# G-12 PedalVision

*User Programmable Instrument Multi Effects Pedal and Light Interface*


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Initial Project Document and Group Identification
Divide and Conquer


Group 12

| | | |
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## Project Narrative

When is comes to music an individual's sound is everything. Musicians are constantly searching for the "best" sound they can find, whether that be with regards to a specific tone quality or cool sounding effect to enhance what is being played. Sometimes people want something to enhance a shows visual aspect and want the visual part of their performance to match their audio portion. With this project idea we aim to kill two birds with one stone allowing the user an assortment of sounds, both digital and analog, and a light display that will react to the electrical signal created by the instrument playing.

Right now many multi effects boards are all digital and if the user wants analog effects they need to buy each unit separately. By incorporating multiple effects into one unit it will create a smaller footprint and reduce the weight of the final product. This all in one product, as shown in Figure 1, will also save the user money since they will only need to by one unit as opposed to a different unit for each effect they want. Also software updates may allow for more digital effects options in the future.

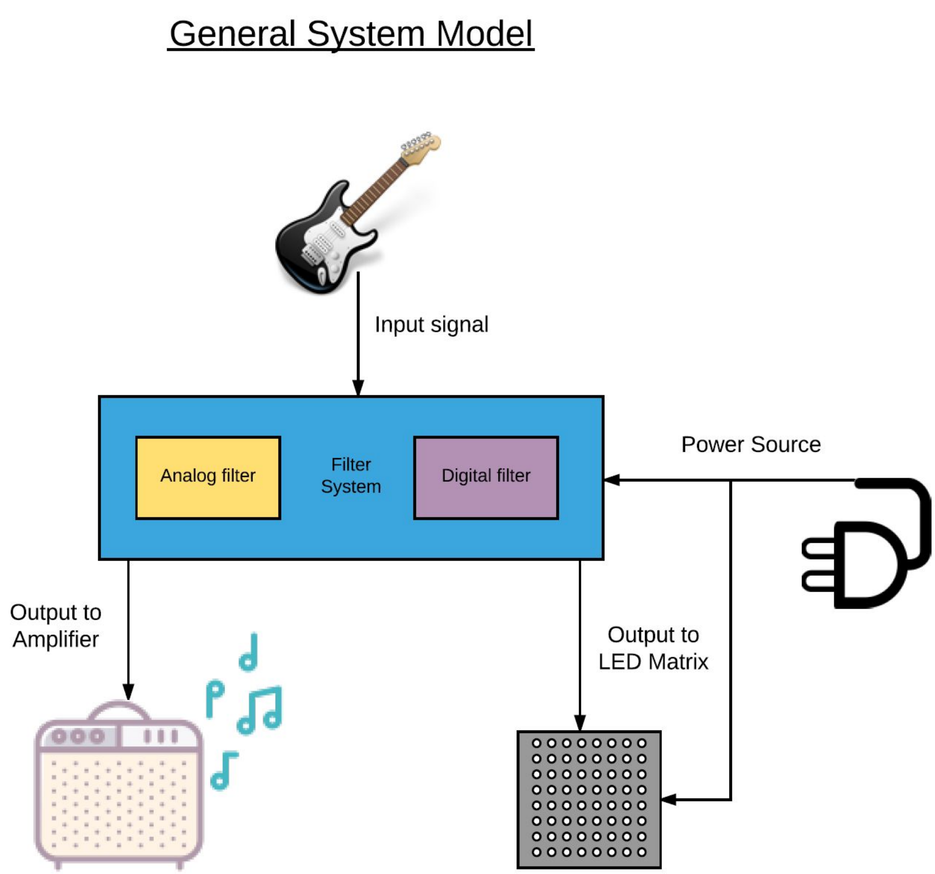


Figure 1

## **Design Description and Specifications**

Digital Effects

There are a few digital effects that our team is going to emulate for this project. The three effects include flanger, reverb, and delay. Since each of these effects are heavily dependent on time, we felt that it would be a good idea to implement these digitally rather than with analog. This would allow for easier manipulation by the user, since they are most likely going to modify these effects more frequently for the purpose of creating a unique sound.

We also would like to create an interface that will be used to communicate with the microcontroller and allow the user to change the settings of the digital effects, as well as turn them off if desired. Having the ability to do this will allow for better user control of each of the digital effects. On a normal effects pedal, the values for each parameter are set by turning a knob until the desired settings are made without knowing the exact values. With the ability to change settings, the user will be able to choose more exact settings for each effect. An example of this would be where the user will be able to choose the exact time between each echo of a note with the delay effect. Having this detailed control of each effect will allow for the user to get the exact sound they are trying to create for their music using the multiple controls shown in Figure 2.

Digital Effects Flowchart

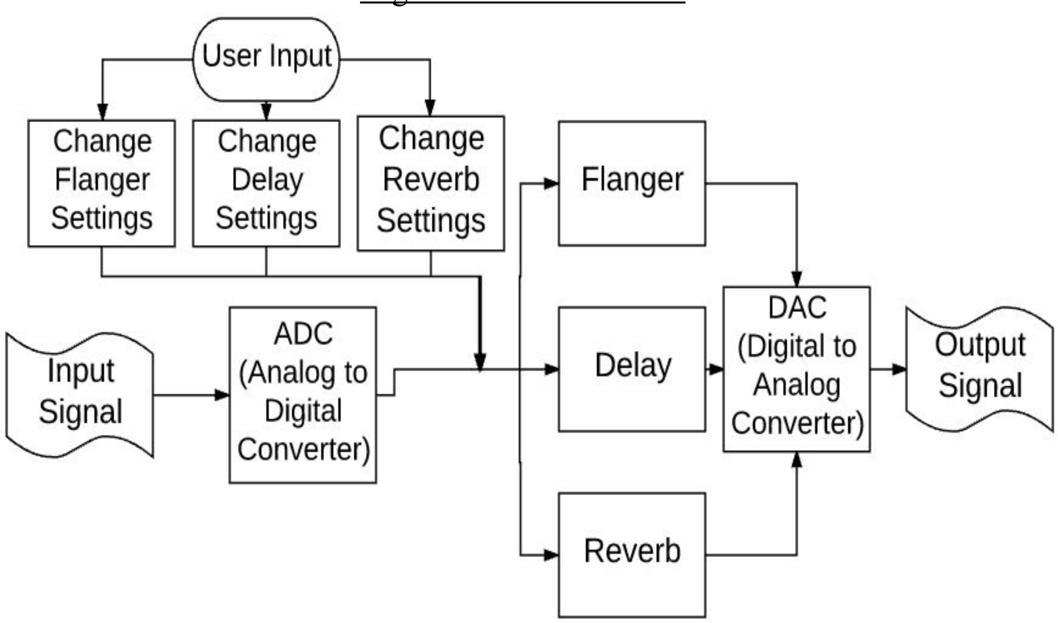


Figure 2

Kevin Leone will be responsible for the implementation of Figure 2. All blocks are currently being researched.

Analog Effects

For the analog portion of our project we are definitely planning to design an overdrive circuit followed by a distortion circuit. For the overdrive circuit, as shown in Figure 4, we are basing our design around placing two back to back diode in the feedback loop of an amplifier circuit. This configuration will clip the input signal slightly as illustrated in Figure 5. The distortion circuit, as shown in Figure 6, will be based around an amplifier as well but instead of the two back to back diodes placed in the feedback loop, the two diodes will be placed from the output of the to ground. By grounding the back to back diodes the signal will be heavily clipped as illustrated in Figure 7.

We are also considering the implementation of an EQ filter network and a compression circuit as well. The EQ filter network will consist of an array of filters consisting of lowpass, highpass, bandpass, and band reject filters in order to change the frequency components of our signal. Compression allows the user better control over their musical dynamics by being able to smooth out any jumps or drops in amplitude with this effect. By reducing these jumps and drops, it creates the appearance of a very smooth sound. Since these effects are not very time based and more frequency based, there was no need to implement them digitally in order to allow for fast and easy manipulation. The flowchart of this analog system is shown in Figure 3. Also as a musician these analog effects provide the characteristic tone quality for your instruments sound. As such these effects will not be changed frequently by the user.

Analog Effects Flowchart

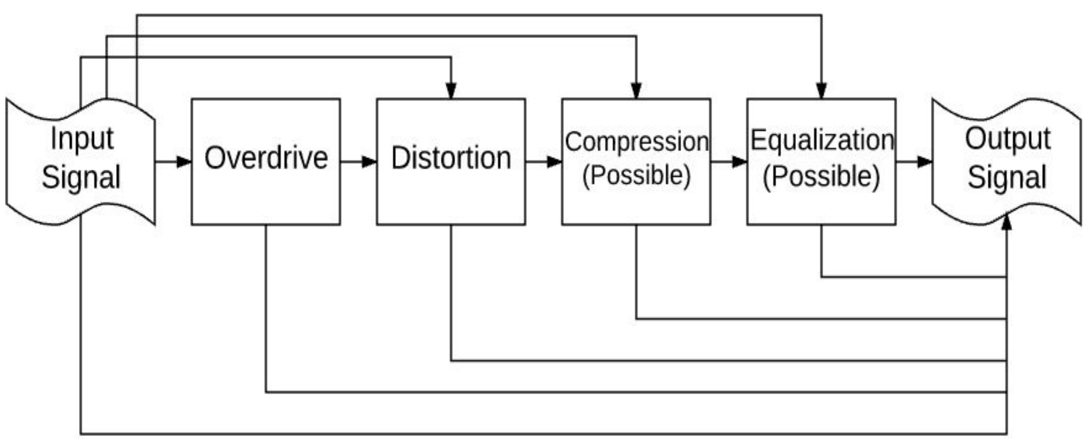


Figure 3

Jose Ramirez will be responsible for the design of Figure 3. All blocks are currently being researched.

Example of Overdrive Circuit

Waveform of Overdrive Circuit

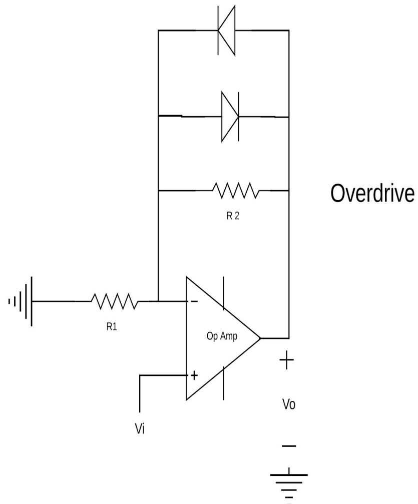


Figure 4

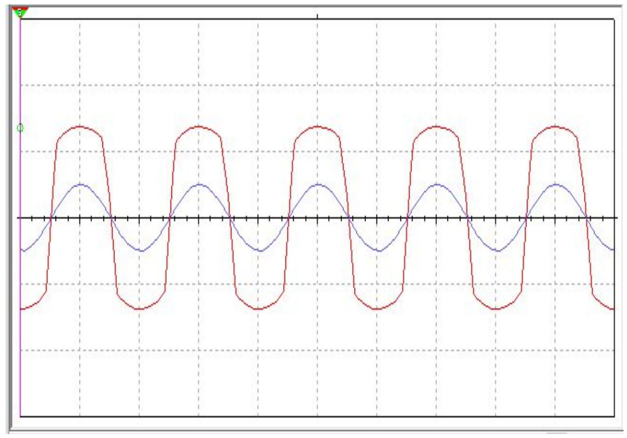

Figure 5

Example of Distortion Circuit

Waveform of Distortion Circuit

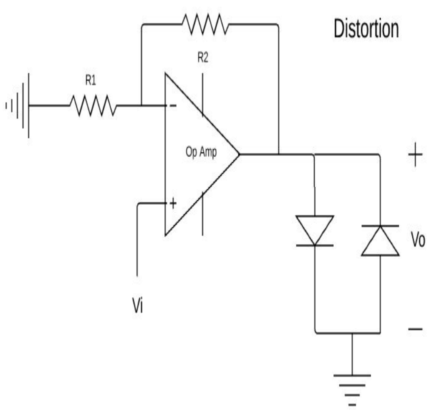


Figure 6

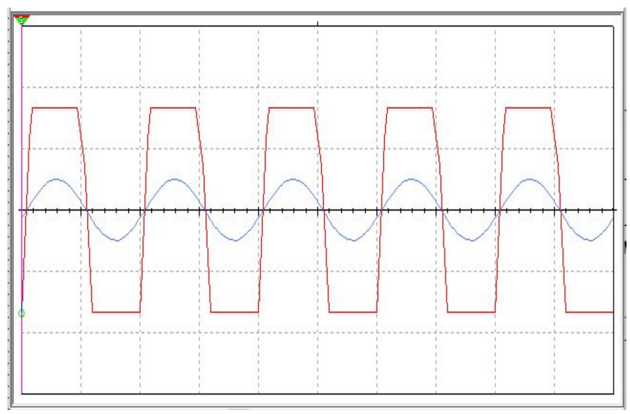

Figure 7

Pcb & light implementation

The pedal will be made up of two PCB designs. One design will deal with the implementation of the digital effects, and the other will deal with implementation of the analog effects. The PCB for the digital effects will use a chip that is programmed to modify the signals accordingly. The PCB for the analog effects will manipulate the signals through filtration to obtain the desired sound.

The PCB's will consist of many inputs and outputs. Power will be supplied through an outlet, and the board will have to step down the voltage as well as rectify it so that it can be used to implement the effects on each board. The pedal will be connected to an amplifier and a guitar. The guitar will send an input to the pedal, one of the PCB's in the pedal will locate the desired effects and manipulate the signal to output the corresponding sound to the Amplifier. A diagram that illustrates the entire system is shown in Figure 8 below.

The LED display will offer a visual representation of the notes being played through the amplifier. This will be achieved by having the output from the pedal feeding into the LED display and the amplifier in parallel.

The LED display will be an array of LEDs arranged in a grid-like pattern that will have multiple output modes that can be toggled on and off by the user. These modes will be as follows but are not limited to.

- Tuning mode- this mode will allow the user to tune their guitar by turning off all effects then changes lights that are in the shape of the note as well as changes between colors through shades of red to green to show how close to the center frequency you are. Example found in Figure 9.
- Single note mode- the lights change based on the note being played to the color designated for each of the frequencies and it shifts right at the speed of the song, the amplitude of the note will also correlate with the brightness of the LED (it adds an almost visual note tracker) This can be done with starting with LED 0 or with column 0 all together.

The LED array will be built with a number of LEDs that has not yet been decided on. Each LED will be run independently of one another (in parallel). Each LED will be controlled by a shift register as well as a storage register, this will allow the user to give commands serially, saving the amount of data wires needed. This also allows the controller to not be under as much demand to update all of the LEDs constantly. These also each have their own pulse width modulation controller built in to allow for independent control of colors and brightness.

Full System Diagram

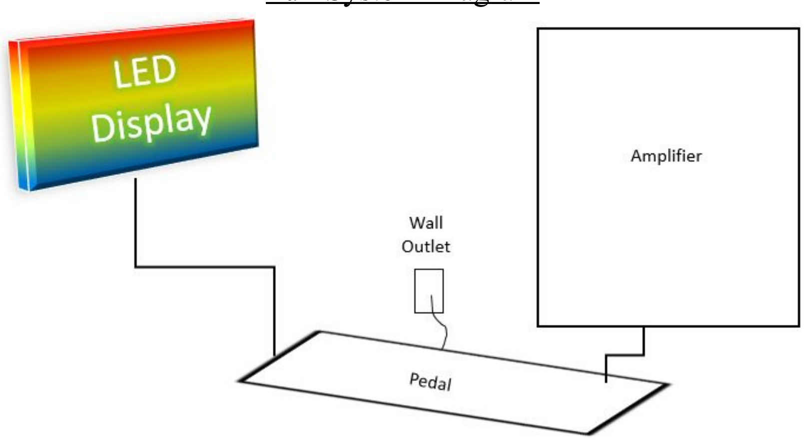


Figure 8

Ayesha Arif will be responsible for the the LED portion of Figure 8 and Figure 9. All blocks are currently being researched. Brian Boga is currently working on the power aspects as well as the LED display with Ayesha. However, when Brian returns from deployment the workload distribution will be subject to change and will be updated accordingly.

LED Matrix Mode Example

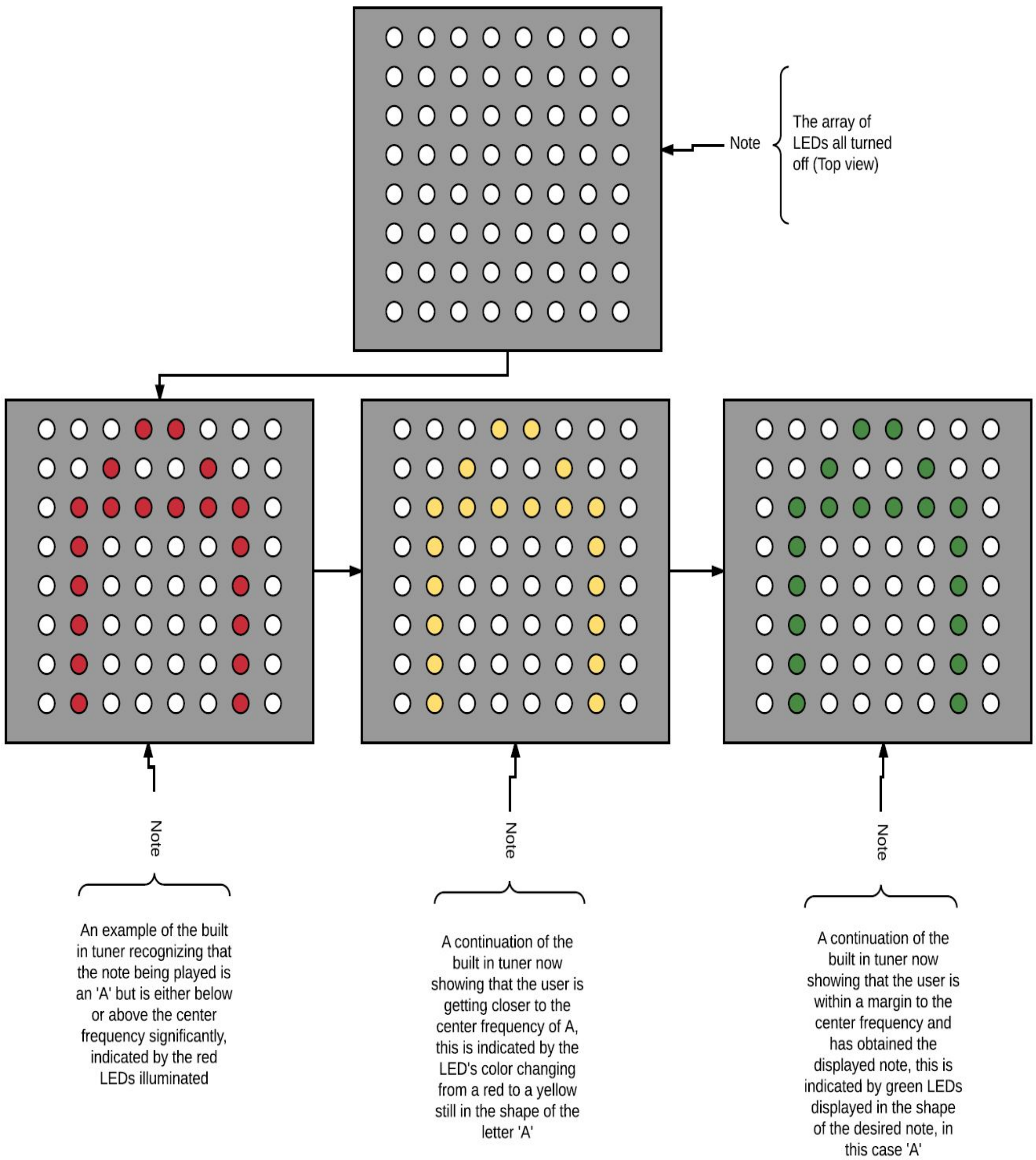


Figure 9

## Specifications

Right now one single effect pedal weighs approximately 1lb and the board to hold multiple pedals weighs approximately 10lbs for an aluminum case and 25-30lbs for a wood case. Our goal is to have a total weight of less than 25lbs. The price is also a main factor. Consumer effects pedals costs about $100 for a single analog effect, this is not including the cost of a board to place multiple analog effects on. A digital multi effects board costs about $500. By integrating both analog and digital effects onto one board we can save the consumer money, thus making this product more appealing. We aim to keep our cost below $500. This product will be versatile in the sense that it has both analog and digital effects in one box. By doing so we can appeal to a broader set of musicians. The House of quality illustrated in Table 1 below shows the marketing vs the engineering trade offs of this product.

- Lightweight Design
- Cost Efficient
- Quality Sound
- Easy to use Interface
- Versatility
    - Analog Effects: Overdrive, Distortion, Equalization Network, Compression
    - Digital Effects: Flanger, Delay, Reverb

**Table1: House of Quality Diagram**

| | | | Engineering | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Cost | Size | Weight | Input Impedence | Output impedence | Power Consumption Audio Effects | Number of Effects |
| | | | - | - | - | + | - | - | + |
| Market | Sound Quality | + | ↓↓ | N/A | N/A | ↑ | ↑ | N/A | N/A |
| | Versatility | + | ↓ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑↑ |
| | Ease of Use | + | N/A | N/A | N/A | N/A | N/A | N/A | ↓ |
| | Portable | + | ↑ | ↑↑ | ↑↑ | N/A | N/A | ↑ | ↓ |
| | Cost | - | ↑↑ | ↑ | ↑ | ↓ | ↓ | N/A | ↓ |
| | | | Less than $300 | Smaller than 15 in^3 | Under 30 lbs | Min 500k | Max 10K | Max 1.5W | 5 minimum |

Table 2 below shows the estimated cost break down of the larger components of this build.

**Table 2: Budget**

| Part Description | Quantity | Estimated Cost | Total Estimated Price |
|---|---|---|---|
| Micro Processing Board | 1-2 | $10 | $10-20 |
| PCB Boards | 2 | $50 | $100 |
| Amplifiers | 8 | $1 | $8 |
| LED Board | 1 | $30 | $30 |
| Pedal Housing | 1 | $30 | $30 |
| FPGA | 1 | $30 | $30 |
| Other | Unknown | $50 | $50 |
| | **Total Cost** | | $258-268 |

In order to ensure that we meet the hard deadlines place for us by the class, we have devised our senior design one milestones in such a way that we give ourselves room to make corrections to documentation and design. The milestone deadlines can be seen in Table 3 below.

As for the senior design two milestones, we have not come up with set dates for our milestones in the spring semester as those dates will depend on the level of execution of our tasks this fall during senior design one. The tasks for senior design two can be seen below in Table 4.

**Table 3: Fall Schedule**

| Fall 2016 | | | |
|---|---|---|---|
| **Task** | **Status** | **Responsible** | **Date** |
| **Ideas** | Complete | Group 12 | August 26 |
| **Project Selection** | Complete | Group 12 | August 30 |
| **Project Document** | | | |
| Initial Document- Divide and Conquer | In Progress | Group 12 | September 9 |
| Table of Contents | In Progress | Group 12 | October 15 |
| First Draft | In Progress | Group 12 | October 20 |
| Final Document | In Progress | Group 12 | November 5 |
| **Research and Design** | | | |
| Research past Projects | In Progress | Individual | TBD |
| Individual research and writing | In Progress | Individual | TBD |
| Prototype design | In Progress | Individual | TBD |

**Table 4: Spring Schedule**

| Spring 2017 | | | |
|---|---|---|---|
| Test Components | | Group 12 | TBD |
| Build and Test Prototype | | Group 12 | TBD |
| Final Assembly | | Group 12 | TBD |
| Peer Presentation | | Group 12 | TBD |
| Final Documentation | | Group 12 | TBD |
| Final Presentation | | Group 12 | TBD |