NICView: An Interactive Neonatal Case Simulator

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Aperture Bioscience Laboratories

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Abstract

The Neonatal Intensive Care Unit (NICU) at Vanderbilt University Hospital wishes to create a case simulator, where pediatric residents can perform virtual procedures on neonatal patients. Because of various rules and regulations implemented by the hospital, as well as a limited number of physical neonatal practice dolls, residents are not getting the necessary practice time needed to sufficiently understand neonatal intensive care. Our project, NICView, attempts to:

- create an effective virtual interface where users get a real-life feel for NICU cases,
- establish a feedback system, where users can see the consequences of their actions and learn the optimal path to success,
- develop a user-friendly software geared towards medical residents that allows user-to-user interaction.

Introduction

There is a great need in most areas of medicine, but especially more rare, emergency specialties such as neonatology, for realistic, safe, convenient, and varied training tools for residents. Because of limitations on working hours and patient safety concerns, residents are seeing fewer cases than they ever have and need a greater volume of quality practice to become good physicians by the end of their training. The simulations must be realistic to mimic real cases as closely as possible. The safety facet is inherent in the fact that the simulation involves no real patient. Variation must be added in the form of multiple scenarios with different decision possibilities and outcomes. Finally, convenience is important to provide the sheer volume of practice cases necessary for residents to learn effectively. Several different approaches have been pursued and proposed in the general area of medical simulation that fulfill these criteria.

The most commonly seen strategy adopted by most medical schools is the medical simulation doll. These generally score extremely high in the realism portion. Most dolls can mimic healthy and diseased vital signs, and more sophisticated ones can even speak. This method, however, has several downsides. The first is the expense and complexity of dolls. Even large medical schools have a limited number, so each resident may only work with them about twice a month. Additionally, most dolls require a live human operator, necessitating scheduling and logistical coordination to initiate a practice session. On the variety portion, these dolls also score very high, as the vital signs and responses are manipulated in real time, so as long as the dolls are capable of a certain response, it can be added to the simulation at any time.

In summary, the traditional approach of a simulation doll serves most needs of a medical simulation save for convenience or volume. It is thus of great interest to produce a type of medical simulation that serves this need specifically. Thus, a less common method of medical simulation: software-based, videogame-like simulation has been adopted by some schools. Because of the difficulty in programming realistic and varied situations into one simple program, research and implementation in this area has been scarce. Several basic considerations must be made in the construction of such a simulation. The program should respond to some type of user input in the form of a treatment decision. It should respond to a user's actions and be both timely and accurate. These two considerations create an effective decision tree of possibly infinite proportions. Additional features, which may prove useful to such a simulation may be program-mediated and user-mediated feedback. The program could specify where a student may have made a non-optimal decision during a case simulation. Senior students or attendings could

provide forum-like feedback on student's reasoning for their decisions or communication skills in informing families of adverse outcomes. Ideally, such a simulation should be easily modified by those skilled in the field so as to continually increase and idealize the cases simulated. This project will seek to create such a simulation through initial prototyping and eventual implementation within the NICU at Vanderbilt Hospital.

History and Context

The project has consisted of four meetings. The first meeting involved the determination of a set meeting time and creation of the Gantt chart with the important dates and deadlines for the project. The second meeting time involved meeting with our project sponsor, Dr. Krakauer. In this meeting, we discussed the objectives of the project, which is to create a simulation in order for medical residents to gain experience through different scenarios. In the case of a bad outcome, the user will have an evaluation through video. The user will also have access to feedback and a forum in order to gain knowledge of what went wrong during that scenario. The group was provided by Dr. Krakauer previous examples of this type of simulator. The last meeting involved the determination and description by Dr. Krakauer of a simple scenario in order to make the prototype in Scratch by the end of the semester (December). This scenario is shown in the following figure.

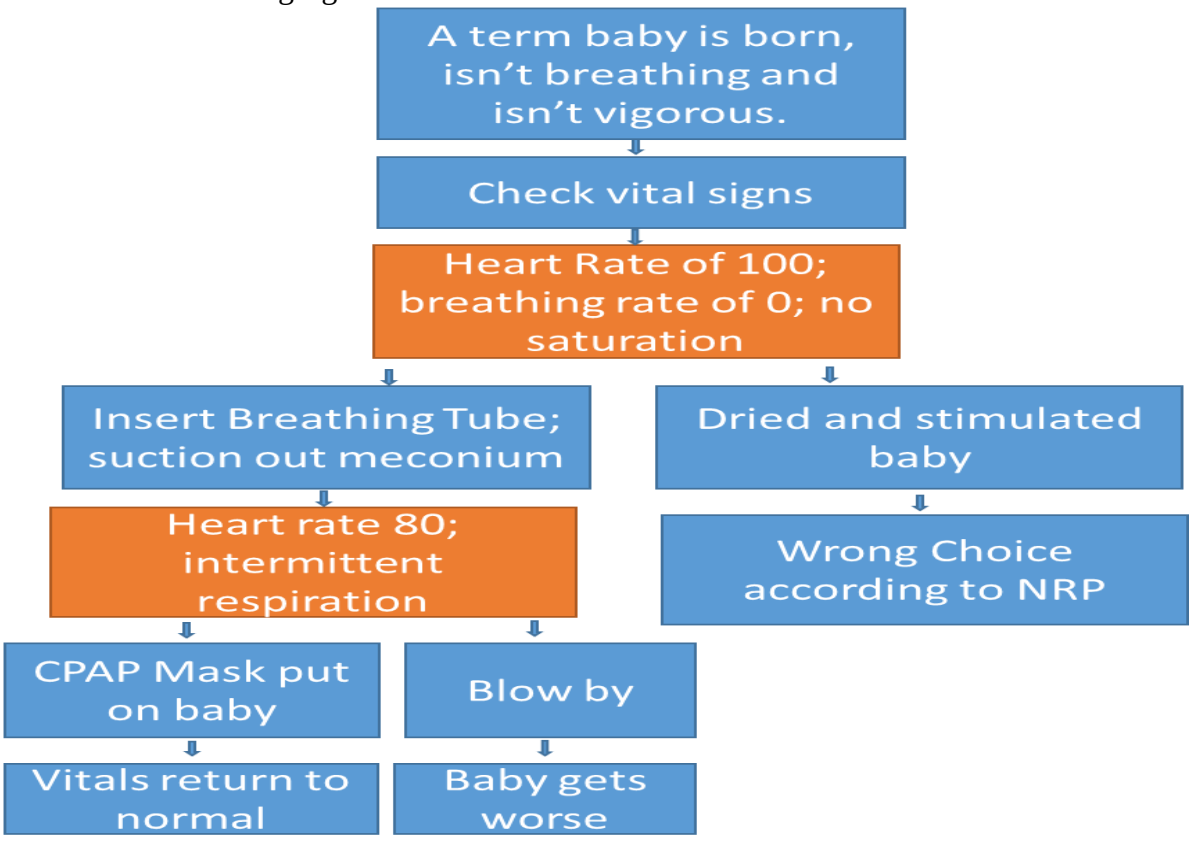

Figure 1: Initial Scenario

The simulation will display the initial situation. The user will then reach the decision point, shown in orange in Figure 1. The user will then choose an option and will continue through the scenario. If the user made a wrong decision, the user will be told that a mistake was made at a certain decision point. The user will be taken back to that point and will repeat the scenario.

When the initial prototype is completed, different scenarios will be added to be included in the final prototype. The first customer will be the Vanderbilt NICU and will be used by its medical residents. The simulation can be changed based on the department; therefore, the early customers will be other departments at the Vanderbilt University Medical Center. As the product is made on a larger scale, the product can be adopted by other medical centers and hospitals.

Team

Our team is composed of five members, all Biomedical Engineering Majors, some with minors and other special areas of interest that will combine to create a dynamic, successful group. Amy Young will serve as the Team Lead, organizing and heading small group meetings and bi-weekly discussions with our project sponsor. She also has extensive research and shadowing experience in the Vanderbilt Hospital. Jennifer Duan has extensive web programming experience and will be in charge of managing our team website, as well as being the point lead on our NICView user forum. She has knowledge using Python, CSS, JAVA, and HTML5, which will be helpful when programming the NICView simulator. Caitlin Li also has programming knowledge and will serve as our liaison with both Dr. Matthew Walker and Dr. Maria Krakauer. Lindsey Sumners has an Engineering Management Minor. She will serve as the data organizer, collecting and compiling group files, as well as creating flowcharts and schedules for meetings and various project plans. Pamela Wu is a Sociology minor, who will serve as our group's secretary during meetings, recording minutes and distributing contact information within the group. She also has programming experience (JAVA), which will be used during the simulator design.

Our project sponsor is Dr. Maria Krakauer. She is a neonatal specialist working at the Vanderbilt University Hospital. She has an M.D. from Eastern Virginia Medical School and did her residency in Internal Medicine and Pediatrics at Vanderbilt Hospital. We plan to meet regularly throughout the year with Dr. Krakauer to learn more about the NICU and the specific cases that our simulator needs to focus on.

Work Plan and Outcomes

Table 1. Proposed Steps

Step:	Description:	Completion:
1	Obtain an initial scenario flowchart from sponsor	10/28/14
2	Observe a simulation session and finish website	11/4/14
3	Choose/purchase a platform for game development	11/5/14
4	Begin translating initial flowchart into appropriate programming language	11/5/14
5	Functional product with one finished scenario	12/2/14
6	Obtain second scenario flowchart from sponsor	1/10/15
7	Finish programming second scenario	3/1/15

8	Obtain third scenario flowchart from sponsor	3/10/15
9	Finish programming third scenario	4/2/15
10	Finish fine tuning aesthetics of the virtual interface	4/15/15
11	Present project at Design Day	4/20/15

Our product's success will be measured by meeting our deadlines as well as by its effects on medical resident training. A successful product will be useable at home to residents and will help them become familiar and comfortable with common NICU scenarios. The residents will then be able to respond more quickly and confidently to sick newborns which will decrease infant mortality in the NICU.

Evaluation and Sustainability Plan

To maintain consistent progress and success with our NICview prototype, we will self-evaluate ourselves based on three categories. At every team meeting, several objectives will be discussed and set for completion by a designated time. The completion of these objectives will ensure our continued and consistent progress towards the next stage in the proposed steps. This will also help motivate and plan for the next stage in design and prototyping and set the objectives for the next meeting. The proposed steps outlined in table 1 will be followed for overall progression in design and prototyping.

The success of our NICview prototype will depend on its functionality. Other factors that influence the success of the prototype are virtual interface effectiveness, feedback system, and usability. The overall success of the prototype would depend on its use as an accurate and effective way for medical residents to learn and practice, virtually, medicine in a NICU.

Appendices

Budget Template with Budget Justification

Proposed Budget:
Table 2. Expected Expenses

Item:	Need:	Cost:
Game Design Platform	Provides necessary framework to create the virtual interface	$100
	Total:	**$100**

Expenditures

The only expected expenses for this project are the purchase of a programming system in order to design and run the simulation.

Resumes

Caitlin Li
Caitlin.l.li@vanderbilt.edu

PMB 356252
2301 Vanderbilt Place
Nashville, TN 37235-6252
(864)978-1656

Education

Vanderbilt University, Nashville, TN May 2015
Bachelor of Engineering, Biomedical Engineering, (pre-med)
GPA: 3.525

Awards, Honors

Cornelius Vanderbilt Scholar: full tuition scholarship awarded to top <1% of incoming class, selection based on academic merit
National Merit Scholar 2010
U.S. Presidential Scholar Seminfinalist 2011

Research/Work Experience

Research Assistant May 2012-present
Vanderbilt University, Department of Pharmacology and Chemistry
Nashville, Tennessee
Dr Craig Lindsley, Ph.D.

- Assisted in total chemical synthesis of Stemaphylline, a natural product shown to have acetylcholinesterase inhibitory activity, which could be useful in Alzheimer's therapy
- Assisted in synthesizing and testing mGlu2/3 negative allosteric modulators, which could be used to study various neurological disorders including schizophrenia and depression
- Techniques utilized include: calcium mobilization assay, competition binding assay, cell culture, and chemical synthesis

Volunteering/Service

Music in the Clinic Volunteer November 2011-present
Weekly piano performance in Vanderbilt Ingram Cancer Center waiting area
Founded the Magnolia Ensemble June 2010-present
A musical volunteer group that plays monthly in a nursing home in Spartanburg, SC

Medical Experience/Shadowing

Vanderbilt Children's Hospital, Endocrinology Clinic
Nashville, TN January 2014-present
Dr Nathan Bingham, MD, Ph.D. Pediatric Endocrinologist
Accompanied doctor during clinic hours

Cardiology Consultants
Spartanburg, SC December 2013
Dr Nalin Srivastava, MD Cardiologist
Accompanied doctor on rounds and in clinic, observed heart catheterizations

Leadership and Activities

Secretary of Vanderbilt University Fencing Club August 2013-present
President of the Vanderbilt University Fencing Club August 2012-December 2012
Competed in Junior Olympics February 2012
Under 20 Women's Sabre fencing, Salt Lake City, UT

Language/Other skills

B1 certified in German (3rd level in the 6 level proficiency system by the Goethe Institut)
Proficient in Matlab and Mathematica

JENNIFER DUAN

1016 18th Ave S. #306 | Nashville, TN 37212 | (918)876-2579 | xinyue.x.duan@vanderbilt.edu

SUMMARY

NCIIA Grant Proposal Resume – Programming/Web Design

EDUCATION

Bachelor of Engineering – Biomedical Engineering — Expected: May 2015
Vanderbilt University

- Awards: Dean's List

AREAS OF EXPERTISE

Programming

- Proficient in Object-Oriented Programming with Java, C++, MATLAB and Python
- Experience in smartphone app development for Android and iPhone
- Experience teaching basic programming and game design to middle school children

Web Design

- Created and maintained an HTML5 and CSS based web page

Leadership

- Served as Co-Community Vice President for Asian American Student Association
    - Planned and executed Asian Pacific American Heritage Month including a buffet for 300 people
    - Elected to serve as Webmaster for 2014-2015 and as a member of the Susan Jung scholarship committee
- Served as Vice President External for Vanderbilt Biomedical Engineering Society
    - Coordinate community service activities
- BME Pulse Newsletter Editor and Designer
    - In charge of 12 staff members

EXPERIENCE

Webmaster — 08/2014 - Present
Vanderbilt University – Asian American Student Association

- Created a one-page scrolling website using HTML5 and CSS code

Summer Intern — 06/2013 – 02/2014
Engineering for Kids of Greater Nashville

- Lead teacher for a class on how to program with LEGO Mindstorm picture-based programming
- Lead teacher for a class on game design using Scratch

Student Researcher — 05/2012 – 08/2012
Retina Foundation of the Southwest

- Created an iPad application to screen for infant/toddler eye health in infants that present with XLRP
- Created a smartphone application to screen for eye health in teenagers with XLRP
- Created a MATLAB program to analyze eye health screening data

Amy Young
amy.m.young@vanderbilt.edu
412.860.0298

EDUCATION

Vanderbilt University, Nashville, TN
Bachelor of Engineering – Biomedical Engineering Major Cu

Moon Area Senior High School, Moon Twp., PA
National Honor Society

EXTRACURRICULARS

Vanderbilt University Student VUceptor **August 2**

- Lead a group of first year students through freshman orientation.
- Become a resource for first year students in regards to academics and college life.
- Lead weekly sessions and small group discussions on issues faced by college students.

Vanderbilt University Crew Team **August 2**

- Attend daily practices and workouts
- Travel to bimonthly competitions
- Raise money to benefit the team

WORK EXPERIENCE

The Vanderbilt Clinic-Kim Lab **August 2**
Research Assistant

- Identifying targets for miRNA-140
- Investigations involving Myelodysplastic Syndrome

The Next Level Games **May 2013-October 2013**
Sales Associate

- Work solo and in a team to organize gaming tournaments
- Assist customers and perform basic sales duties

Vanderbilt University Medical Center –Young Lab
Lab Assistant

- Lab maintenance and chemical restocking
- Assist experiments and trials when needed

Express **May 2012-September 2012**
Sales Associate

- Assist customers and maintain floor integrity
- Ring up customers for purchases and cover the fitting rooms

Sewickley Martial Arts Academy **M**
Instructor

- Lead classes and prepare students for belt testing
- Conduct self-defense seminars for non-students at local schools
- Sign up new members and handle various fees

LEADERSHIP EXPERIENCE

Moon Area High School Stage Crew **Au**

- **Stage Manager-**Fall 2009 through Spring 2011.
- Supervise the construction of sets for plays and musicals
- Lead a group of ten to fifteen peers backstage during productions

American Taekwondo Association-Leadership Program

Level Two Judge and Specialty Certified Instructor

- Attend annual leadership seminars
- Lead rings during competitions on the state level
- Assist in level one instructor certification camps

VOLUNTEER WORK

VandyPaws **Au**

- Aid local Nashville humane societies at shelters and Petsmart

National University of Ireland-Galway Teddy Bear Hospital **January 2014-March 2014**

- Educate local children on the benefits of healthcare

Pamela Wu

pamela.wu@vanderbilt.edu

Home 516-694-4658 **Cell** 917-816-6593

Home Address
238 N. Delaware Ave.
Massapequa, NY 11758

Education

Vanderbilt University, Nashville, TN
May 2015
Bachelor of Engineering: Biomedical Engineering
Minor: Sociology
Cumulative GPA: 3.00/4.00

Experience

Raymond Cecora, Massapequa, NY
Physical Therapist Aide

- Assist physical therapists with equipment, patients, and technological data input for office administration
- Evaluate patients health and help therapists determine and improve treatment plans
- Maintain office, gym, treatment areas, and ensure patient service by solving potential problems with patients and within the office

Vanderbilt University, Nashville, TN
Inter-library Loans Worker

- Compile book information into Illiad database to update inter-library loans services
- Prepare books for check-in and check-out of Inter-Library Loans office

Leadership

Living Learning Community: Leadership Hall
Group Leader
August 2012 – May 2014

- Designed a nutrition program that teaches children and adolescents healthy foods and eating habits in a proactive and fun way for potential use in a school workshop
- Learned about leadership through community/campus volunteer activities

Rehabilitating Adoptable Dogs (RAD)
Founder/Vice President
November 2013 - present
Secretary
December 2011-Novemeber 2013

- Coordinate weekly meetings, write meeting minutes, and plan philanthropy events
- Promote the organization through Facebook, Anchorlink, and Gmail
- Planned events were dog walks and de-stress events to promote awareness for RAD

Phi Sigma Rho: Engineering and Technical Science Sorority

Founder/Social Chair
March 2013 – Present

- Plan social events that increase inter-relational bonds within the sorority that included Game Night, Fro-yo Social, and Adventure Science Center Day

Campus Involvement

BMES: Biomedical Engineering Society

- Student and national organization that promotes engineering and technology

School of Engineering Alumni Mentor Program

- Program that partners up current students and alumni to foster relationships through the sharing of professional and life experiences

Skills

Language: Conversational Cantonese, Basic Spanish
Programming: Proficient in coding and modeling in Matlab, Mathematica, LabView, and Rstudio
Databases: Previous experience using Illiad, Ariel, JSTOR, PubMed, and Google Scholar
Computer Skills: Microsoft Word, Excel, and Powerpoint.

Lindsey Sumners

Current Address:
PMB 353119
2301 Vanderbilt Place
Nashville, TN 37235

lindsey.c.sumners@vanderbilt.edu
(931)-309-7527

Permanent Address:
150 Johns Cemetery Rd
Pulaski, TN 38478

Education

Vanderbilt University, Nashville, TN — May 2015
Bachelor of Engineering, Biomedical Engineering
Minor in Engineering Management
GPA: 3.133

Relevant Projects

Vanderbilt University, Biomedical Instrumentation — January 2014-April 2014

Learned to use LabView and Arduino
Designed and tested an infrared thermometer to measure body temperature without contact

Vanderbilt University, Analysis of Biomedical Data January 2014-April 2014
Gathered real data from a lab at Vanderbilt University and researched the experiment of the lab
Conducted different statistical tests in order to interpret data

Experience
Richland Market, Lynnville, TN August 2011-August 2013
Cook/Cashier
Prepared food, cleaned kitchen, managed sales transactions, and stocked products before close

Habitat for Humanity Collegiate Challenge March 2011, March 2012
Volunteered during Spring Break with local Habitat for Humanity groups building houses

Leadership
CIRCLE, Nashville, TN
Co-President March 2014-Present
Run leadership meetings
Schedule different speakers for weekly meetings and fun activities for the group, such as touring Nashville landmarks

Wesley/Canterbury Fellowship, Nashville, TN
Vice President March 2013-March 2014
Designed posters, promoted group on campus, and extended outreach through first year interaction at The Commons

Service Chair March 2012-March 2013
Coordinated and scheduled different groups on campus to work Room in the Inn during the months of November to March
Scheduled other service activities, such as volunteering at the annual Miriam's Promise fundraiser

Sigma Phi Lambda, Nashville, TN
Treasurer April 2014-Present
Created budgets for each semester, collected dues, and established payment plans

Pledge Trainer January 2014-April 2014
Coordinated a weekend retreat for new members and led weekly meetings for the new members

Edification Chair August 2012-May 2013
Started a weekly program honoring different sisters and organized prayer partners for 40 people

Coursework
Biomechanics• Biomedical Instrumentation• Systems Physiology• Introduction to Tissue Engineering• Foundations of Medical Imaging• Therapeutic BioEngineering• Fundamentals of Management• Technology Strategy• Applied Behavioral Science
Skills
Programming Languages: Matlab(3 years) • Mathematica(2 years)
Microsoft Office: Word• Excel• Powerpoint

Supporting Documents