Music Learning Experience Design Plan

Group Members:

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Project Abstract

We will create a device and application that can easily teach kids about music. This will include the production of an electronic piano-like device using a microchip. Board and 3-D printed body. The devices will be designed for kids, a smaller form factor, hard to break, and colorful. Our software is going to be built to be robust, yet simple, so kids can pick it up and learn with little outside intervention. Our hope is to teach kids about music theory and creation in a fun and educational environment.

Project Description

The project will be an application created using C# that will help kids learn how to create basic beats and rhythms. The game will come with a 3-D printed piano, and there will be a menu and tutorial to help the kids get started with the application. The ability to save and load the beats that are made will be possible, and there will be different visual effects for each beat, and note, so each sound will be easily discernible. It will mainly be created for kids, but the parents may use it a little bit to see if it is something that they want to buy for their kids.

Project Proposal

Project Title: Music Learning Experience

Project Advisor: Dr. Carla Purdy

Team Members:

Adam Tait – Computer Science

Eric Gatto – Computer Science

Jason Judis – Computer Science

John Rose – Computer Science / Embedded Systems

Problem Statement:

Many children around the country do not have access to a music education. This is due to funding cuts and a lack of music teachers.

"A 2016 study at the University of Southern California's Brain and Creativity Institute found that musical experiences in childhood can actually accelerate brain development, particularly in the areas of language acquisition and reading skills. According to the National Association of Music Merchants Foundation (NAMM Foundation), learning to play an instrument can improve mathematical learning and even increase SAT scores." [1]

According to many different sources, a music education is very important for young children and can help them in more ways than one. The problem at hand is a lot of children are not getting this important education early.

Proposed Solution:

We propose a simple musical keyboard that will teach the children the fundamentals of music. This keyboard will consist of a single octave of music which will teach kids the relationship. The hardware of the keyboard will be paired with a partner software application. This application will use the hardware keyboard as a controller to allow the child to create their own music. This will follow a basic music theory pattern. The software will allow inputs from the keyboard to let the children fill in the notes on a measure that can be saved and played back at a later time.

Proposed Features:

- Be able to interpret hardware signal into a musical note
- Allow the saving/loading of songs for future playback
- Build a custom keyboard that will send inputs to the software

References:

1. "Children and Music: Benefits of Music in Child Development." *Bright Horizons®*, www.brighthorizons.com/family-resources/music-and-children-rhythm-meets-child-development (accessed Nov. 25th 2019)

User Stories

There are four main user stories that go along with our application. The kid who will use our application, the music teacher, a music student, and the parent of the kid.

Child

The child will want to learn the basics of music. They want to gain the ability to create their own music, and it will give them a good head start if they want to learn an instrument later in life. It will be helpful to get the child into music at an early age as well.

Teacher

The teacher will want an easy tool to teach the younger students. Teachers are always searching for different ways to teach their students. This could be a good way to get their younger students interested in music, and it is far different than traditional methods that are regularly used.

Student

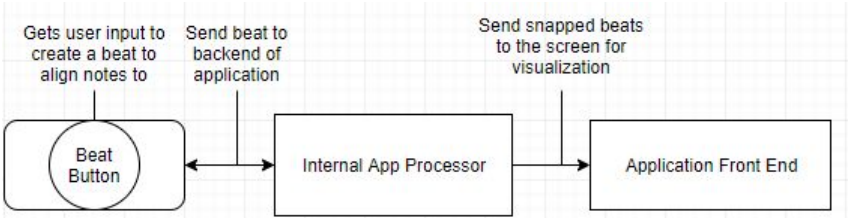
The student will want an app to help them learn the fundamentals of music. It may not be focused at older music students, but if someone does not have a very good foundation in the creation of music, then this could be a good way to start learning. It would be basic, and it would not be super helpful if someone wants to create more complicated music, but it will be a good place to start for the student.

Parent

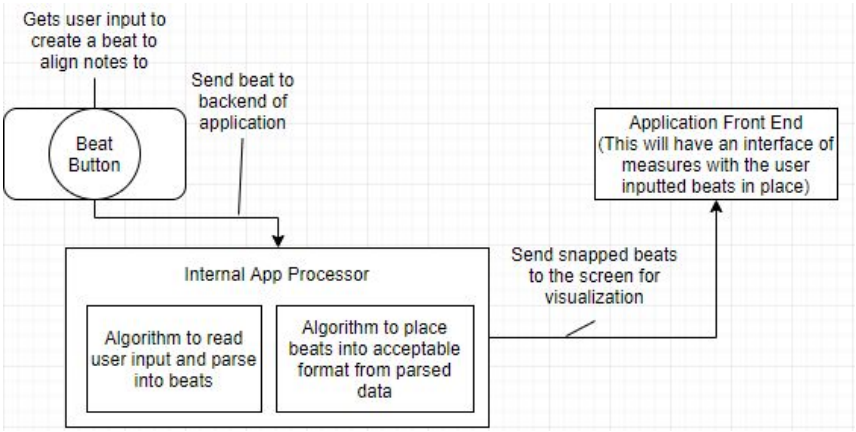
The parent of the child will want to encourage the child's interest in music and music creation. They may want their child to learn an instrument, and this could be a good start, or they may want to increase their child's want to learn music at an early age. At worst, they want an application that is kid-friendly, safe, and will not show anything harmful to their children.

Design Diagrams

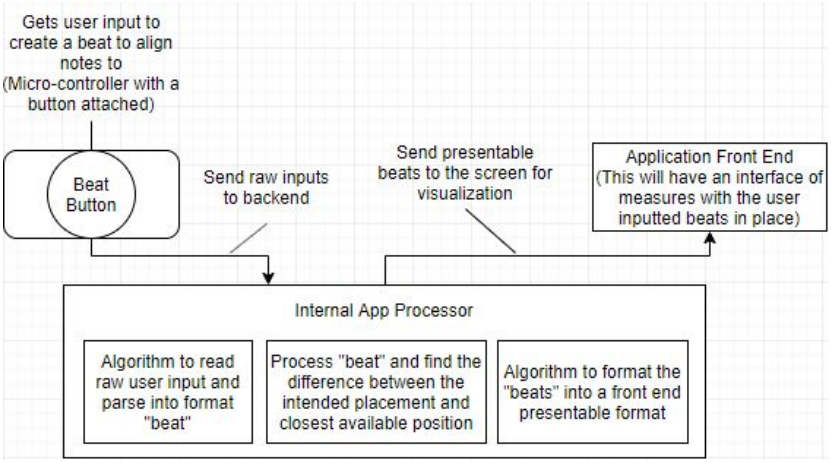
Level 1-



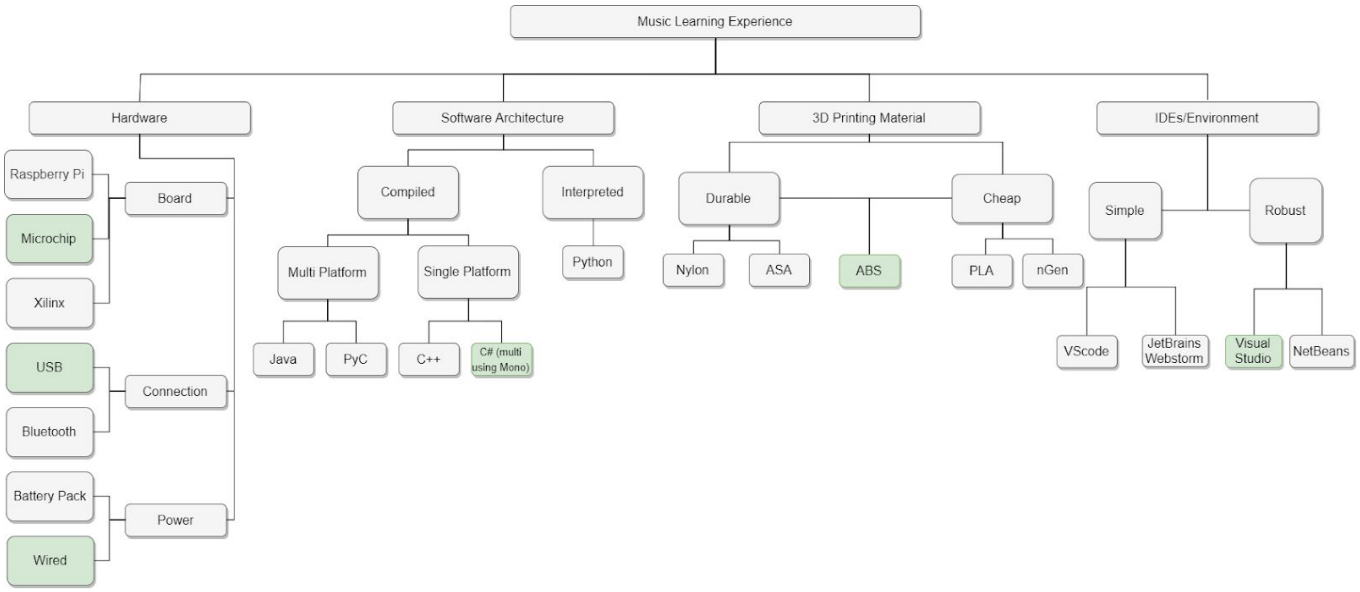
Level 2-



Level 3-

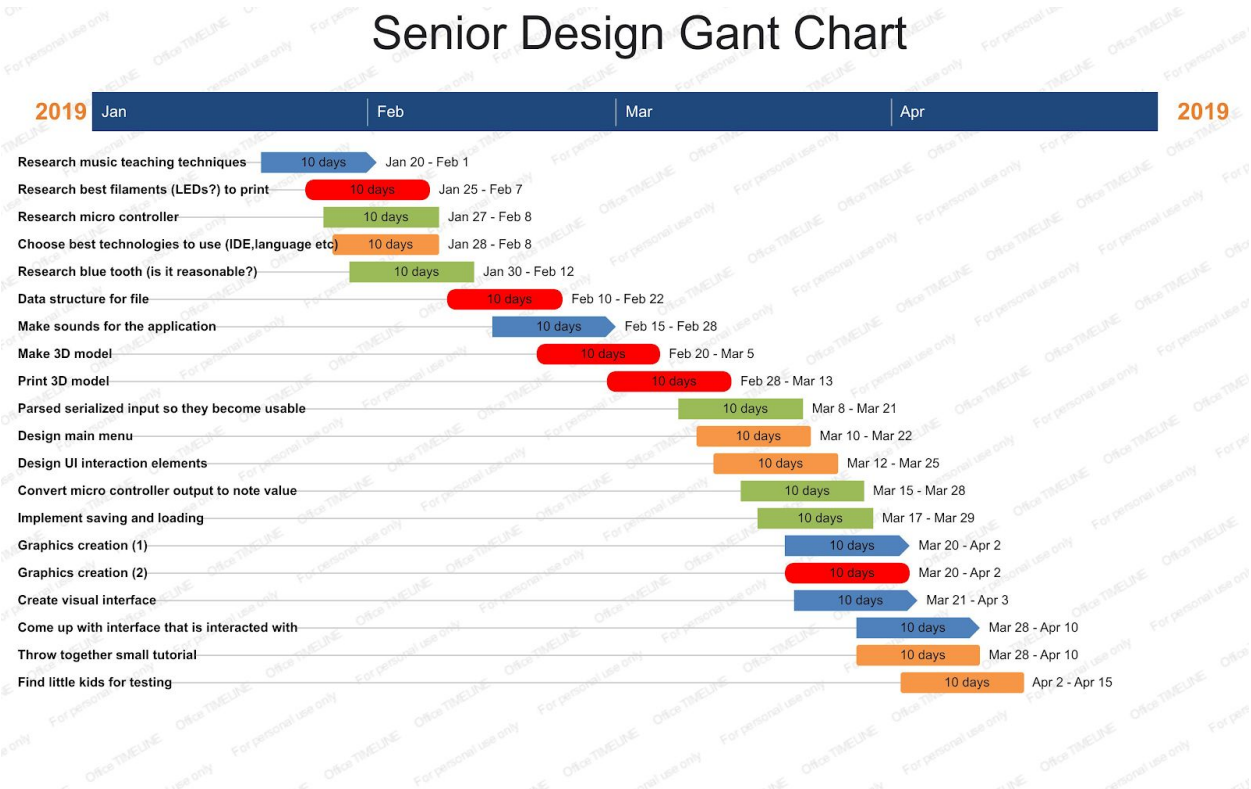


Technology Tree



Gantt Chart

Type	Title	Start date	End date	Duration (in days)	% Complete	Primary Person	Adam	Eric	Jason	John
Task	Research music teaching techniques	01/20/2020	02/01/2020	10	5	Adam Tait	13			
Task	Research best filaments (LEDs [Y]) to print	01/25/2020	02/07/2020	10	10	Eric Gatto		8		5
Task	Choose best technologies to use (IDE,language etc)	01/28/2020	02/08/2020	10	15	Jason Judis			5	
Task	Research micro controller	01/27/2020	02/08/2020	10	20	John Rose				23
Task	Research blue tooth (is it reasonable [N])	01/30/2020	02/12/2020	10	25	John Rose				10
Task	Create data structure for file	02/10/2020	02/22/2020	10	30	Eric Gatto		2		
Task	Make sounds for the application	02/15/2020	02/28/2020	10	35	Adam Tait	14	2		
Task	Make 3D model	02/20/2020	03/05/2020	10	40	Eric Gatto		22		
Task	Print 3D model	02/28/2020	03/13/2020	10	45	Eric Gatto		16		
Task	Parsed serialized input so they become usable	03/08/2020	03/21/2020	10	50	John Rose				10
Task	Convert micro controller output to note value	03/15/2020	03/28/2020	10	55	John Rose				5
Task	Come up with interface that is interacted with	03/28/2020	04/10/2020	10	60	Adam Tait	11	3		
Task	Graphics creation (1)	03/20/2020	04/02/2020	10	65	Eric Gatto	2	5		
Task	Graphics creation (2)	03/20/2020	04/02/2020	10	70	Adam Tait	10	3		
Task	Design UI interaction elements	03/12/2020	03/25/2020	10	75	Jason Judis			3	
Task	Design main menu	03/10/2020	03/22/2020	10	80	Jason Judis			25	
Task	Create visual interface	03/21/2020	04/03/2020	10	85	Adam Tait	17		17	
Task	Implement saving and loading	03/17/2020	03/29/2020	10	90	John Rose		0		0
Task	Create application tutorial	03/28/2020	04/10/2020	10	95	Jason Judis			4	
Task	Find children for testing	04/02/2020	04/15/2020	10	100	Jason Judis			0	2
HOURS							67	61	54	55



Self Assessment Essays

Adam Tait -

The project we are planning is a music app to give kids the opportunity to experience creating music that they potentially would not have had the chance to experience otherwise. From an academic standpoint this will incorporate many different disciplines into one. Obviously, it will incorporate computer science, but it will also include music theory and embedded systems. Music theory will be behind all the content of the app, what the user is actually experiencing. One of our project members is receiving a minor in embedded systems so we are required to include an embedded system. The plan for this is to include a piece of hardware that the user can tap a beat into to then use in the app to make music.

There are a variety of classes that are going into this project and we all bring different backgrounds into the project. For example, I have a background in music which will contribute to the content of the project and others have a background in embedded systems which will help us implement a hardware solution. I am currently taking a music theory class (FAM1001) which will help with the content of the application. I also have a background in music from a hobbyist perspective so I will be able to bring everything I know about music into this project. I am also currently taking a UI (CS5167) class and Computer Graphics (CS5160) class which will help in the design of the app. Having an easy to use UI will be critical in this usefulness of this app as it is designed for kids and needs to be able to be used by kids with a wide variety of backgrounds.

When it comes to work background, we all have diverse experiences that we can bring together to work on the project. I worked at ITI as a co-op and I worked in Python on a CAD-Server connector. This in itself does not really bring much to the project, however, I did get experience working on a large project with other people which will in turn help greatly on this project. Something that I learned on co-op which will be helpful is designing implementations that users of different levels will be able to work with and understand. During work if I was implementing a new feature I would have to think of the customer who asked for the feature and would have a background understanding of the new feature as well as the users who would receive the feature in a new update and how to make the new feature accessible to them. This will be critical in this project

because not everyone who uses the app will have the same background in music or in technology.

My motivation for this project is pretty personal. I love creating music and it's something that a lot of people don't get exposure to. I personally had very limited exposure as a child and the only exposure I did have was because of my parents, not schooling or any other avenue. I want to make something that gives kids an interest in learning music and a cheap/free way to meddle with making music. I would like to take what I have taught myself over the years and turn it into a way to get kids interested in making music. I think kids should be given the opportunity to explore different hobbies and potential professions and I think music is one that kind of gets left behind.

Our project approach is rather simple but difficult to get perfect. The end goal is to have some kind of application where the user can tap in a beat and add notes to the beat to make a melody. If that is accomplished, then I think that will indicate a good job. The difficulty comes in the small details, such as snapping notes that were tapped in to fit the measure without changing the users intended beat too much. Another difficulty will be implementing the actual sound of the notes and making sure we can accommodate for different note lengths (quarter note vs. whole note). I think this is one of those projects where aiming for small chunks at a time will help keep the project in perspective and make the end goal easier to accomplish.

Eric Gatto -

From an academic perspective our project will encompass a lot. We will be using embedded systems to interact with our program. We will of course be using computer science for the actual development of our project. Agile methodologies will be used in order to keep our project on track and moving forward. Knowledge of algorithms and data structures will be instrumental in making our program run smooth and efficiently. User interface knowledge will also be key in identifying a target audience and building towards them.

As mentioned above our knowledge gained from the curriculum will play a huge role in developing this project. We will be using information from classes such as Data Structures CS2028C. This class will come in handy during the process of writing the code and making sure its readable and efficient. Another useful class that will help with this project is User Interface 1, CS 5167. This class will make identifying our audience for the project easier. Along with that we will also know how to develop a useful interface for that audience.

My co-op experience will play a huge role in the development of this project. I only co-oped at Duke Energy as a Midwest Developer. During my time at Duke I learned a lot about working on large projects. I learned how to work on a team as well as how to keep project folders clean. I learned a lot of C# programming as well as ASP .NET development. I mainly acquired these skills on a regulatory project that required my team to build a new webpage for suppliers to use. During this process I also learned how to develop for a target audience, the business AKA “not the most tech savvy”.

I’m very excited to work on this project. The main reason to start a relatively large project from the beginning. At work all the large code bases that I worked on were all ready coded and I would have to read their code to try and figure out how my changes fit in. Starting from the beginning means I get to build from the group up and know every in and out of the code. I will also be able to identify my target audience from the very

beginning. After understanding my audience, I will then be able to come up with a vision on how I'd like everything to work and implement it.

This project also introduces a lot of technical learning. I feel like I have a lot of technical knowledge but with every project I'm sure I'll learn 100's of things. Whether it be a new language or a new architecture or even just better practices and techniques. I think that is where most of my excitement for this project comes from, is just the ability to learn more. Luckily I know all of my team members which provides an easier environment to learn from as we are all very open to giving and receiving feedback. I expect that through this project we will all learn a lot and all come out being much more well rounded developers.

Jason Judis -

Our project will end up being a way for kids to learn how to create beats and rhythms to create music. Essentially, a music helper for children and possibly young adults. We will need to include a friendly display that entices children and we will also need to have some hardware involved for the pressing of buttons to create the beats. That could be anywhere from tapping on a touch screen or trying to use a full-on electronic instrument hooked up to our application.

The knowledge that I have gained going through this curriculum at UC will help me tremendously on this project. A class I am taking now on User Interface (CS 5167) will help us develop the audience we want to create our application for and then go forward with creating a friendly application environment for that audience to work through. Also, I took courses like data structures (CS 2028) and software engineering to get a feel for how to go through the process of writing clean code and also how to handle different ways to develop a project in a group using things like agile programming and holding scrum meetings.

My coop experience will also help me through this process. I worked for Great American Insurance in the exec net department and I worked for Cincinnati Children's Hospital. At Great American I did work in C# ASP NET MVC and using visual studio as the IDE. The experience at Great American helped me understand that having a good control system that is used to keep track of code leads to developing a successful project. I also learned C# from never having used it before and I found it was easy to learn and probably a good code base to use for the application we want to build.

My main motivation is to help kids get into music. I was never musically inclined as a child, but everyone likes music in their own way, so at one point every child wants to create it. I think this would be a great starting point for a young child who wants to learn what different notes are and what different beats are and how they become important in creating songs. I would have liked to have this growing up as a kid.

As a basic point, we discussed that we want our application to be friendly to children. I think this means that it cannot be overly complicated, and it has to incorporate some touchy-feely component. We want to include a controller of some kind that can be tapped to create beats on the application. We also want to include the software part where the sound of the beats will come out. It could be a website or mobile app. I think we will

designate parts to certain people in our group and if one part doesn't come through then it would be obvious that someone did not put the work in. We will still do it together and help each other out, but if one person needs to do two times the work for another person it will become obvious. Our embedded systems guy will work on the hardware controller and the three computer science guys will have a hand in the development of the software application. Maybe one will figure out the best UI and the other one will try to create the code for the notes to actually include the correct sounds.

John Rose -

Academic Perspectives

The academic perspective of our project is hitting 3 core fields: Computer Science, Embedded Systems, and Music Theory. We will be using Computer Science for development of the foundation to our music app. This means development of a User Interface and implementing correct data structures to make data easy to handle between the multiple levels of the design. Embedded Systems will be used for the creation of a musical instrument, most likely an electronic piano. This will require software on the musical device to be able to interact with the music app. This will also require the creation of a physical device that is easy to use and handle. Music Theory is needed to develop the core functionality of the app. The app will require some development on basic skills that should be taught to learn how to play instruments. This could mean like a lesson on reading music and hitting the right notes on the musical device. We will also use an Agile style to keep on task and meet deadlines correctly.

College Experiences

College courses will have a big impact on the development of our music app. "Embedded Systems", EECE 5117C, will probably have the most impact on my development of the musical device. I will be working with either a Raspberry Pi or an FPGA to create the device. Embedded Systems main topics were how to deal with FPGAs and other Real Time Operating Systems to create simple devices. I will also use "The Theory of Formal Language and Automata", CS 5170, to create a correct flow of data and operations to reduce on wasted cycles. Automata also had a focus on creating diagrams, which will be imperative here when multiple groups will have to interact together. I can also see "Software Engineering", EECE 3093C, being crucial here in design and development. "Software Engineering" had a major focus on design techniques to lower the burned on development.

Coop will also have a great impact on our senior design project. I initially worked at Emerson as an IT Helpdesk Technician. This job will be in handy for User Interface development, because I often had to help out coworkers interact with software. I will be able to notice elements that can cause confusion and elements that should be added to ease the burden of use. My most recent Coop was as a Research Assistant at The Air Force Institute of Technology. My main point of research was on Cube Satellite Development. I got experience working with Real Time Operating Systems and Embedded Systems. Our main focus was on safety and efficiency of code, this will be

helpful in the development of the musical device. I also got to see a multitude of data packetization styles, this will be useful in choosing a method to communicate from our music device to the app.

Motivation and Project Approach

I am excited to work on this project because it will encompass almost everything I have learned at college. I will also get to work on a whole project from design and requirements through development and finally ending at delivery. College and Coops have mostly had projects where the students come in for a specific stage in a project, but this senior design will let me have one full experience. The preliminary approach to our solution is to design out how the different facets of our project will interact and decide on many key decisions. We need to decide on what hardware we would like to use, communication protocols and packetization, core framework, and design ideology. This will be interesting because our whole group has different experiences so we can all weigh in on these decisions.

Our expected results will be to learn about how to work as a team to design and implement a project from beginning to end. I think we will accomplish creating an app that kids can use with a physical instrument to learn how to read and produce music. We will also learn many different disciplines in development from each other as a team. We will evaluate contributions most likely by using deliverables and deadlines for each member. This is the easiest way to keep track of everyone's individual progress with relation to the final product. We will know when we are done when an app has been created that interfaces with a musical device to teach kids how to play an instrument. A hard deadline of telling when we are finished will be hard to decide on, but most likely will be when there is enough lessons for a kid to interact with it for over an hour or two.

Professional Biographies

Adam Tait

Contact Information
614-314-5298 | taitah@mail.uc.edu

Work Experience
ITI Global | December 2016 - August 2019 At ITI

I learned skills involving CAD systems. I worked on a connector between CAD (NX, CREO) and server (Aras). I used python to implement new features and worked on customer requests.

Skills
Python, C#, C++, JavaScript, Java, SQL, HTML/CSS, PTC Creo, Siemens NX, Aras, MATLAB, Blender, Unity3D, Android Studio, Visual Studio, Photoshop, Microsoft Suite

Project Sought
I would like to work on a project that is different than something I have done before, I feel this is a good opportunity to learn a few new skills and expand my knowledge base. This could mean working with an embedded system or web development.

Eric Gatto

Contact Information
513-504-4350 | gattoej@mail.uc.edu

Work Experience

Duke Energy - Software Developer (Jan 2017 - Current)

- Devloped Scripts for file transfers
- Devloped front end website for supplier authorization file uploads
- Devloped VBA Macros to increase workflow
- Manage Agile Kanban boards
- Assisted with a double Windows server replacment
- Performed mass data pulls on DB's for information gathering
- Created numerous presentations for data interpretation

Skills

- C#
- VBA
- Python
- Powershell
- SQL
- ASP.NET
- Power BI

Project Sought

I am looking for projects that require software development. A project that could be useful or informative to a large audience would interest me.

Jason Judis

Contact Information
419-351-6958 | judisjt@mail.uc.edu

Work Experience

Great American Insurance- Software Developer

- Learned and developed in C#
- Worked in ASP .NET MVC for the first time
- More proficient in Visual Studio
- Projects
    i. Updated their navigation system so it looks better and is easier to use
    ii. Created a new ecommerce system using sitefinity custom widgets for their asset disposal team
    iii. Developed an application to add items to the grab and go lunch application

Cincinnati Children's Hospital - Software Developer

- Developed website for NICU patients and families using angular 4+
- Used google firebase for holding our information in a database
- Learned about making a PWA (progressive web apps) and how to make our app one using node js and angular
- Used Oauth2 for authentication

Skills

Angular 4+, Visual Studio, ASPNET MVC, Sitefinity, TFS, React Native, Android Studio, Jet Brains Web storm, GitHub, Unity, SQL

HTML, CSS, JavaScript, TypeScript, Python, C#

Project Sought
I guess I would be seeking a project that would have a website or mobile part to it that needs front-end development because that is really where all my experience lies so far. I have some minor back end experience, but not that much.

John Rose

Contact Information
937-631-4329 | rose24@mail.uc.edu

Work Experience

IT Help Desk Technician - Emerson Electric Co. (Jan 2017 - Dec 2017)

- Fixed factory tech issues
- Helped with office operations
- Integrated new technology into the production chain
- Documented and optimized factory work flow
- Worked with multiple remote tech teams

Research Assistant - AFIT (May 2018 - Aug 2018)

- CubeSat design and development
- Updated hardware interfaces in Rust
- Designed main radio communication interface using Visio

Research Assistant - AFIT (Jan 2019 - Aug 2019)

- Worked in a Scrum team environment
- Updated and optimized hardware using C++ and FreeRTOS
- Designed backup radio communication interface using Visio
- Developed main radio communication interface in Rust
- Designed and developed ground station software using Python and Flask

Project Sought

I am looking for projects that contain both Embedded Systems and Computer Science topics. Most of my professional experience has been with integrating hardware and software. A project that could allow me to develop hardware components that interact with a software layer, like a website, would interest me.

Budget

We decided that we will not need any additional funding from UC. The project should be cheaper than most projects. We just need the filaments for the 3-D printer because one of our group mates has a 3-D printer. Also, we need the microcontroller, and a raspberry pi. Our project will not be that expensive, and our group decided we can easily eat the cost of the project without any problems.

PicClicker	**https://www.mikroe.com/clicker-pic18fj**	**$20**
2x ABS Filament	**https://www.microcenter.com/product/485641/inland-175mm-white-pla-3d-printer-filament---1kg-spool-(22-lbs)**	**~$40**
ABS Paint	**???**	**~$20**
3 State Mux	**https://www.debcoelectronics.com/product/74hct354-8-input-muxregister-3-state-20-pin2pk/**	**~$1.50**
Button Components	**???**	**~$10**
LEDs	**???**	**~$10**

Appendix

External Research

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"Is There Any Type of Filament/process That Can Safely 3D Print a Child's Toy, I.e. That if They Chew It, They Won't Be Poisoned?" Quora - A Place to Share Knowledge and Better Understand the World,

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"Reasons to Learn C#." The Software Guild, 24 Feb. 2016, www.thesoftwareguild.com/blog/reasons-to-learn-c-sharp/.

"Why Choose C#?" AT Blog, 15 Aug. 2019, atblog.org/technology/why-choose-c/.

Presentations

PowerPoint Presentation
PowerPoint Video

Code Repository

Work Hours