LED Light Sign - ECE 455

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Overview

Background

Existing Solutions

Methodology

Results

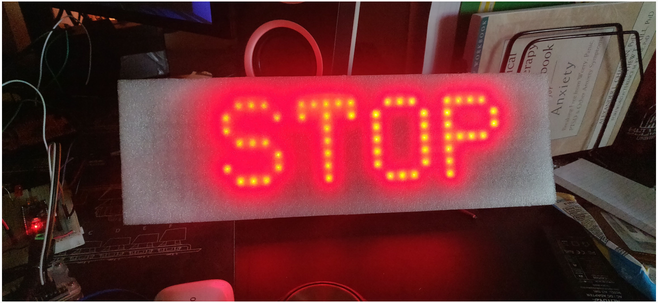
Conclusion

Background

Roommates and Work-from-Home

- COVID-19 has normalized work from home.
- I start a remote job in January.
- My roommates love to knock on my door while I'm working.
- I am far too susceptible to a long conversation with them.

Solution



Use an LED Light Sign to display my availability to the outside.

Materials

- Raspberry Pi Zero W
- TM4C123 Launchpad[1]
- LED Matrix
- Powering solution.

[1] Arduino Nano used in working implementation

Existing Solutions

The state of the market

- Use a non-IoT solution: e.g. white board, magnet.
  - Can't be automated.
  - Boring.
- Numerous options on Amazon.
  - Expensive: $150-ish.
  - Not likely to be live programmable.
  - The reviews tell bad interfaces.

Why is this worth it?

- Cheaper: $35
- The interface is controllable.
- Could be integrated into other smart home solutions.
- Proven to be cooler if self-made.

Methodology

Diagram

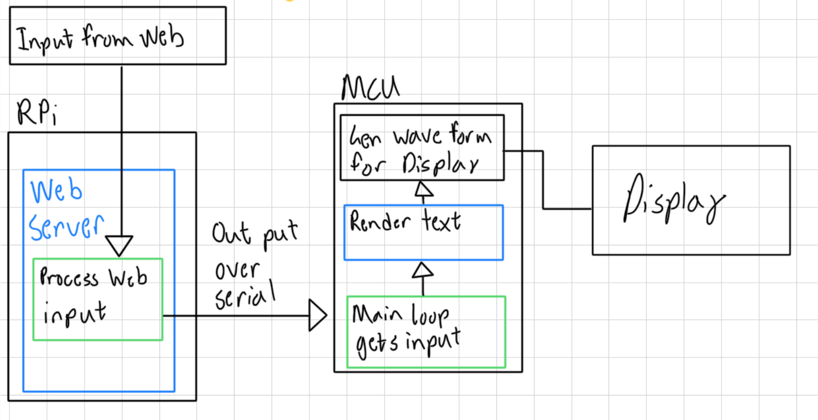


Figure 1: Simple Block Diagram for the System

Web Server

Custom web server on Raspberry Pi Zero W

- Written in Rust.
- Uses a custom thread pool.
- Custom Solution used so the input from the web could be easily piped over an interface.

Light Sign - Overview

- Data Stream Description
- Rendering Method

Light Sign Data Stream - Bits/Packet

- Period is set to the time for one bit.
- Interrupt on each period.
- The duty cycle of the PWM will determine a 1 or 0.
- The line is held low for reset.

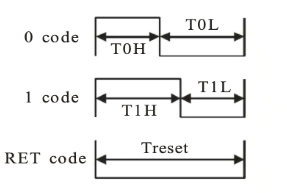
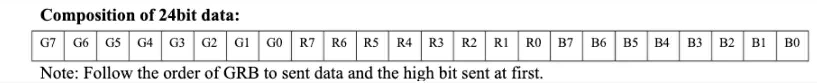


Figure 2: Timing Description



Composition of 24bit data:

G7	G6	G5	G4	G3	G2	G1	G0	R7	R6	R5	R4	R3	R2	R1	R0	B7	B6	B5	B4	B3	B2	B1	B0

Note: Follow the order of GRB to sent data and the high bit sent at first.

Figure 3: Packet Description

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[2] WorldSemi. "WS2812B Intelligent control LED integrated light source". In: (2021).

Light Sign Data Stream- Multi-Packet

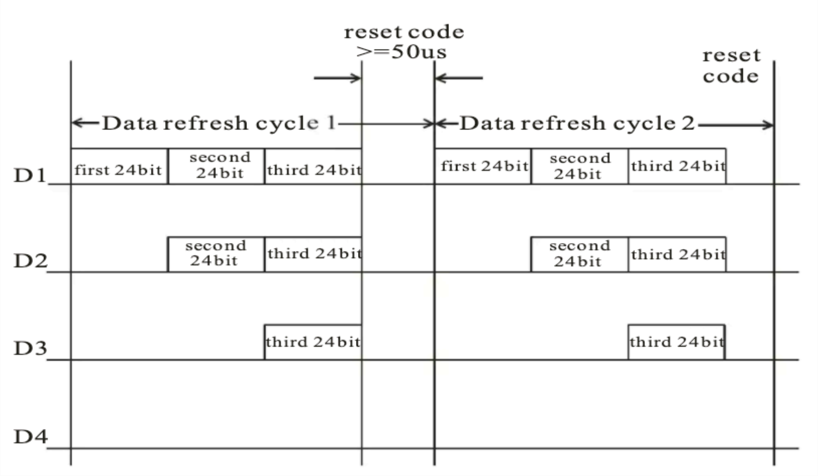

Figure 4: Timing for multiple Packets

[3] WorldSemi, "WS2812B Intelligent control LED integrated light source".

Light Sign Rendering

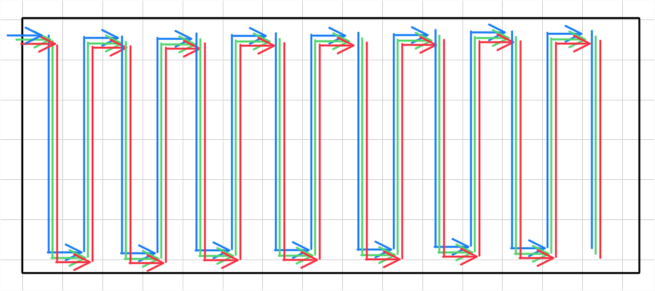

Figure 5: LED Arrangement

- Pre-render strings into a serial data stream.
- Translate string into indexes into a font header.
- Render the strings to the dimensions of the sign.
- Flip columns accordingly to appear correct on the screen.

Results

Overview

- **Proof of Concept** - Works!
  RPi 0w + Arduino
- **Tiva MCU + Rust** - Doesn't work
  RPi 0w + TM4C123 using Rust
- **Tiva MCU + Keil** - Doesn't work less
  RPi 0w + TM4C123 using C

Proof of Concept

Show video of it working.

Complain about Beamer and MacOs.

Failure

- Successfully built and flashed the binary.
- Via the HAL: used basic peripherals.
- Cortex-M standard interrupts worked.
- **No other interrupts would work.**

Show video.

Tiva MCU + Keil

- Could render strings and display the sign.
  Pre-rendering kept the ISR footprints small.
- Some other interrupts could be used in conjunction.
- **The use of UART would ruin the LED sign output.**

Show video.

Conclusion

Plans for improvement

- The use of a DMA for the UART could changed the amount it interrupts other ISRs.
- A controlled load sequence could also fix this issue.
- **Ultimately, a controller for the light sign would have been the most efficient.**

Plans for Deployment

- PWM dimming for the LED sign.
- Solder it into perf-board and make an enclosure.
- Add a power switch.
- Make the system battery power.
- Or clean up cabling.

Thank You

Questions?

References

References

WorldSemi. “WS2812B Intelligent control LED integrated light source”. In: (2021).