

DGMD E-598 Digital Media Design Capstone Tutorial

Final Proposal for Frank Pizzuta - Summer 2019

1. Project Scope

1.1 Project Title

Enhancing an Analog Pinball Experience using IoT, NodeJS and Visualizations.

Digital Media Capstone Track

CSCI E-31 Web App Development/Node.JS

CSCI E-3 Web Programming / JavaScript

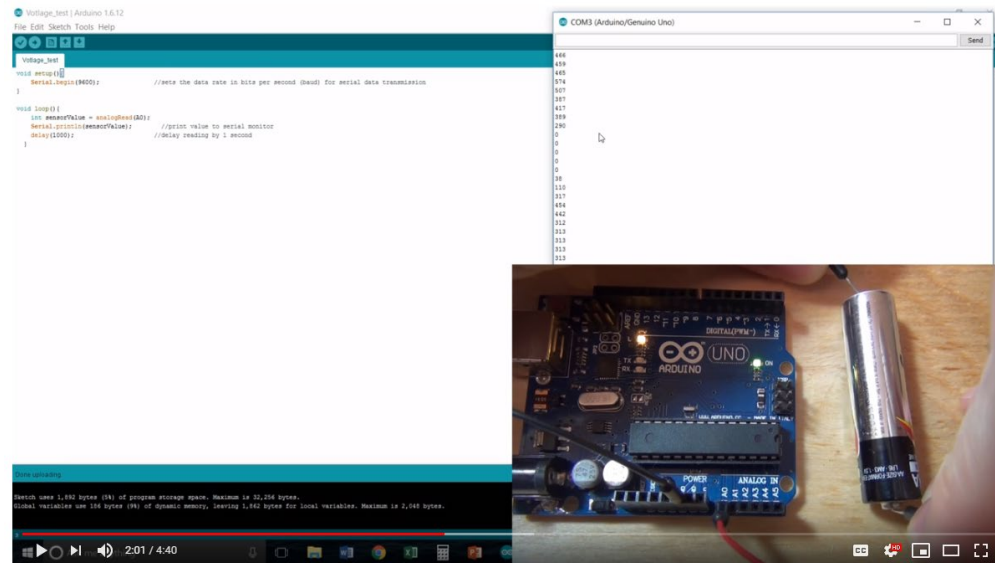
1.2. Project Goal

Older game systems are a large niche market where customers are willing to spend large amounts of money for restoration and customization. There are many older analog game systems, but for this project I will focus on pinball. Newer pinball machines, while containing some digital technology, still create essentially the same game experience as their electro-mechanical counter parts. I want to build off this established game experience. My initial efforts will be at enhancing this experience.

To achieve this, the goal of my capstone is to convert an analog signal, such as a voltage change, to digital and cause a synchronized digital event to occur via a web service. This digital event could be a video played on a screen, effect the environment around the machine such as turning lights on and off, or video rendered inside of an Augmented Reality setup.

1.3. Learning Goals

1. Use an Arduino, Raspberry Pi, or other IoT device to detect a voltage drop.



Code and Testing - Arduino Voltage Sensor Tutorial

The basic concept for detecting changes in voltage came from this YouTube video.

https://www.youtube.com/watch?v=MjqND1y2X_4

2. Have the IoT device send information to a web service.

The Arduino can send http post statements to a web service. The following linkedin article talks about the basics of doing this. <https://www.linkedin.com/pulse/how-make-rest-api-http-post-call-using-arduino-uno-esp8266-taha-ali/>

3. Use the web service to drive the graphical events in sync with the originating signal.
4. Use the web service to change the state of IoT devices such as led lights that are completely separate from the pinball machine.

1.4. Target Audience

1.4.1 Personas



Dennis

Life long pinball player

Demographics

Age: 51
 Job: Programmer
 Family: Married with 2 kids

Facts

- Owns multiple pinball machines
- Plays in a pinball league
- Attends pinball tournaments and conventions.
- Active on pinball forums
- High disposable income



Mark

Occasional pinball player

Demographics

Age: 37
Job: Designer
Family: Married with 2 kids

Facts

- Dreams of owning a pinball machine
- Plays in a pinball league one night a week
- Moderate disposable income



Rachel

Little to no pinball experience

Demographics

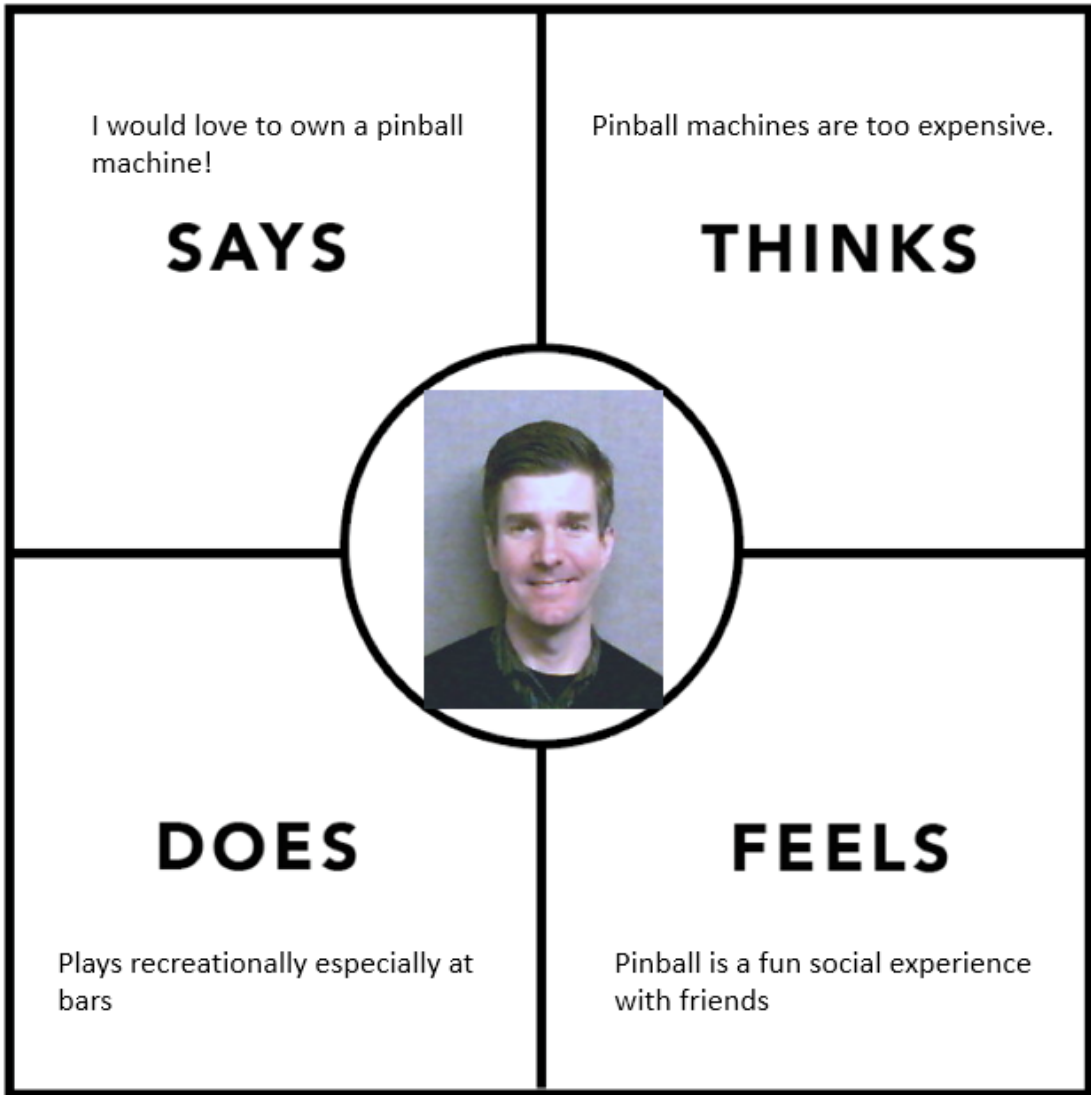
Age: 27
Job: Web Analytics
Family: Single

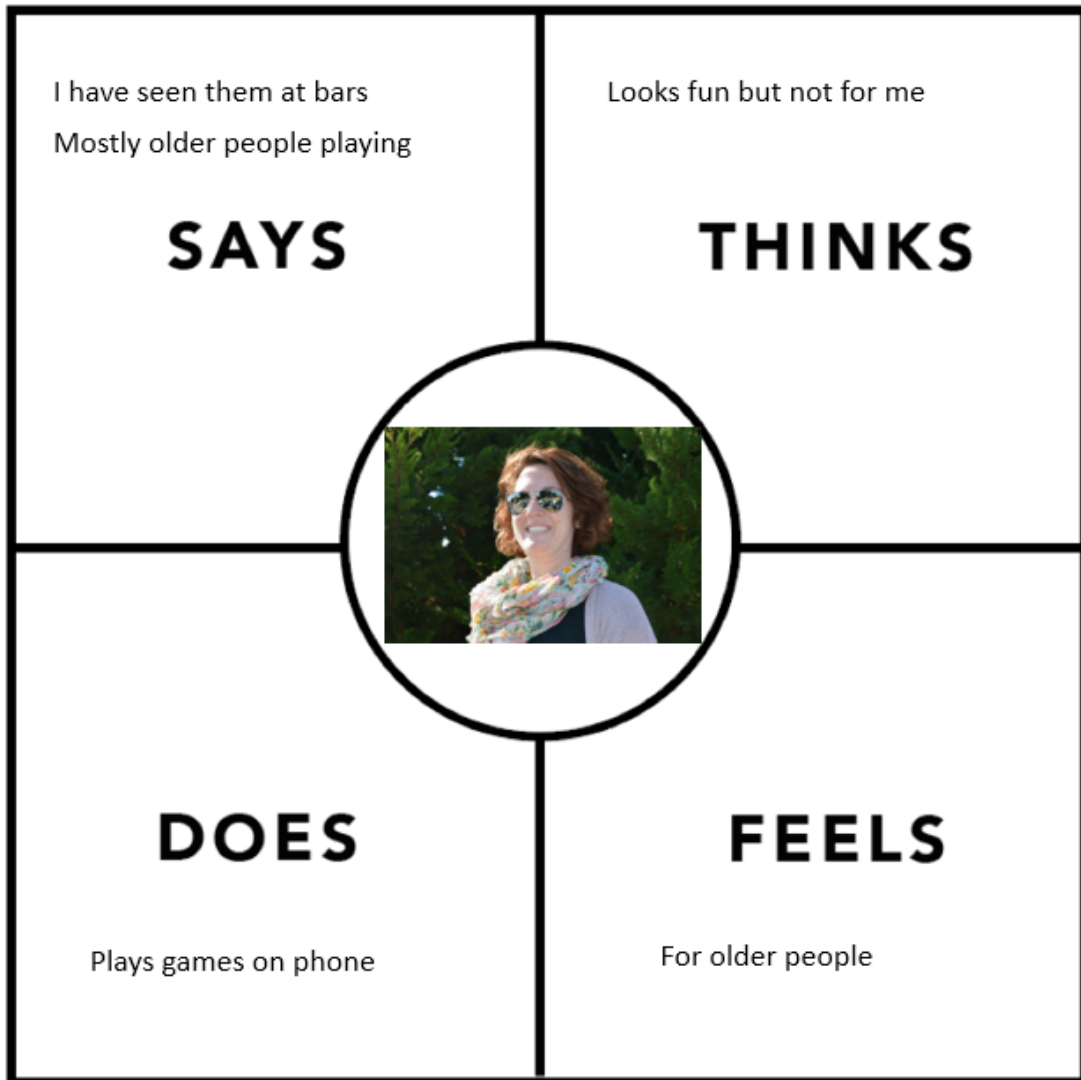
Facts

- Has seen pinball machines at bars
- Thinks pinball looks fun
- Gaming is through phone
- Low disposable income

1.4.2 Empathy Maps







1.5. Elevator Pitch

Older games, such as pinball, were successful because they physically engaged users in the experience. We can capitalize on this success not by completely virtualizing the experience but instead combining the physical and virtual worlds. My project will use this idea of physical computing to create a new gaming experience.

1.6. Metrics

	1	2	3	4	5
How often event fires	Distracts from gameplay				Enhances game experience

Timing of external event	Lag effects gameplay				No perceived lag
Play video on screen	Distracts from gameplay				Enhances game experience
Player experience	Does not like				Would buy
Solution Cost	> \$500	> \$400	> \$300	> \$200	<= \$200

1 - non-satisfactory 5 - outstanding

1.7. Life of the project beyond capstone

Does this project exist beyond completing the capstone course?

Restoring my pinball machine is a passion project and I would like to extend its functionality and then share the results with the pinball community. Hopefully, other people will be interested and it can turn into a niche side business. However, this project is a proof of concept around a broader idea. My ultimate goal is to integrate the viewing environment with the visual experience. I would like to create a standard by which third party providers could tie an in home movie or videogame to their smart phone, lights, or any connected technology that would enhance the experience.

Will it help you get a job, get a promotion, create a portfolio, or launch a business?

While it will not get me a job, I believe showcasing a wide range of talents and interests on your resume and LinkedIn profile can lead to opportunities. As mentioned previously, my project could lead to a small side business.

Will your capstone be used or experienced by your target audience after this class?

Use by my target audience depends on how hard it is to implement my idea and cost. I view this project as my proof of concept and feedback from the pinball community will determine if it gets adopted by the larger audience.

2. Competitor review

For my project, I am listing competitors in three categories. The first is new pinball machines. These machines have been manufactured in the last 10 years. For the most part they are still electro-mechanical but have a PC and Ethernet bus system instead of custom hardware to drive the game. With the PC they can integrate video and internet connections. The second category is virtual pinball machines. These solutions range from software based pinball fields to full virtual reality fields.

Finally, there is the pinball modding community. All sorts of add-ons and additions are made for pinball machines. While none of these options are exactly what I am proposing there are pieces of each one in my project.

Competitor Matrix

	Cost	Setup Complexity	Interaction
New Pinball	\$7k+	High	High
Virtual Pinball	\$30 - \$2500	Medium	Medium
Mods	\$30 - \$200s	Medium	Low
Project	<\$200	High	High

2.1 New pinball machines

All newly manufactured pinball machines are computer based. There are a handful of manufacturers making them and only in limited releases. The top manufacturers are:

1. <https://sternpinball.com/>
2. <https://www.jerseyjackpinball.com/>

Both produce pinballs with LCD for back glasses (as seen in image below) and use a PC to drive the pinball game. The PC runs custom code and is only updateable by the manufacturer.



2.2 Virtual Pinball Machines

Virtual Pinball Machines are fully rendered in software with a physics model that mimics real life play mechanics. The software allows the player to choose from a list of pinball machines. The playfield is then rendered on a 4k monitor.

2.2.1 LCD based and computer driven

Virtua Pin



<https://virtuapin.net/>

Pros: Almost any pinball machine playfield is available.

Cons: No tactile feedback. It has the look of pinball but lacks the feel.

2.2.2 Virtual Reality Pinball



<https://www.oculus.com/experiences/rift/1044201475659209/>

<https://www.youtube.com/watch?v=TLYIEm9kkvU>

Pros: Little to no physical space needed. Large collection of playfields

Cons: No tactile feedback. Current hardware has trouble rendering pinball speed properly. Removes social aspect of playing.

2.3 Mods

Mezel Mods

<https://mezmods.com/collections/tv-video-display-mods>

Pros: inexpensive, comes with pre-loaded video

Cons: limited to certain machines, has to be attached to playfield, no customization

Modfather Pinball Mods

<https://modfatherpinball.com/collections/mods>

Pros: Highly customized accessories

Cons: limited to certain machines, no change to gameplay, look only

Lighted Pinball Mods

<https://lightedpinballmods.com/>

Pros: Large assortment of lighted mods for most pinball machines, driven by Pinball machine power, turns on with Pinball machine

Cons: Look only, no effect on gameplay. Most mods light when machine is turned on and not to game event.

3. Technology requirements

Technology #1: Arduino or Raspberry Pi

Reason: I need a way of reading voltage changes when lights and sensors are tripped in the pinball machine. Both the Arduino and Pi have boards available for this type of interfacing.

I will be learning this technology as I go.

Technology #2: NodeJS

Reason: Node is used for back end infrastructure builds. It allows me to use JavaScript (which I am very comfortable with) to construct web APIs. Being open source, it has a large library of modules for me to choose from when adding functionality.

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Technology #3: Home Automation (i.e. Insteon ISY)

Reason: Allows the project to control devices plugged into any power outlet or available via Wi-Fi.

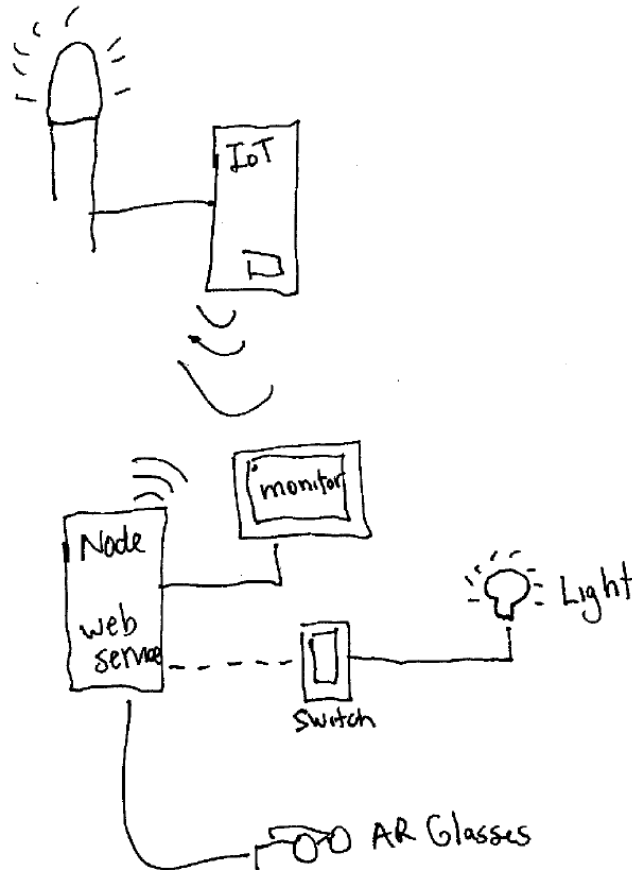
I have installed Insteon digital switches but have not tried to control them programmatically.

Technology #4: Augmented Reality System

Reason: I am not sure what system, if any, I will be able to use. This part of the project may more of a survey of what could work.

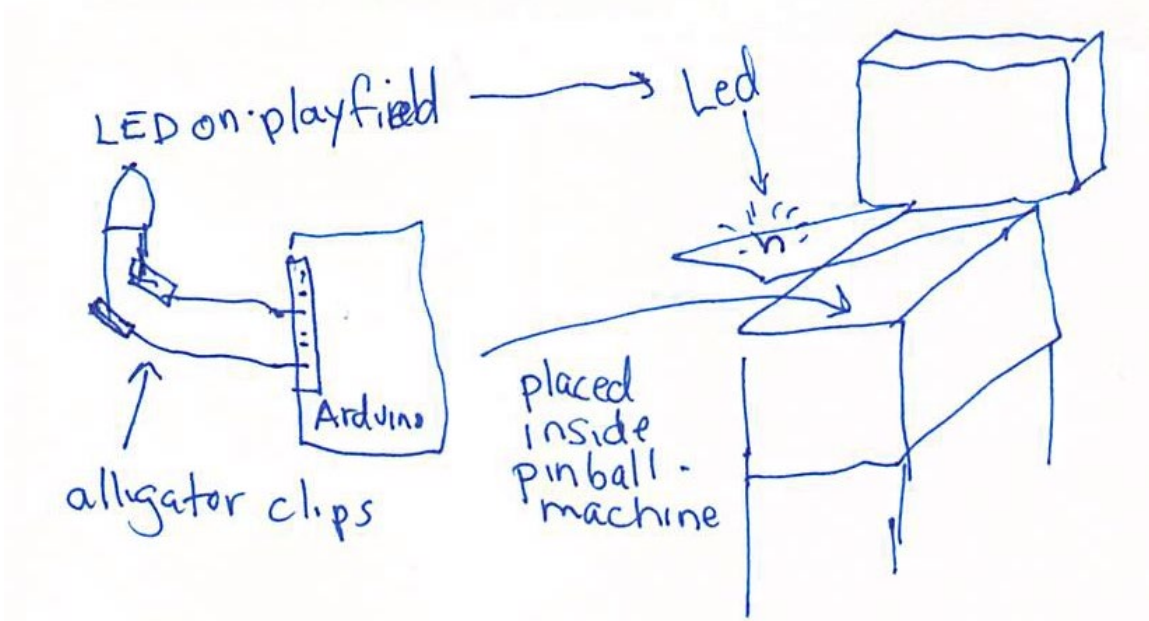
I will be learning this technology as I go.

4. Visuals describing how your product will be used

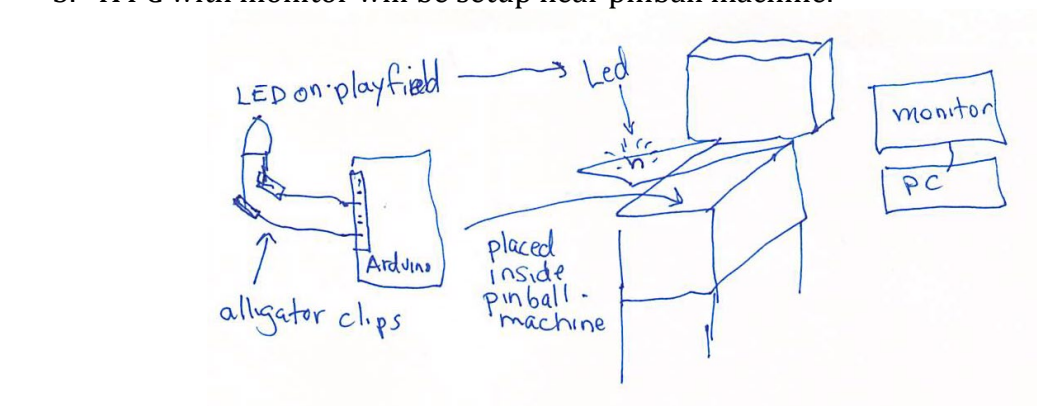


Installation




1. The user will connect the analog ports of the Arduino to the leads of the LEDs via alligator clips.



2. The Arduino will be plugged into a power port inside of the pinball machine and connected to wifi.
3. A PC with monitor will be setup near pinball machine.



4. Nodejs software will be installed and run on this PC.

LTS Recommended For Most Users		Current Latest Features	
 Windows Installer <small>node-v10.16.1-004.msi</small>		 macOS Installer <small>node-v10.16.1.pkg</small>	
		 Source Code <small>node-v10.16.1.tar.gz</small>	
Windows Installer (.msi)		32-bit	64-bit
Windows Binary (.zip)		32-bit	64-bit
macOS Installer (.pkg)		64-bit	
macOS Binary (.tar.gz)		64-bit	
Linux Binaries (x64)		64-bit	
Linux Binaries (ARM)		ARMv6	ARMv7
Source Code		node-v10.16.1.tar.gz	

5. API software will be downloaded onto PC from Github

The screenshot shows the GitHub repository page for 'fpizzuta / DigitalMediaCapstone'. At the top, there are navigation links for 'Code', 'Issues 0', 'Pull requests 0', 'Projects 0', 'Wiki', 'Security', 'Insights', and 'Settings'. Below these, there are statistics: 'Unwatch 1', 'Star 0', and 'Fork 0'. A message states 'No description, website, or topics provided.' with an 'Edit' button. Below that, it says 'Manage topics'. The repository statistics show '1 commit', '1 branch', '0 releases', and '1 contributor'. There are buttons for 'Branch: master', 'New pull request', 'Create new file', 'Upload files', 'Find File', and 'Clone or download'. The commit history shows 'fpizzuta Initial commit' with the latest commit '378e704 now'. Below the commit history, there are two files listed: 'LICENSE' and 'README.md', both with 'Initial commit' and 'now'.

Monitor Version:

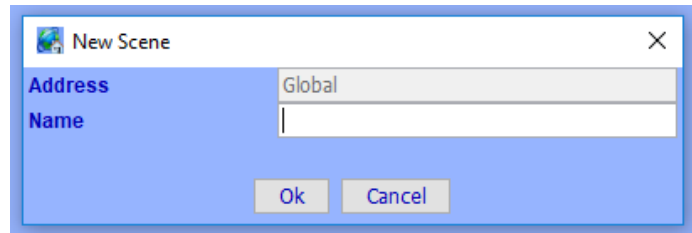
1. In the future, the user will also download the multimedia appropriate to their pinball machine. For purposes of this project, media will be included with the API install.
2. Game can now be played. When connected LEDs light the appropriate media should show on monitor.

Insteon Version (monitor only needed for configuring PC)

1. Download Insteon connectivity software from Github.
2. Configure config file for Insteon API to allow access to Insteon ISY controller



3. Create scene in ISY for lights near pinball machine



4. Add scene name to API config file
5. Game can now be played. When connected LEDs light, home automation events should activate.

AR Version

1. For purposes of this project, steps for Monitor Version should be completed and working.
2. Download AR API software from Github.
3. Install AR app on phone.

How to download apps and games from the App Store in iOS 10 and older

1. Tap the **app** or game you wish to purchase or **download** for free.
2. Tap Get if it is free, or the price of the **app** if it is paid.
3. Tap Install or Buy when the icon switches.
4. Enter your Password or use Touch ID when prompted.
5. Wait for the **download** to finish.

4. Game can now be played. When looking through phone or glasses while playing pinball QR code will show on monitor and be replaced via AR software with AR media.

5. Work plan and milestones

This project will have four phases.

Phase 1:

The first phase will be to successfully read a voltage change on the pinball machine and call a web service as a result. The voltage change can be the result of a led lighting or an electro-mechanical sensor tripping.

Milestone

1. Arduino detects voltage when led is lit.

Phase 2:

The second phase will involve playing a video, sound, etc. when the web service is called. This will likely be accomplished by sending html to a dynamic web page.

Milestone

1. Arduino detects voltage when led is lit.
2. Web service properly responds to test calls.
3. Web service updates web page when call from Arduino is received.

Phase 3:

The third phase would involve controlling devices such as led bulbs, strip lights, etc. that are not connected to the pinball machine.

Milestone

1. Home automation light turns on when web service receives message from Arduino.

Phase 4:

The fourth and final stage would be to investigate showing the video through an augmented reality setup so that the animation blends seamlessly with the gaming experience.

Milestones:

1. Augmented Reality media is displayed when QR code appears.

User testing will be performed by members of a local pinball league and a group of non-serious pinball players. I am curious to see if hard core players will accept a new concept applied to their hobby.

From a project management perspective, I will use a Lean methodology approach. I am looking at the capstone as my minimal viable product (MVP). I need to test the core concepts of my idea and then be ready to change my approach if it doesn't test well. Most importantly, I need to get something into the hands of my users as opposed to building the whole system without any feedback.

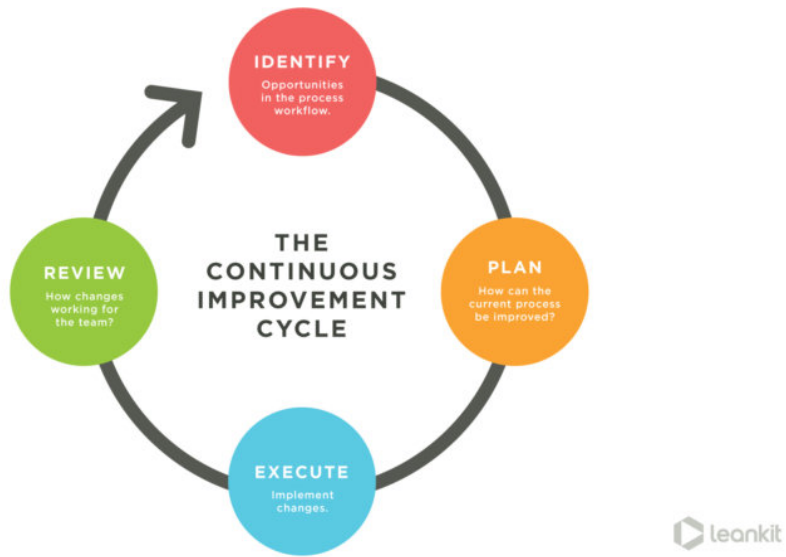


Figure 1 Lean Continuous Improvement (from leankit.com) (leankit.com, 2019)

6. References

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lean-methodology

leankit.com. (2019, 04 8)

<https://leankit.com/learn/lean/lean-methodology/>

Lean is a business methodology for product development and continuous improvement. It stress's getting your product in the hands of users, iterating rapidly through feature and functionality offerings and pivoting away from dead ends.