Problem

• Current LED decorations are not very customizable
• Linearity of LED strips hinders ability to display texts and images

Solution

• Design and implement modular LED panels
• Can be configured in any configuration
• Connect to smartphone over Bluetooth
• Display text and dynamic displays
Initial High Level Requirements

- The four panels must be able to display text, images, and dynamic effects that can adapt to current configuration.
- "Core panel" must automatically recognize any change to the configuration of expansion tiles, updating the display output to each tile to fit within the new boundaries.
- Panels must be able to be controlled through Bluetooth by a smartphone or other external device (must connect to Bluetooth device within 5-7 seconds).
Block Diagram

Core Panel
- Power
  - 120V AC from wall
  - SV AC to DC
  - Voltage Regulator (5V to 3.3V)
- Control
  - ESP32
- Bluetooth device (Smartphone)

LED Array (8x8)
- ws2812b LED
- ws2812b LED
- ws2812b LED

Expansion Panel
- Power
  - 3.3V Power
  - Serial Data
  - i2c
  - Ground
- Control
  - ESP32
- Expansion port (4 ports, 1 on each side of panel)
- LED Array (8x8)
  - ws2812b LED
  - ws2812b LED
  - ws2812b LED
  - ws2812b LED
PCB Design

- Expansion Panel is almost identical to Core Panel but without the power components
Why the ESP32?
- Integrated Bluetooth connectivity
- Adequate memory
- In stock and easy to solder

Challenges
- Flashing code was initially difficult
- Redesigned second PCB for correct pin connections

Initial Design vs Final Design
- Got rid of ATmega1609 from design
  - ATmega1609 runs off of 5V so eliminated need for level shifter to utilize I2C protocol
  - PCB design simpler
  - ESP32 already had enough storage
Connectors

• Utilized JST-PH 2.0 Connectors
• 4 on each side for I2C lines (SDA & SCL), power, and ground

Challenges

• We initially had to crimp the wires ourselves
  • Led to poor connections and wires disconnecting
• Bought machine crimped wires resulting in better connections
Components

- Utilized barrel jack and 3.3V Voltage regulator (LM117-3.3)
- Allows user to simply plug into wall outlet
- Power components are only on core panel
  - Power supplied to expansion panels through expansion ports

Testing Observations

- LED data sheet claims 256 LEDs will draw ~11.5 W
- After testing, however, we observed the power draw to be significantly less
  - Allowed us to power LEDs with 3.3V (an advantage since ESP32 also runs on 3.3V)
How to Use

1) Connect phone to ESP32 through Bluetooth
2) Enter configuration mode and enter in configuration on phone
3) Type in “text” or “ball” mode
4) Text/ball is displayed on panels
Project Video

Video of “Ball” Mode

Video of “Text” Mode
Requirements and Verification

Core Panel

- Must be able to process the algorithm to determine overall tile layout within 1 second

Expansion Panel

- Must receive data from core tile and parse contents
- Must be able to process and display packet data addressed to it onto the led array
- Display text and dynamic displays

Simple visual verification test on 2 boards with “hi” typed in on smartphone, and then displayed correctly on panels
Bluetooth Connectivity Times

- Time to connect to Bluetooth much less than 5-7 second requirement (Average of 1.36 sec)
- Quick enough for easy use of panels

<table>
<thead>
<tr>
<th>Trial</th>
<th>Time to Establish Bluetooth Connection (sec)</th>
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<tbody>
<tr>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>2</td>
<td>1.3</td>
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<tr>
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<td>1.5</td>
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<td>1.2</td>
</tr>
<tr>
<td>5</td>
<td>1.7</td>
</tr>
<tr>
<td>Average</td>
<td>1.36</td>
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What We Learned

• PCB design, process of choosing and ordering parts, soldering
• Importance of communication and planning

Future Steps

• Implement more effects
• Allow for varying shapes and sizes of panels
• Find a way to make the boards hot swappable
• Design a better API/App

Example of proposed future dynamic display
Thank You

Questions?