers, Department of Interior and has worked internationally in Costa Rica, Ghana and Egypt, and Zambia. He has led a number of STEM educational projects at CSU and is the leader of the team of directors coordinating the Center for Excellence in Emerging Technologies at Central State University established by the State of Ohio. Dr. Sritharan is leading the effort on setting up a geospatial data base center (GDBC) at CSU under the Center for Allaying Health Disparities through Research and Education (CADRE) Project, funded by National Institute of Health.

Xiaofang Wei was raised in southeastern China. In 1988, Xiaofang went to college and became a major in Aerial Photogrammetry and Remote Sensing at Wuhan Technical University of Surveying and Mapping. After graduation in 1992, she went back to Fujian Province and worked in the Center of GIS and Remote Sensing. During that time, she obtained her Masters degree in Marine Environmental Science. In 2001, Xiaofang came to Indiana State University to pursue her doctoral degree in Geography and completed her study in 2008. In fall 2007, she joined the Department of Water Resources Management at Central State University as an Assistant Professor in Geography. She is currently working on the USBR Applied Remote Sensing of Evapotranspiration project, NNSA Hyper spectral Imaging Analysis (HSIA) Summer Institute project, the CADRE project, and NSF Advancement of Women in Academic Science and Engineering (ADVANCE) project.

Ramanitharan Kandiah, an Assistant Professor of Environmental Engineering holds a PhD in Civil Engineering. His Research interests are data mining applications in civil & environmental engineering, water quality, and air and noise pollutions. He is a registered Professional Engineer in Ohio and is a member of American Society of Civil Engineers, National Society of Professional Engineers, American Geophysical Association, and the Association of Environmental Engineering and Science Professors.
Fine and Performing Arts

Humanities
Sunken Garden on the Campus of Central State University
Granddaddy

A Short Story
By
Lauren Colvard

The last of autumn’s leaves lay scattered across the graveyard. They crunch beneath my boots, imprinting into the moist ground. I thought that I would feel haunted as I walked past the weary graves. Instead, with each step warm tingles of anticipation rush up my legs and through to my arms. My hands tremble slightly, maybe from the morning chill, but I am probably a little nervous, too. It has been four years since the funeral. It all happened so suddenly.

Thanksgiving day, 2004. The entire family had gathered over my Aunt Jackie’s house. The flavors of our southern heritage filled the air. So did the laughter. At the center of it all was my Granddaddy, Albert. He had one of those contagious laughs where you could not help but to laugh along with him. This particular day he and my Uncles Rock and Joe joked with one another while playing a game of speed.

“You still as slow as molasses old man,” Granddaddy teased

“Oh, shut up, man. I’m only slow because you got the cards stuck together. You and that darn peanut brittle,” Uncle Rock countered.

“You hear this, Joe? He hasn’t beaten me in sixty years and now he wants to blame the peanut brittle,” Granddaddy said to my Uncle Joe. The two of them laughed while Uncle Rock managed a smirk.

People are like fireflies, drawn to his light, his aura. He has that special quality of being able to set everyone around him at ease.

Chapman, Cline, Coleman... It would not be long now before I got to Colvard. I slow my pace down. I’ve wanted to come here for so long. Now that I am actually here I get this weird feeling. What is it going to feel like to speak to someone who can’t speak back? Will he even hear me? I try to dismiss my thoughts as nonsense and steadfastly continue on.


“You Granddaddy is sick.” my mom said in a disheartened tone

“What do you mean? How sick?” I asked
“The doctors are concerned about his heart. They will need to monitor him for a few days to determine whether or not surgery is needed. He has been sick for quite some time now,” she replied.

We drove to the VA and took the elevator up to the third floor, the intensive care unit. Holiday decorations adorned the lobby where we signed in. Doctors and nurses bustled up and down the hallway, seemingly unaware of any occasion. When we got to the room at the end of the hall, we entered to find my Granddaddy resting on his side. My mom walked over to his bed and touched his frail arm. He had lost so much weight. Alert, his eyes brightened and he rolled over and gave us a weak smile.

“Is that you, Lauren?” he said faintly.

I stood a few steps behind my mom. She reached over and pulled me up to the bedside. I did not want to look at him like that; hooked up to an IV and laboring to breathe. To me he was still a king, nonetheless, a king riding off into the sunset.

“Come closer,” Granddaddy whispered. I obeyed. “This thing here,” he said pointing to machine monitoring his heart, “This ain’t nothing. I’m going be out of here real soon. And when I do, I want to take you and your sister on vacation with me. Remember how we used to hit the road?”

I thought back to the time Granddaddy took my sister Keisha and I with him to visit his hometown of Cochran, Georgia. We cruised to in his 1979 Cadillac with the dusty roads as our backdrop and the funky sounds of James Brown as our soundtrack. From the back seat I watched as Granddaddy bobbed his head and shimmied his shoulders to the beat. He caught a glimpse of my amusement from the rearview mirror.

“You hear that, Lauren?” he said, “That’s real music. Not that crazy stuff that Keisha listens to,” he chuckled, playfully nudging my sister who was engulfed by her headphones.

I conceded with a smile. I loved hearing my Granddaddy laugh. It gave me a sense of security somewhat, like everything was going to be ok.

“We’re going to do that again. As soon as I get out. You just take care of yourself and your mother until then, ok?”

Too unsure to speak, I simply nodded in agreement. I turned to my mom who stood away near the door. Her red rimmed eyes spoke for her. She and I both knew in our hearts
that this could be bad. We kissed Granddaddy goodbye and headed for home. Little did I know that day would be the last time that I would see him alive.

*Albert Colvard.* Loving and devoted father, Army World War II, 1924-2004. I knelt down to brush away fallen leaves from the tomb. I have not been here since his funeral.

“Ready, aim fire! Pow! The blast from the three sawed-off shotguns ripped through my distant thoughts and shattered my subconscious trance. Wounded shell casings rattled off the cobblestone ground. Immediately, I am snatched back into my somber reality. Freezing rain pelted down the granite sides of the rotunda. The wind seeps through the openings in the walls and swims up the columns of my black sweater. Out of the corner of my eye I see an old man approaching. He walks slowly but methodically; his steps hit the ground in timed intervals. His navy blue uniform is engraved with many of the same distinctions as my grandfather’s: World War II, Distinguished Service, Hero. Beneath his arm sways a small, brass trumpet. He looks on reverently as he raises the trumpet to lips and begins to render that familiar, melancholic tune. As “Taps” played on, I peer into the faces of my loved ones. Written on them I see stains of hurt and loss. But as the song went on, I began to feel a tremendous sense of pride swell in my heart for Granddaddy that I know they must have felt, too. He was a patriot and a serviceman. This was his time to receive all the honors that accompanied such bravery. After a final prayer, we rose and prepared to say our final goodbyes.

“It took me a while to come here,” I spoke. “I have grown up a lot since you last saw me. I got a car now, an old Buick.” I paused for a second. This is silly, I thought. Maybe I should be more serious. “You know, there is a big election coming up.” No, no, no don’t say that. I sighed contemplating what to say next. “I guess what I want to say is that I miss you. I miss going fishing at the lake. I miss your famous grilled cheeses. I miss the sight of your Fedora hat next to your alligator shoes on the steps. But I know that you are in a better place. I hope heaven is as grand as we imagined it to be. Take care.”

Feeling a sense of peace, I kissed the headstone and rose to walk back to the car. Waiting for me was my mother. Her face beamed with pride.

“I am proud of you, sweetie,” she said, “and I know that your granddaddy is too.”

Yes, I am proud of her. I am proud of all of them. All I have ever asked of God was to lookout for my family. To let me see my children and grandchildren grow and go on to be successful people. He gave me that and so much more. He gave me the courage to be a
soldier. He gave me the strength to be the cornerstone of my family. Miss me some, but let me go. I am in a better place now. I only hope that you hold fast to the things I have tried to instill in you. I am with you through it all. And for that I am forever thankful.

Lauren Colvard is from Cleveland, Ohio and is a junior majoring in International Business and Political Science. She has received numerous awards and scholarships for her outstanding academic merit. She has been on the Dean's List every semester while working, volunteering, and serving as Vice President of Gamma Beta Psi Christian sorority. Her writings, poetry, and paintings reflect a sensitive and unique point of view. The following story is one that she wrote as a tribute to her late grandfather, Albert Colvard.
Come Alive
Original Music
By Michael Jamel Williams

Verse:
Let your presence take over
Inhabit our praise, Inhabit our praise
We invite you, come closer
Inhabit our praise, inhabit our praise
Let your glory be made known
Inhabit our praise, inhabit our praise
Let it flow from your throne
Inhabit our praise, inhabit our praise

Chorus:
You live in our worship
You live in our praise
So come alive
Come alive

Bridge:
You arose from the grave
Our lives to save
And now you live
Your name shall be praised
From age to age
Because you live

Vamp:
Release your power (glory, freedom)
Release your power (glory, freedom)
Come Alive, come alive
Release your power (glory, freedom)
Release your power (glory, freedom)
Come alive, come alive

We worship you
We worship you
You’re alive, you’re alive
We worship you
We worship you
You’re alive, you’re alive

You’re alive!

Listen to song on Journal website:
www.csuundergraduateresearchjournal.shutterfly.com

Artist Statement:
I am a CSU graduate currently working as part of the musical staff at the Church of Judah Family Worship Center. "Come Alive" is a song that I wrote while still a student at Central State University. The song was written in my dorm room in Foundation Hall. While sitting at my desk, I just began to hear the verse. I began writing the verse and then about 20 minutes later, the song was finished. The message of the song is simply this: when people come together and begin to Praise God from a pure heart, His very presence meets us where we are and then leads us into all truth.
Title: “Remember”

The inspiration came as a reminder to all African-American girls that they are beautiful and can become anything they want to be.

Artist: Ashle Easley

Ashle Easley is a senior Advertising Graphics and Computer Science major, from Peoria, Illinois. She keeps a busy schedule, as the Marauders Cheerleading Captain.
Title: "Evolution of the Symbolic Head"

This piece represents the change in technology and culture in society.

Artist: Clarence A. Ray, IV

Clarence Ray is a sophomore Advertising Graphics major at Central State University. He is from Trotwood, Ohio, and aspires to own his own national advertising art company.
Title: Self Portrait

Betty J. Mitchell is a Studio Art Major who came to Central State University seeking a second undergraduate degree. She graduated from Wright State University in 1984 with a B.A. in Psychology. She attended the Wright State School of Professional Psychology and worked for the State of Ohio for 19 years before being Disability Retired in 2007. Ms. Mitchell was drawn to CSU because her son works there, and after seeing samples of Professor Abner Cope’s artwork, decided to come here to be educated by CSU’s fantastic Art Department. It is everything she could have hoped for and more.

Artist: Betty Mitchell

Title: Foot

Britney Green is a junior Studio Art major, who hails from Los Angeles California. Her goal is to obtain a masters degree in studio art or fashion design.

Artist: Britney Green
Title: “Drumline”

Collage was created to depict the different sides of Brandon

Artist: Brandon Bates

Brandon Bates is a senior Advertising Graphics major, from Cleveland, Ohio.
Title: "Boy or Girl"

A piece that was submitted in an art exhibit in March of 2010
Theme: Touching Tomorrow Today
Medium: Digital

Artist: Kendrick Jones

Kendrick Jones is a graduating senior majoring Advertising Graphics. He is a native of Louisville, Kentucky, and plans to go on to graduate school to study Freelance Graphics.
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