PROJECT MINI-RAVE

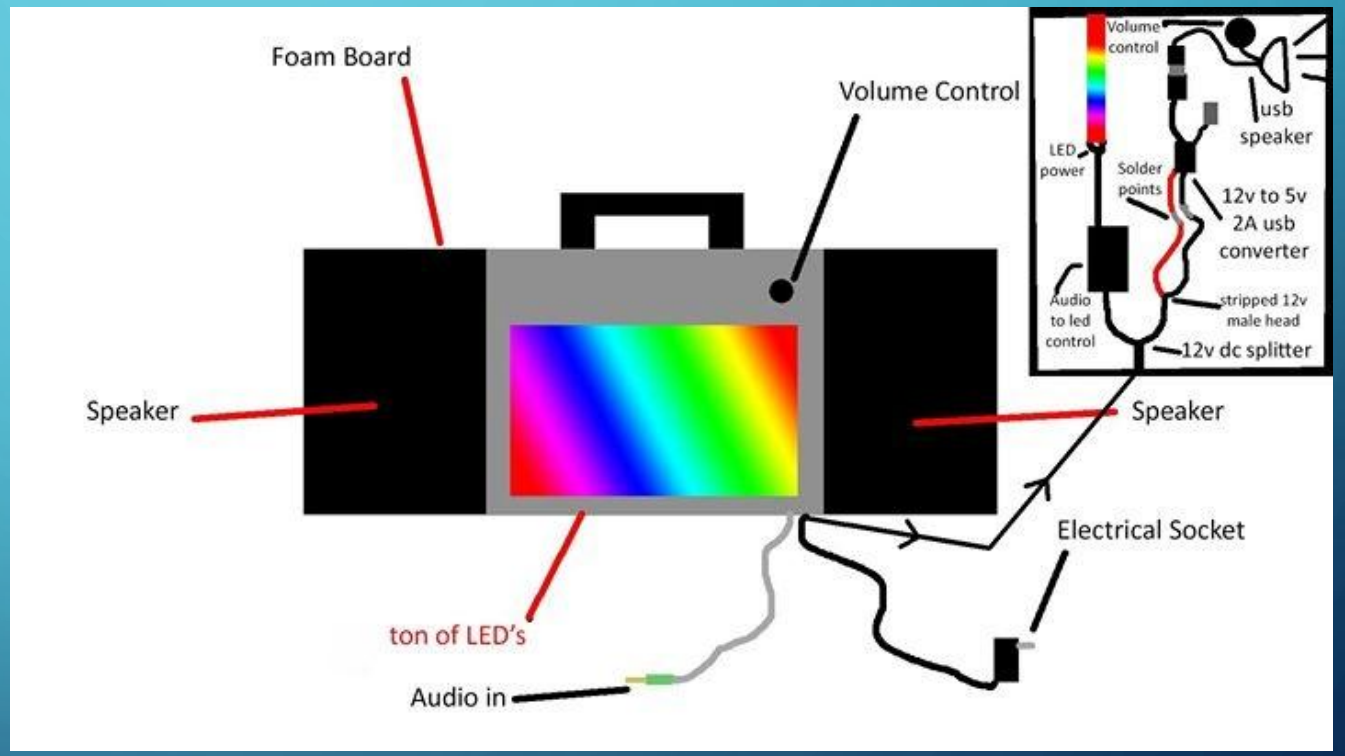
LIVE-FEED AUDIO-VISUAL CONVERTER

MK1 ORIGINS (1/15)

- Wanted to give someone a unique birthday gift
- She really likes music
- I had a dream of making a speaker with lights that respond to music
- Research and preliminary design began the following morning
- At this point my deepest understanding of electricity was $V = IR$

MK1 DESIGN (1/15)

- Started researching ways to make my dream a reality
- Found a controller on Amazon that uses a microphone to control a single color RGB LED Strip
- Built the rest of project around the controller
  - Simple in design, just had to make sure everything was wired correctly
  - Voltage regulator required to power subsystems



MK1 RESULTS

- Achievements:
  - Portable Speaker System powered by battery or AC power supply
  - Sound Reactive Lights (see video demo)
  - Lightweight Durable Chassis
  - 5V USB hub for charging portable devices
  - She loved it
- Skills Learned:
  - Basic Knowledge of Circuits
    - Voltages & Current requirements/limits
    - Stripping, Soldering, and Electrical Insulation
  - Structural Design
    - Material Selection for sound amplification
    - Force Distribution to maintain rigidity


THE mini RAVE

MK2 ORIGINS (3/16)

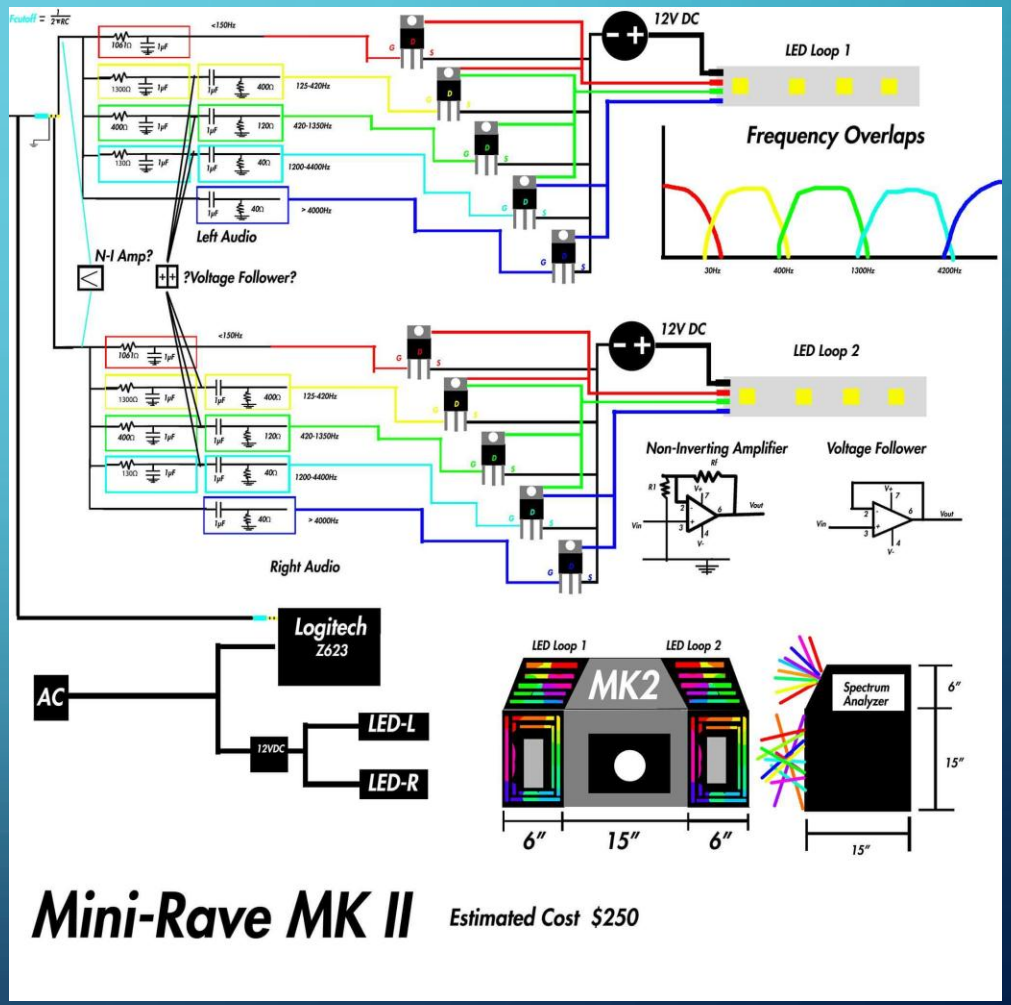
- About year after the completion of the Mini Rave, I decided to revisit and reinvent the idea
- I found the original LED controller to be very basic and unimpressive technology; however I could not find anything similar on the market
- I decided to build my own controller from the ground up

MK2 DESIGN (3/16)

- 5-band frequency filters controlled MOSFET's controlled connected to LED strip grounds
- Each ground (RGB) serves as a gate changing intensity of a single color depending on the frequency band connected to it

- Problems:
  - At lower frequencies, negative cycle of AC signal caused noticeable flickering
  - Modern music has very filled frequency spectrum, maxing out each gate produced entire sections of pure white light

- Final Verdict:
  - Works as planned but unforeseen issues create a messy lightshow
  - Design 1 scrapped

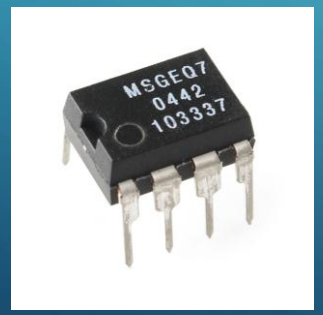


MK2 DESIGN 2 (NEW HARDWARE) (6/16)

MSGEQ7 IC

- Takes AC signal and outputs amplitude readings across 7 frequency bands
- Outputs a single digital data signal
- Shrinks circuit size (integrated circuit)
- Saves time for replication and increases consistency

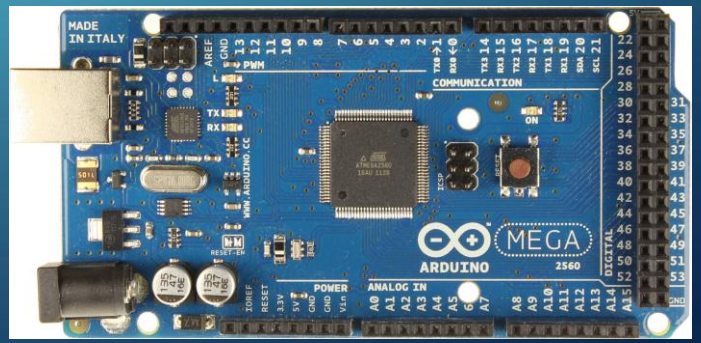
- New Challenge:
  - Communication between IC and Arduino
  - Building a circuit to appropriately use the chip



ARDUINO MICRO-CONTROLLER

- Programable controller with digital I/O connections and PWM outputs
- PWM outputs connected to LED grounds removed long flicker issues
- Allowed data to be processed before being sent to lights

- New Challenge:
  - Learning how to code, bought the controller with no clue how to use it

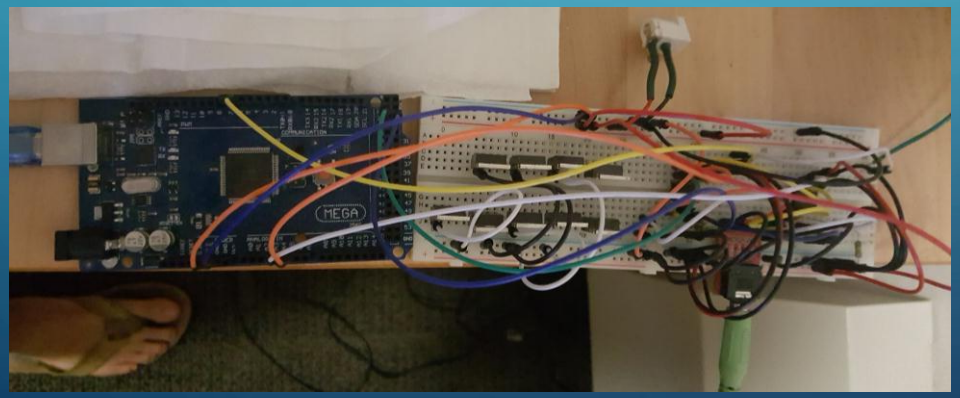


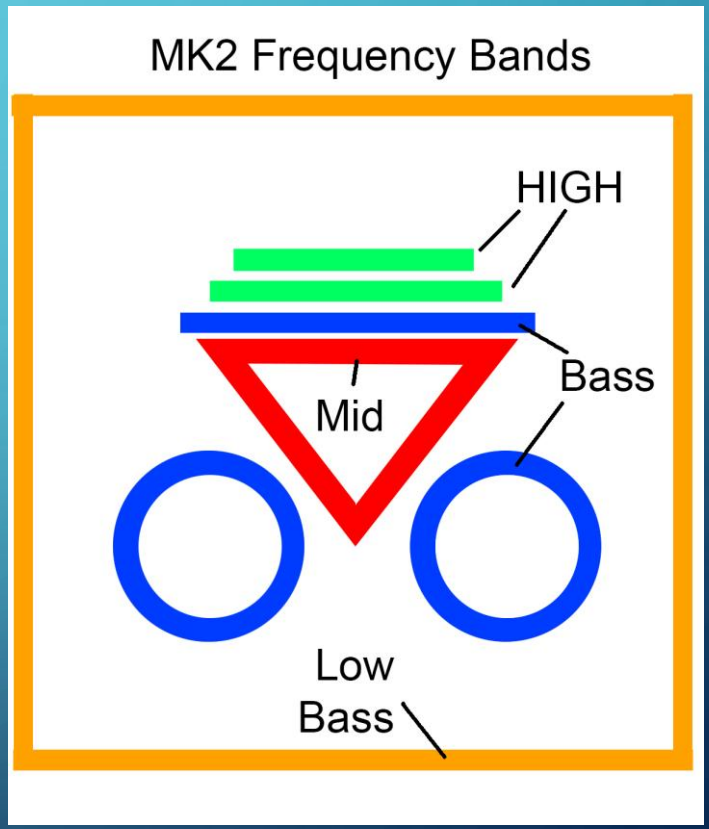
MK2 FINAL DESIGN AND OPERATION (7/16)

- Two MSGEQ7's read audio signal (left and right)

- Arduino Processes volume levels and converts them to digital signals
  - 12 output signals total
  - More outputs turn on as overall "loudness" increases
    - Lower intensity light show at lower volumes

- 12 MOSFET's control LED strips
  - 3 MOSFET's per strip (RGB)
  - 4 LED strip types associated with different frequency ranges





MK2 RESULTS

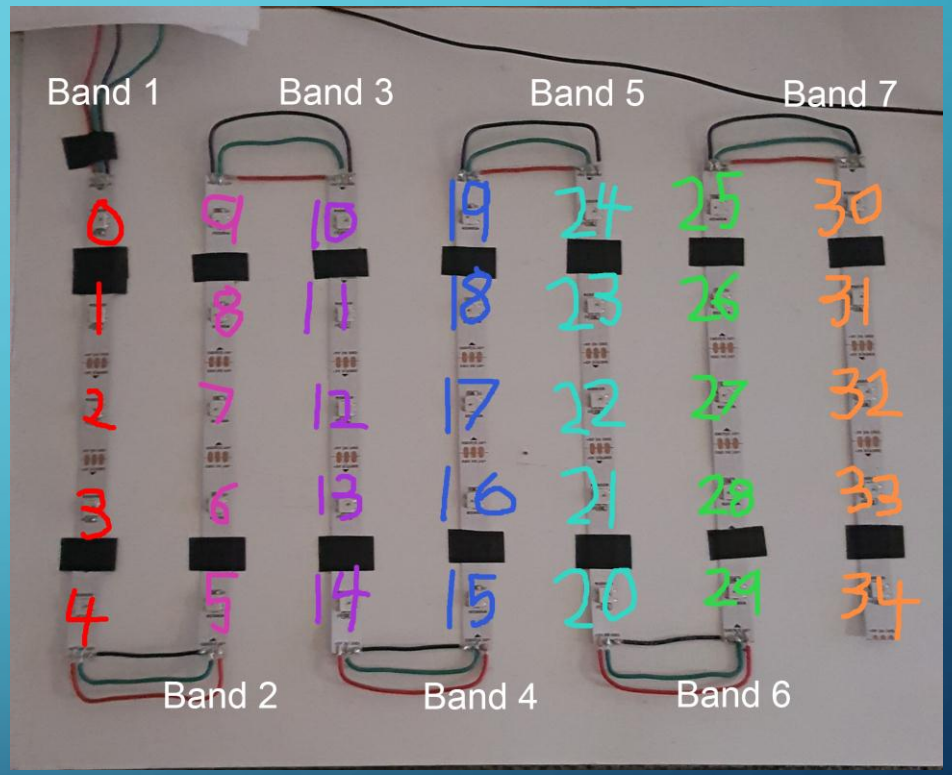
- Improvements and Achievements:
  - Significant improvement in audio detection (single band to 7 band)
  - Integration of microcontroller opens many new pathways (data processing)
  - Multiple colors present at a time rather than monochromatic shifting (looks a lot better)
  - Successful integration of MSGEQ7 (Took a week to make this happen)
- Skills Learned:
  - Basic Hardware Communication
  - Intermediate Circuit Design and Testing
  - Creating Basic Computer Algorithms for data processing

MK3 ORIGINS (7/16)

- About two weeks after the success of the Mini-Rave MK2, I saw an advertisement on Facebook for an LED strip individually addressable diodes
- After a little research on this new strip
  - 3 Contacts vs. 4
    - 12V, Red Ground, Green Ground, Blue Ground → 5V, Data, Ground
  - Color Controlled by Data signal
    - Vastly increased color variety due to precision control of RGB ratios
  - Individually Addressable
    - Shapes and images can be created with on/off control rather than physical geometry

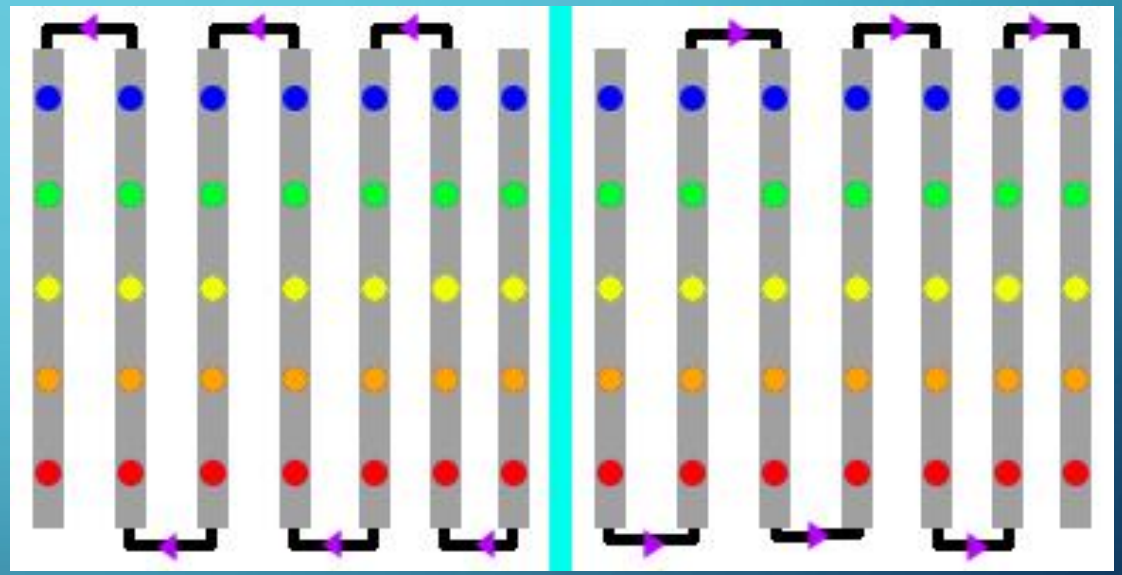
MK3 DESIGN (7/16)

- The MK3 uses a strip of 35 LED's cut and arranged in discretized domain with even spacing
- Each column represent 1 of 7 frequency bands
- The LED's have corresponding numbers which allows them to be individually controlled using the Arduino
- With these features, the MK3 can fully adhere to a complex Sense Plan Act algorithm



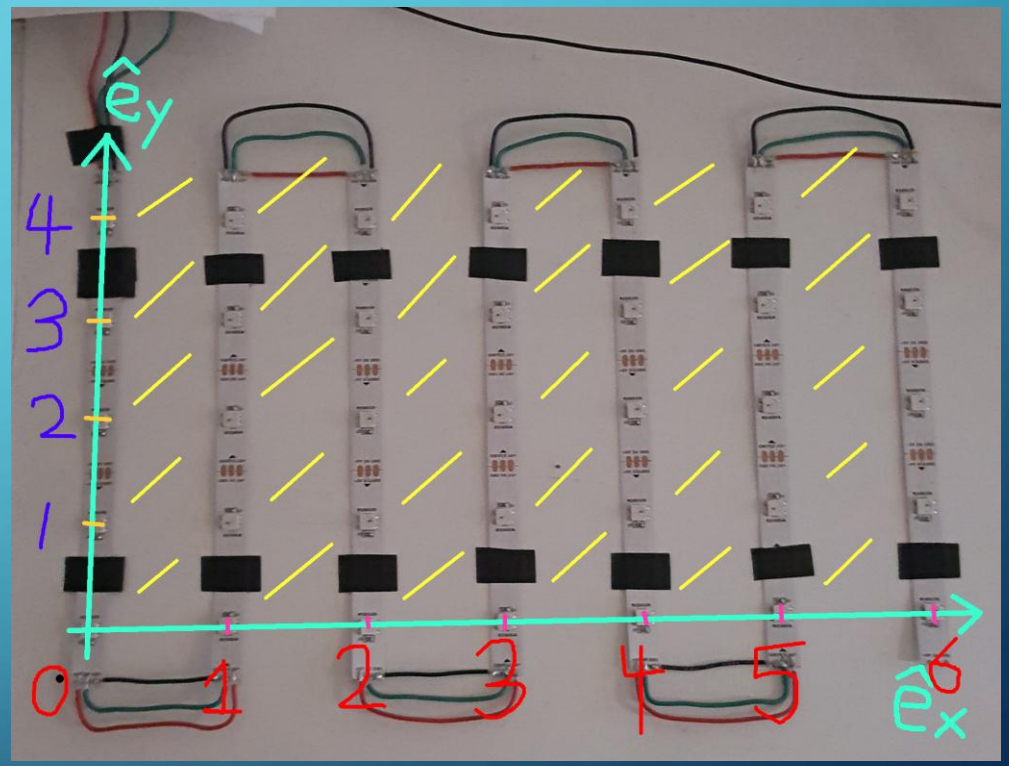
MK3 DESIGN (CONTINUED)

- A mirrored clone of the main display board was built in order to make the display full and symmetrical
- The benefit of creating a physical mirror is that I can double the number of LED's displayed without having to compute any additional information
  - This allows the MK3 to process each frame more quickly from the data it receives



MK3 DESIGN | VISUALS (8/16)

- To further improve the visual effects of the MK3 I had to be able to create relations between LED's that make geometric sense
  - To accomplish this, a cartesian grid was implemented
    - An algorithm converting 2 point discretization to 1 point had to be implemented to make this possible
      - (x,y) → x
    - With this scheme, each band has 5 volume levels and will turn on each LED as each level is met or surpassed



MK3 DESIGN | COLORS AND ANIMATIONS

- The color schemes displayed by the MK3 consist of 15 schemes that are controlled by overall volume and a random number generator
- At higher volumes (typically choruses) the MK3 will switch between coded animations and its primary spectrum analyzer function
    - Animations are created frame by frame as functions
        - All shapes can be hard coded (individually selecting which diodes to switch on)
        - The MK3 can also plot superposed functions such as two diagonal lines and shift them using an x-axis displacement after each frame

MK3 CURRENT VERSION

- At this point, the hardware side of the MK3 is solid
- The primary area of focus is the code which is constantly improved as I improve my coding skills
    - The code is currently about 1000+ lines
    - I have plans to continually improve the project as I learn more (Enrolled in Control Systems this quarter)
- Skills Learned:
    - Data Acquisition and creating Useful Information
        - Using a serial monitor and numerical analysis I can look at trends in audio information create algorithms to detect drum beats and choruses
    - Numerical Schemes
        - Finding relationships between discretized points and relating them with mathematical algorithms, allow me to maximize the efficiency of the code and minimize processing time