

The background features a dark blue gradient with a starry sky pattern. On the left side, there are several technical diagrams, including circular gauges with numerical scales (40, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260) and various circular arrows indicating motion or flow. At the bottom of the image, a silhouette of a mountain range is visible against a lighter blue sky.

# SMART MIRROR PROJECT

GROUP 31

TYLER NEWMAN – COMPUTER ENGINEER

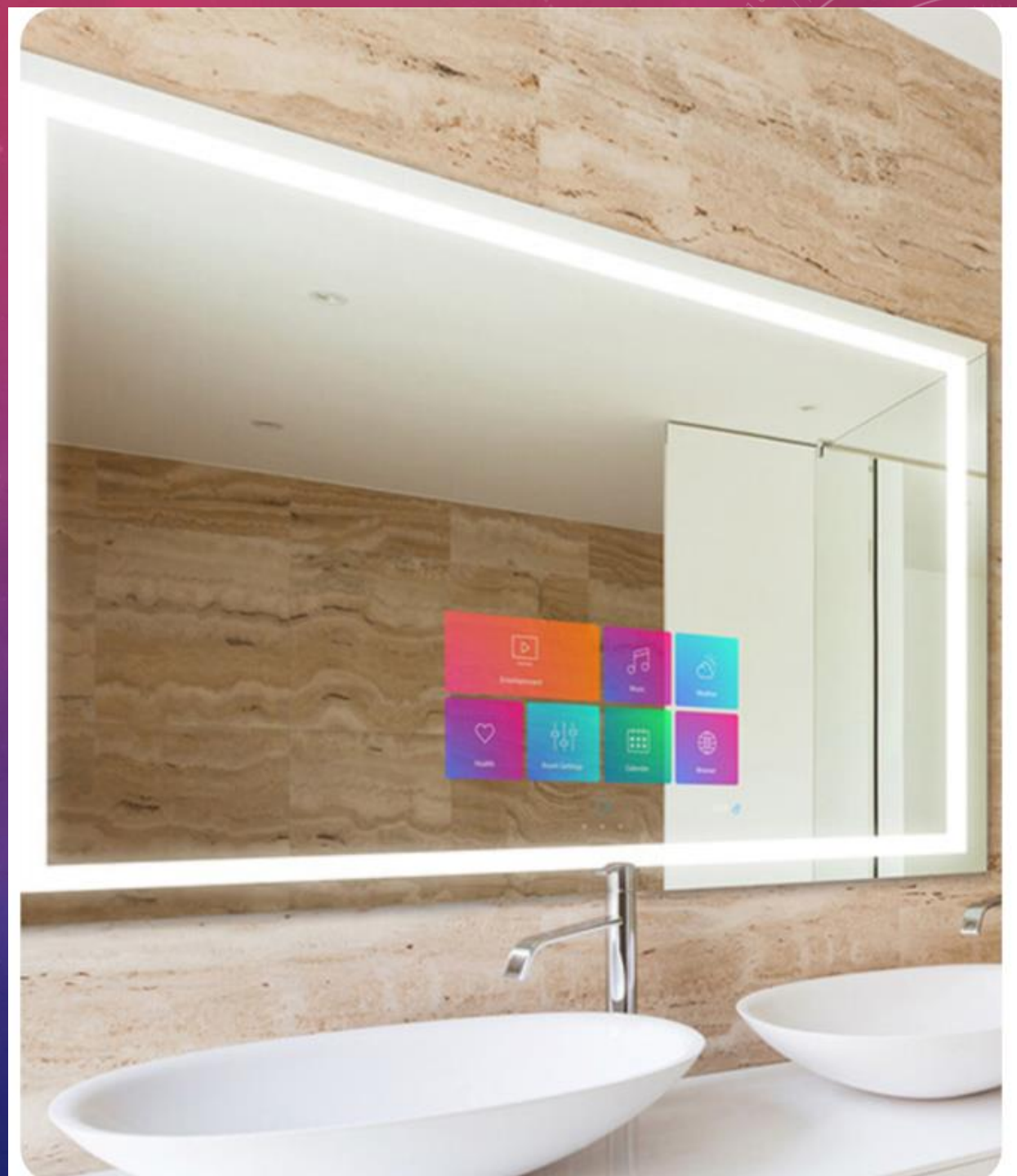
AXEL ARISTUD ORTEGA – COMPUTER ENGINEER

JONATHAN MARTIN – ELECTRICAL ENGINEER

JACOB WILLIAMS-MOORE – COMPUTER ENGINEER

# MOTIVATIONS

- Create a device that conveniently conveys information to the user during their daily routine
- Smart home technology is a rapidly growing industry
  - Amazon Echo
  - Samsung Smart Fridge
  - Ring
- Develop a unique smart home device not yet widely available on the market





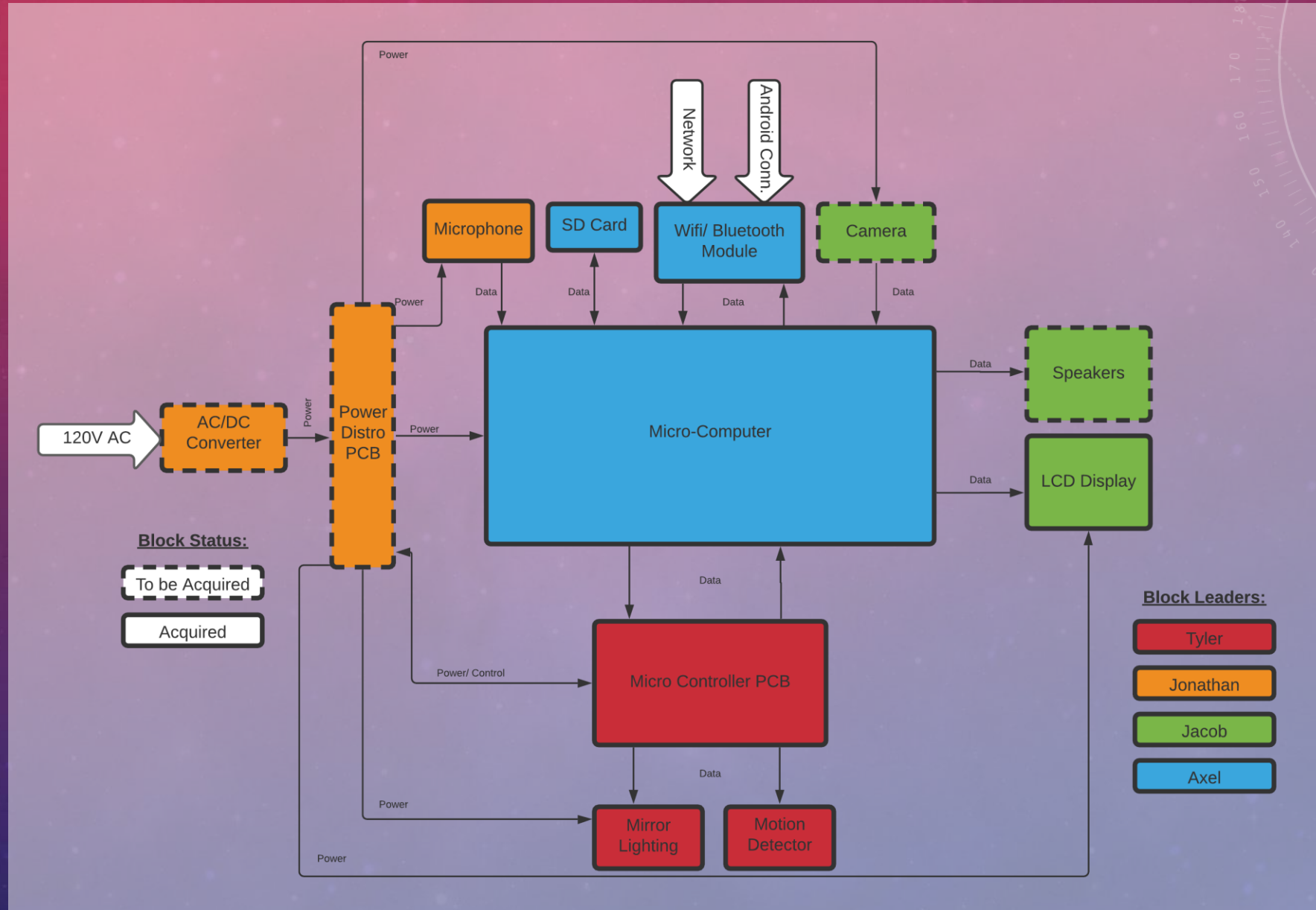
# GOALS AND OBJECTIVES

- Improve on a person's morning routine and make preparation for the day a bit easier
- Deliver useful information to the user that they personally feel is important
- Assist in bringing more smart devices to users' homes to further improve daily life
- Create a device with a simple user interface with ease of use features
  - Presence Aware
  - Speech Recognition
  - Facial Recognition

# PROJECT SPECIFICATIONS

Requirement	Design Specification
Display Size	12x24 Inches
Total Weight	Less than 25 Pounds
Power Input	120VAC 60Hz
<b>User Voice Input</b>	<b>Voice Recognition within 2 feet</b>
<b>User Proximity Detection</b>	<b>Proximity Sensing within 5 feet</b>
<b>User Facial Recognition</b>	<b>Facial Recognition within 2 Feet</b>
Camera Resolution	At least 720p
Functionality	Mirror will have at least 5 different functions (Time/Date/Weather/News/Social Media/YouTube/IoT Control)

# PROJECT BLOCK DIAGRAM



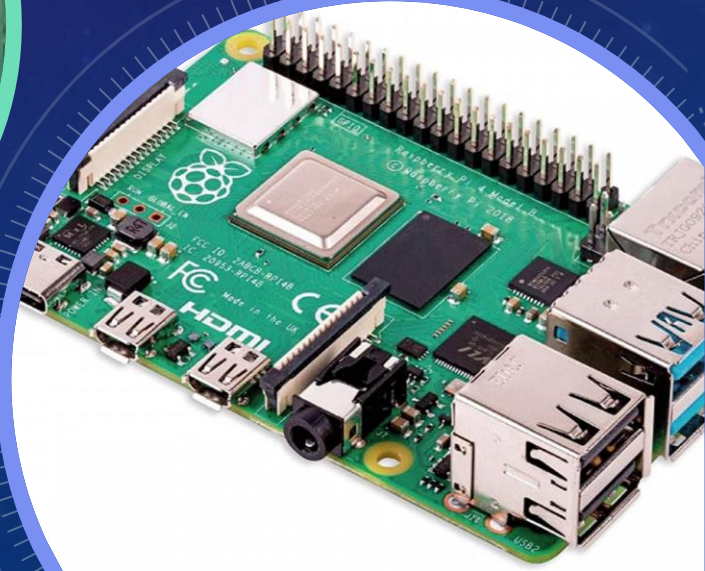
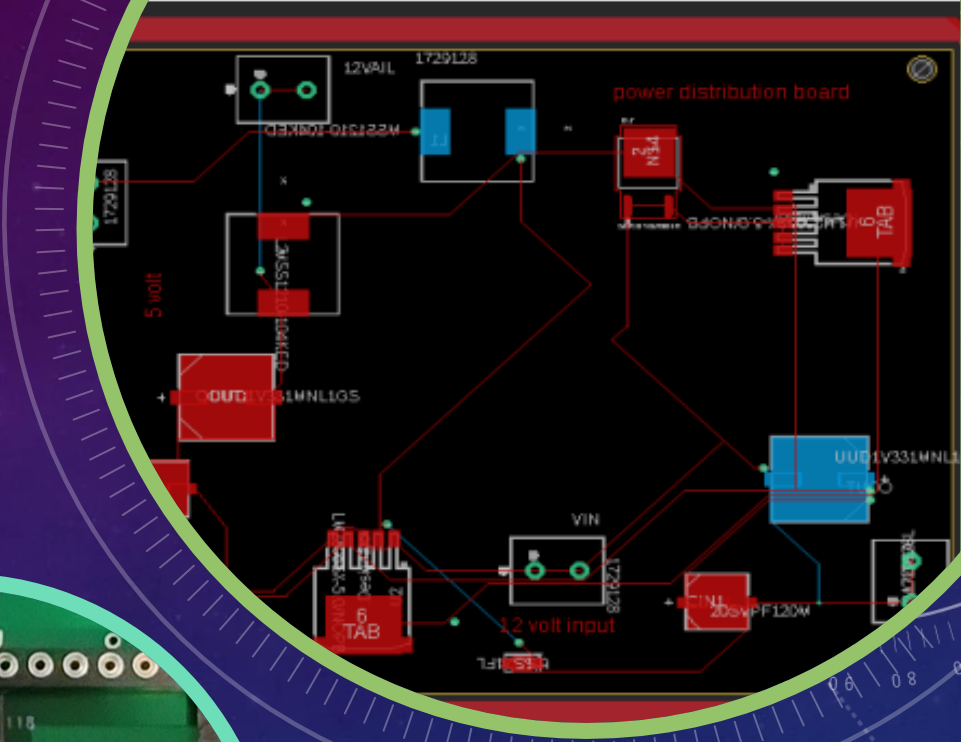
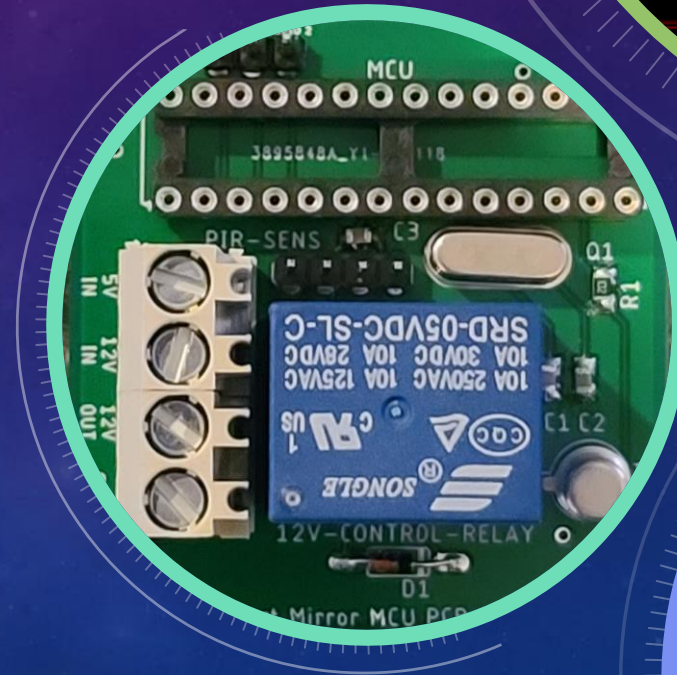


# HARDWARE INTEGRATION



# HARDWARE SEPARATION

- 3 separate boards will be used/ designed
  - **Micro-Computer**
  - **Micro-Controller**
  - **Power Distribution Board**
- Distributes load across multiple components
- Allows flexible mounting in final mirror frame
- Allows group members to work remotely from one another till final assembly



# HARDWARE SEPARATION

## Micro-Computer

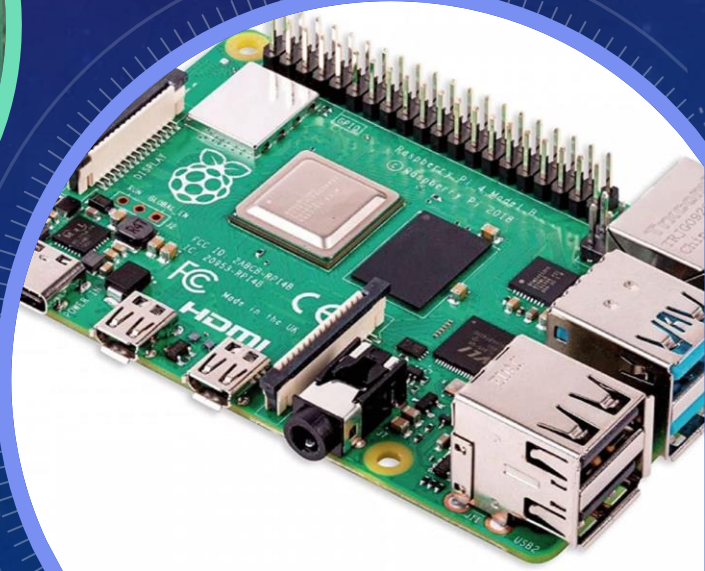
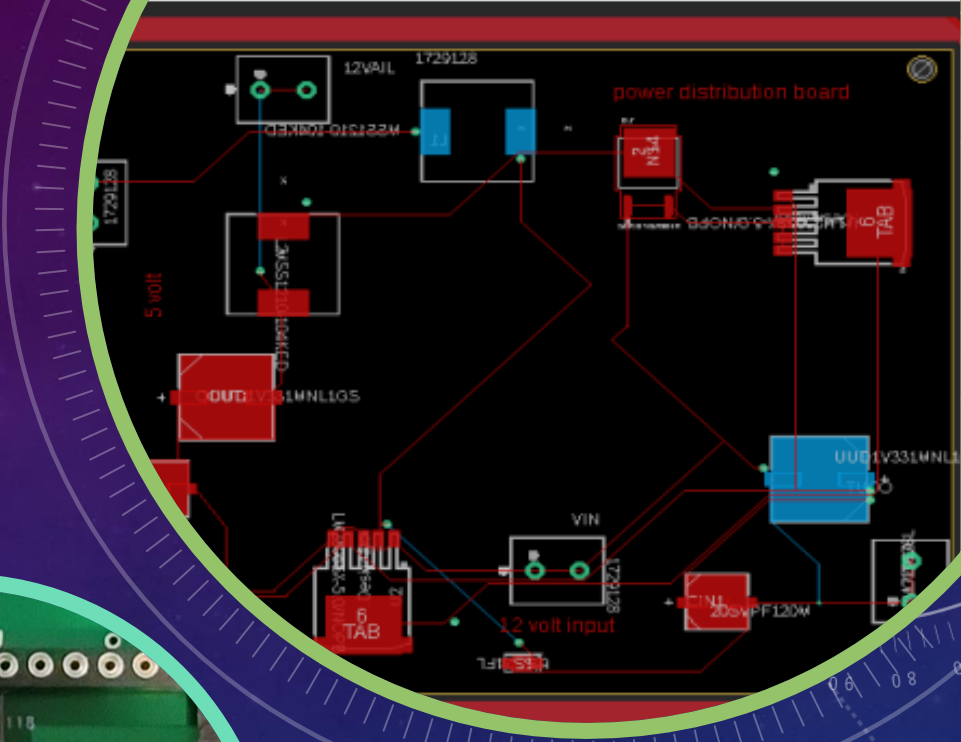
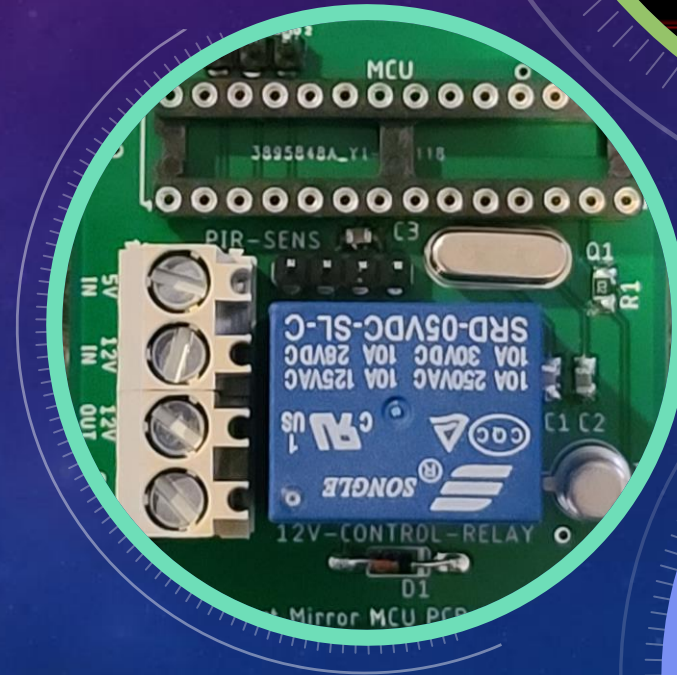
- Facial Recognition
- User Interface
- Screen Content
- Voice Recognition
- Networking

## Micro-Controller

- Vanity Lighting Control
- User Presence Detection

## Power Distribution

- Provide 5VDC Power
- Provide 12VDC Power





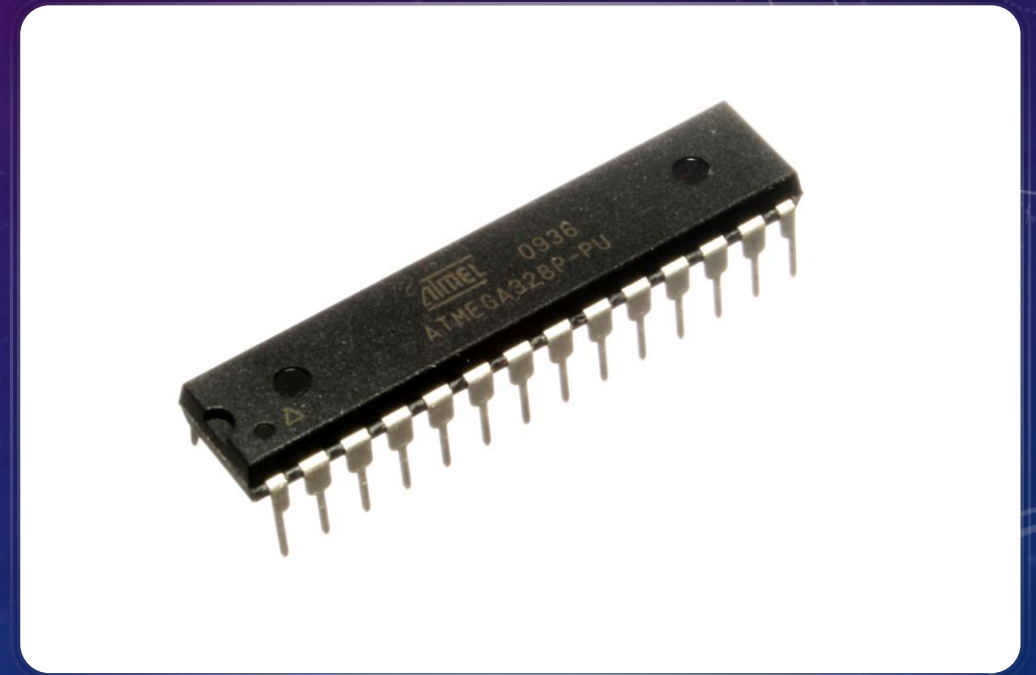
	<b>MSP430G2553</b>	<b>MSP430FR6989</b>	<b>ATMega328P</b>
<b>Operating Voltage</b>	1.8 to 3.6 VDC	1.8 to 3.6 VDC	2.7 to 5.5 VDC
<b>Max Clock Frequency</b>	16MHz	16MHz	8MHz to 16MHz
<b>GPIO Pins</b>	24 Pins	83 Pins	23 Pins
<b>MCU Bits</b>	16-bit	16-bit	8-bit
<b>Sleep Power Consumption</b>	0.1uA	0.02uA	1uA
<b>Standby Power Consumption</b>	0.5uA	0.4uA	N/A
<b>Active Power Consumption</b>	230uA	100uA/MHz	1.5mA
<b>I2C/ UART</b>	Both	2xBoth	USART
<b>Programming Language</b>	C	C	Arduino
<b>Software</b>	TI CCS	TI CCS	Arduino IDE
<b>Non-volatile memory</b>	16KB	128KB	32KB
<b>RAM</b>	0.5KB	2KB	2KB
<b>Price</b>	\$1.929	\$7.023	\$2.28

# MCU OPTIONS

# ATMEGA328P

- Will control lighting and user presence detection
- Will communicate user presence status with the micro-computer
- Will use external crystal for highest most reliable clock speed
- Easy to find and cost effective, can be found for a few dollars

Feature	Specification
Voltage	5V
Clock Speed	16MHz
Memory	32KB
GPIO Pins	23



# PRESENCE DETECTION OPTIONS

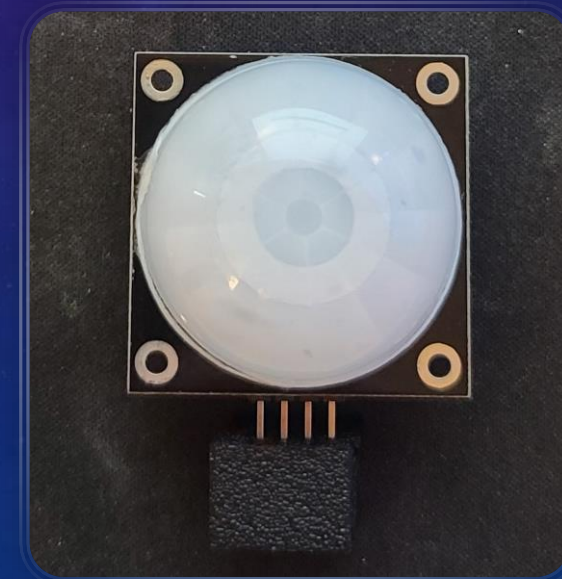
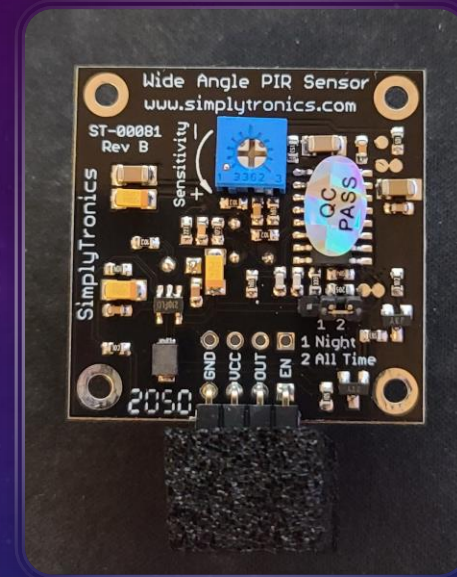
	<u>Ultrasonic Range Sensor</u>	<u>Wide Angle Passive Infrared Sensor</u>	<u>5.8GHz Doppler Radar Sensor</u>
<b>Operating Voltage</b>	5VDC	3VDC to 6VDC	5VDC
<b>Max Detection Range</b>	13.12ft	30ft	32.8ft
<b>Sensor Angle</b>	15 Degrees	180 Degrees	104/153 Degrees
<b>Interface</b>	High/Low	High/Low	UART
<b>On Board MCU</b>	No	No	Yes
<b>Standby Current Consumption</b>	N/A	150uA	40mA
<b>Active Current Consumption</b>	15mA	3mA	70mA
<b>Can Pass Through Non-Metals</b>	No	No	Yes
<b>Low Light Operation</b>	Yes	Yes	Yes
<b>Pin Count</b>	4-Pin	4-Pin	3-Pin
<b>Price</b>	\$3.95	\$12.99	\$6.95



# WIDE ANGLE PIR SENSOR

- Will tell the MCU when a user is present
- Will be mounted on the frame and communicate with the MCU via a cable
- Sensor has adjustable sensitivity as well as a low light mode

Feature	Specification
Voltage	5V
Communication	1/Bit
Detection Range	30ft
Detection Angle	180 Degrees
Cost	\$12.99



# MIRROR VANITY LIGHTING OPTIONS

	<b>Lepre</b>	<b>BTF-RGBCCT</b>	<b>BTF-RGBW</b>	<b><u>YUNBO</u></b>
<b>DC Op. Voltage</b>	12V	12V	12V	12V
<b>RGB</b>	No	Yes	Yes	No
<b>Warm White</b>	Yes	Yes	Pick One	Pick One
<b>Cool White</b>	Yes	Yes		
<b>Width</b>	10mm	12mm	12mm	4mm
<b># Of Pins</b>	3-Pin	5-Pin	5-Pin	2-Pin
<b>Waterproof</b>	No	IP67	IP67	No
<b>Cuttable</b>	Yes	Yes	Yes	Yes
<b>Adhesive</b>	3M	Knock-off	Knock-off	Knock-off
<b>Max Power Draw</b>	15W	150W	120W	36W
<b>Control</b>	Included	N/A	N/A	N/A
<b>Length</b>	16.4ft	16.4ft	16.4ft	16.4ft
<b>LED Count</b>	300	300	300	300
<b>LED Type</b>	2835	5050	5050	2835
<b>Price</b>	\$18.99	\$50.88	\$26.88	\$12.99

# MIRROR VANITY LIGHTING

- Will be placed behind light diffusers
- Will be used to light the users face and mounted on the mirror frame
- Cheap 12V LED strips will be used
- Will be controlled using 12V power from distribution PCB running through a relay
- On/Off status determined by user presence and on off switch in series with one another

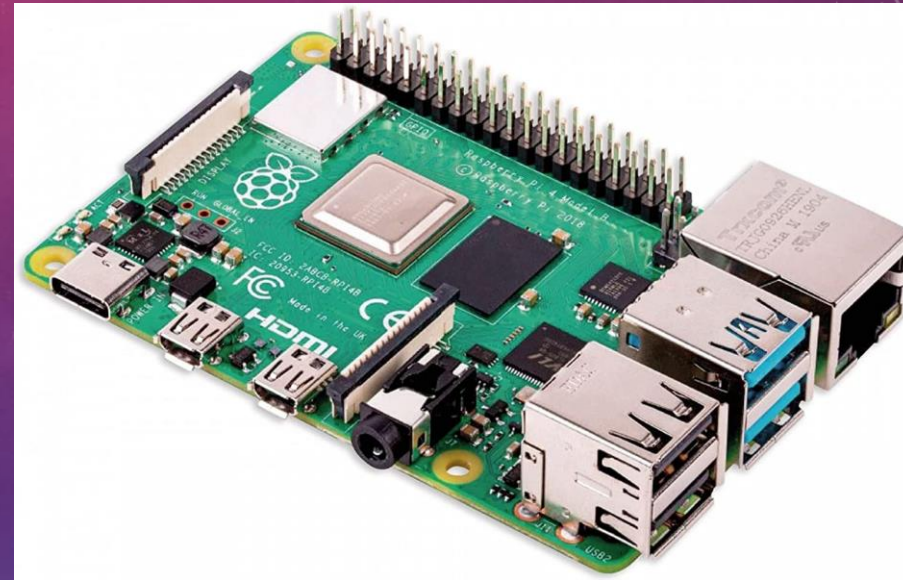


Feature	Specification
Voltage	12V
Width	4mm
LED Count	300
Length	16.4ft
Max Power Draw	36W
Cost	\$12.99



# RASPBERRY PI

- Bluetooth and Wi-Fi enabled
- Small and compact design makes it simple to install behind mirror
- Enough power to run all the necessary software
- Most easily accessible MCU on the market with lots of online resources available.



# MICRO COMPUTER COMPARISON

Micro Computer	Beaglebone Black	Raspberry Pi 4 Model B
MSRP	\$60.00	\$55.00(4GB ver.)
Processor	AM3358 ARM Cortex A8 @ 1GHz	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Memory	512MB DDR3 RAM	4GB LPDDR-3200 SDRAM
USB Ports	1	2 USB 3.0 + 2 USB 2.0
Power Consumption	5V/2A (10 Watts)	5V/3A (15 Watts)
Operating System	Linux	Raspberry Pi (Linux based OS)
Storage	4GB 8-bit eMMC on-board flash storage	MicroSD Expandable(64 Gb)

# REFLECTIVE PANEL

- Acrylic is a reflective material that can be used as a “mirror.”
- This material has a desirable “Visual Transmittance”
- With a VT of 40%, most light will be reflected, meaning the user will be able to see themselves.
- Just low enough that light from display can pass through





# DISPLAY

- The display is taken from a 24-inch Sceptre monitor (E248W).
- At a resolution of 1080p, this panel will provide a clear and bright picture for our product.
- The display will be connected through HDMI to the Raspberry Pi.



Monitor/ Television	Sceptre E248W-19203R	Sceptre E278W- FPI	Insignia N10 Series	LG-28" Class LED TV
Retail Price	\$139.97	\$179.97	\$109.99	\$179.99
Screen Size	24 inches	27 inches	24 inches	28 inches
Panel Type	VA	IPS	Standard LED	Standard LED
Resolution	FHD	FHD	HD	HD
Refresh Rate	75Hz	75Hz	60Hz	60Hz
Response Time	8 ms	5 ms	14 ms	8 ms
Color Gamut	95% sRGB	99% sRGB	n/a	68% CIE1931
Power Specifications	Adapter: 100-240 VAC, 50/60 Hz, 1.0A (Max) Output: 12V DC, 2.5A	Adapter 12V 3A 100-240V, 0.8A, 50-60Hz	n/a	PSU: 55W Input: 100-240V
Dimensions (W x H x D)	21.59" x 1.28" x 12.71"	24.12" x 14.14" x 1.12"	21.7" x 13.1" x 2.7"	25" x 15.2" x 3.0"

# SPEAKER

- For audio feedback, an external speaker will be used (LIELONGREN USB Speaker).
- The connection will be made through USB to the Raspberry Pi.
- The speaker provides fair sound at high volumes.



Speaker	Display-Built-In Speaker	LIELONGREN USB Powered Speaker	LENRUE Bluetooth Speaker
Retail Price	(included with monitor)	\$17.98 - 21.98	\$19.99
Connection Type	HDMI	USB 2.0	Bluetooth 5.0
Drivers	Variable	Two 3W + 2W	-
Total Output	Variable	8W	Battery Powered
Frequency Response	Variable	100Hz – 20kHz	-
Connection Length	Variable	3.8ft	Variable
Dimensions (W x H x D)	n/a	7.17" x 2.2" x 1.81"	6.9" x 1.8" x 2.8"

# MICROPHONE

- For vocal input, a standard lapel microphone is used to accept voice commands from the user.
- More complicated microphones would merely add more cost to the end user without necessarily improving functionality.



Microphone Arrays	UMA-8 USB mic array - V2.0	ReSpeaker6-Mic Circular Array kit for Raspberry Pi	Movo M1 USB Lavalier Lapel Clip-on Omnidirectional
Price	\$105	\$39.90	\$29.95
Microphones	7x Knowles SPH1668LM4H	6x MSM321A3729H9Cp	-
Sample rate	24bit 11/16/32/44.1/48 kHz	48KHz	18KHz
Compatibility	UAC2.0 with Windows ASIO driver, OS X driverless, Linux ALSA 2.0, Mac/Win GUI for real time control of DSP settings, API for microphone control Raspberry Pi	Raspberry Pi Zero, Raspberry Pi 1 B+, Pi 2 B, Pi 3 B, Pi 3 B+, 4	USB connection
Dimensions (diameter) mm	90 mm diameter / 20mm height	1mm x 1mm x 1mm	N/A
Sensitivity	-29dBFS (Omnidirectional)	-22dBFS (Omnidirectional)	N/A
Audio Channels	8	8	1



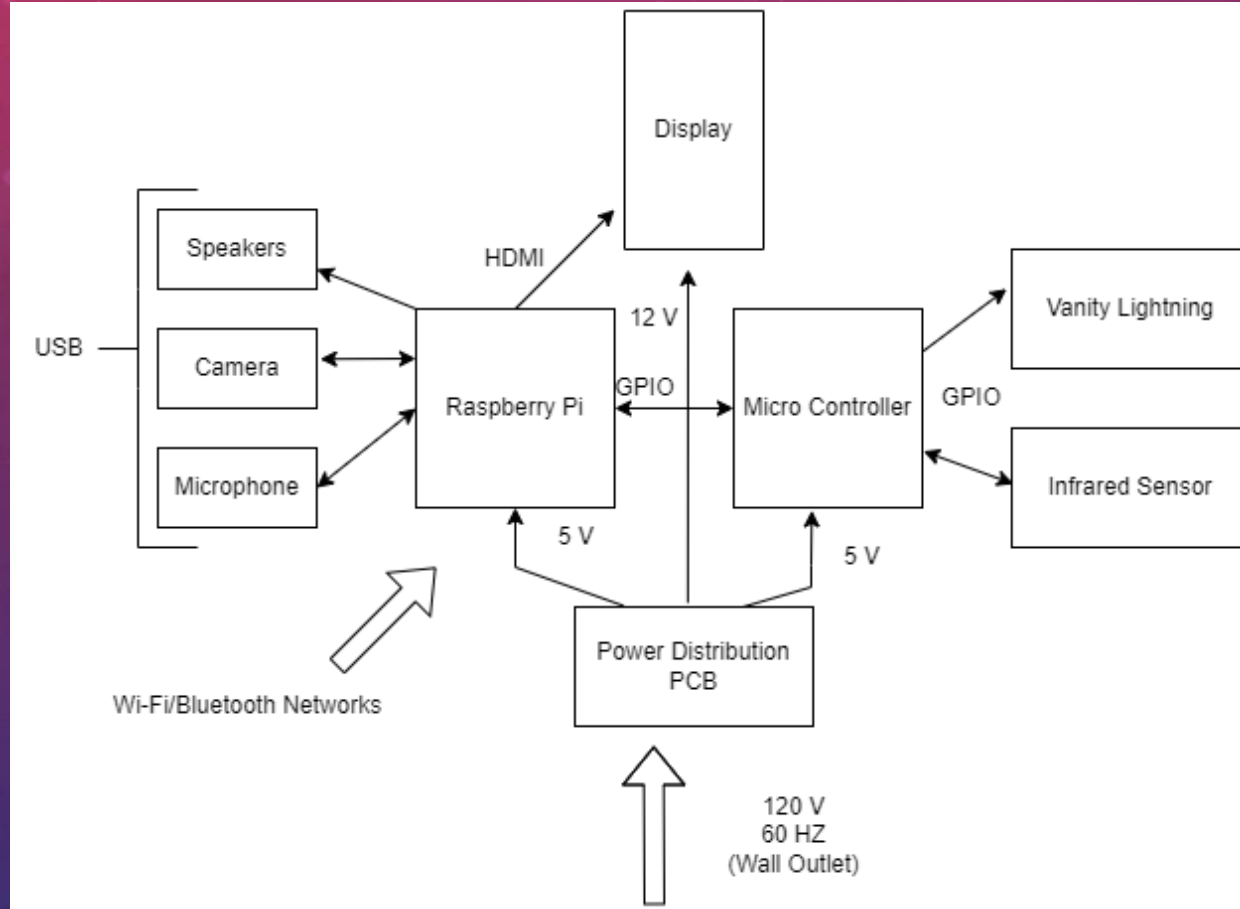
# CAMERA

- The Arducam connects directly to the Raspberry Pi's CSI port through a dedicated ribbon cable.
- Arducam is capable of autofocus, meaning facial recognition will work better in different distances and angles.



Camera	<del>Logitech C920x</del>	<del>Logitech C615</del>	<del>Amerest 1080p Webcam</del>	<b>Arducam</b>
<b>Retail Price</b>	\$59.99	\$39.99	\$27.99	\$29.99
<b>Image Resolution</b>	15 megapixels	8 megapixels	megapixels	16 megapixels
<b>Video Resolution</b>	1080p video calling and recording	1080p video calling and recording	720p video calling, 1080p recording	1080p @ 30fps/ 720p @ 60fps
<b>Lens/Sensor</b>	Glass	Glass	Glass, CMOS	Glass, Sony IMX219
<b>Field of View (Diagonal)</b>	78 degrees	78 degrees, 360 degrees swivel	70 degrees	~79 degrees
<b>Microphone</b>	2 omnidirectional	1 omnidirectional	Built-in "high sensitivity"	None
<b>Connection Type</b>	USB 2.0	USB 2.0	USB 2.0	Ribbon connection to board

# OVERALL INTEGRATION



# SOFTWARE INTEGRATION

```
require File.expand_path("../support/spec_helper.rb", __FILE__)
# Prevent database truncation if the environment is production
abort("The Rails environment is running in production mode!")

require 'spec_helper'
require 'rspec/rails'

require 'capybara/rspec'
require 'capybara/rails'

Capybara.javascript_driver = :selenium
Category.delete_all; Category.create!
Shoulda::Matchers.configure do |config|
  config.integrate do |int|
    with.test_framework :rspec
    with.library :rails
  end
end

# Add additional require lines here.
# Requires supporting ruby files with spec support,
# spec/support/ and its subdirectories.
# spec/support/ will be loaded before this file.
# in _spec.rb will be loaded before this file.
# run twice. It is recommended to run this file
```



# MCU SOFTWARE DIAGRAM



# FACE RECOGNITION

Facial "landmarks" will be identified with training images. These landmarks include the nose, eyebrows, lips, and jawline.

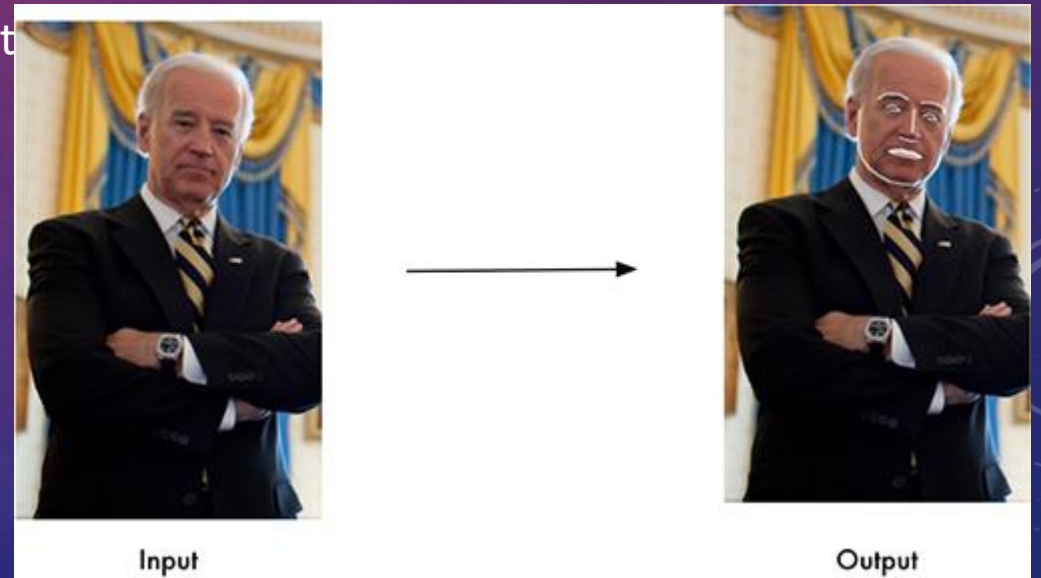
As user begins interaction, photo will be taken, then the mirror will perform an authentication process.

Photo will be matched against training images



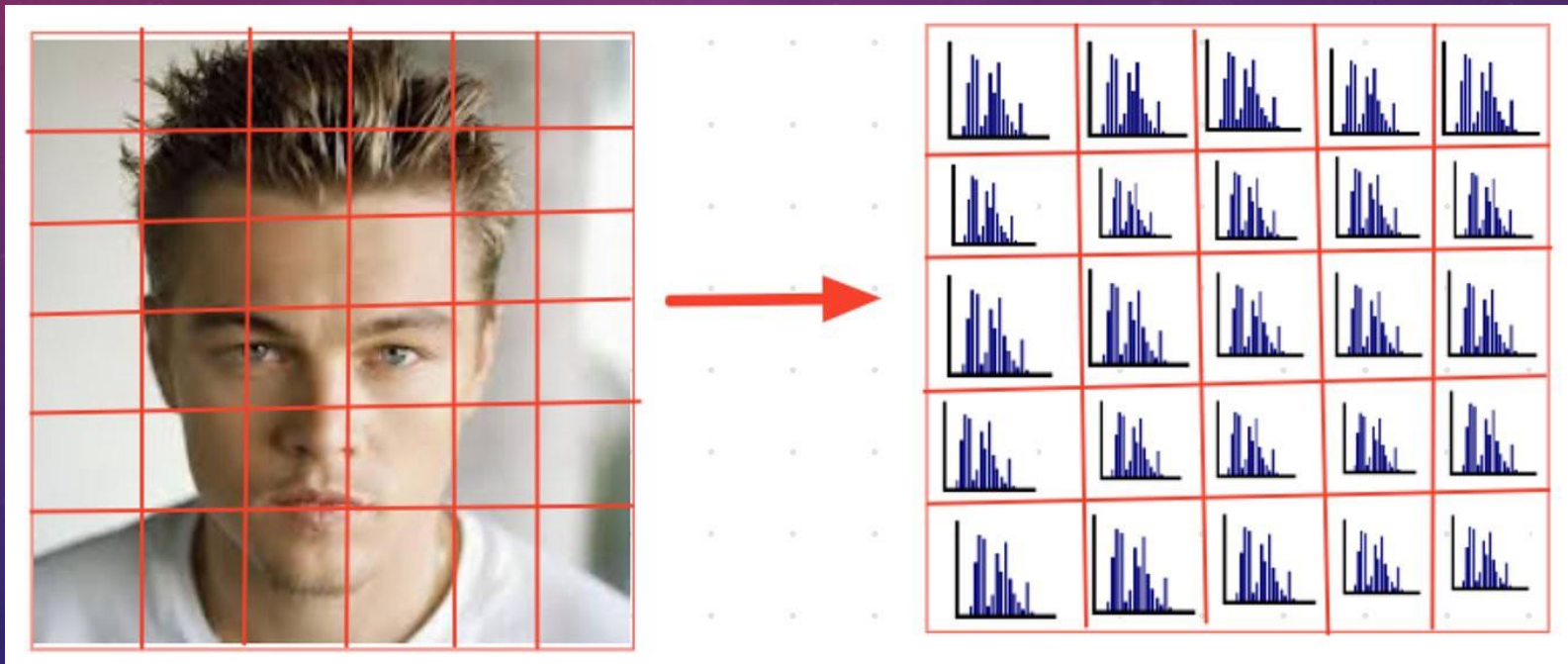
Click to add text

Click to add text



# HISTOGRAM OF ORIENTED GRADIENTS(HOG)

- Logic behind the face detection. Works by first dividing the entire image into grids.
- The pixels in each individual cell are organized into a histogram depending on several features of the pixel, such as color or intensity.
- These grid values can be saved into an xml file which the software can use as a face database.





# MEDIA INTEGRATION

- Mirror will have designated sections for news/social media feeds
- Feeds will auto update after a set amount of time has passed
- Information displayed will depend on who is currently using the mirror



# GOOGLE SMART ASSISTANT(SPEECH RECOGNITION)

- Using the publicly available SDK, Google Assistant will be integrated for additional functionality
- Speech recognition is included in the assistant SDK
- Users will be able to ask their mirror questions and receive helpful information regarding the rest of their day
- Users may also log in to their google accounts from the assistant for a more personalized experience



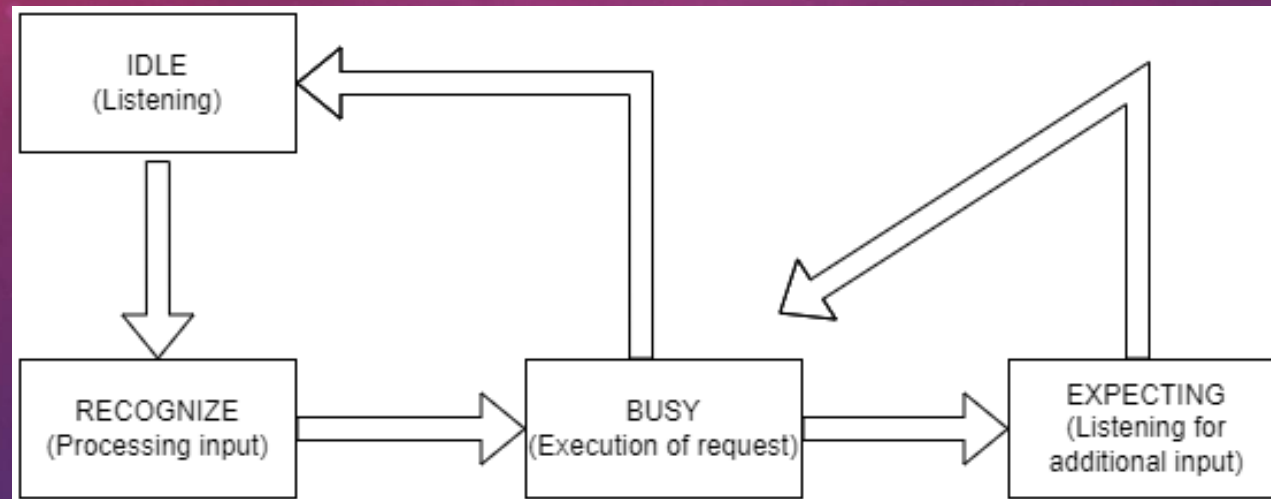
# ASSISTANT COMPARISON

Assistant	Google Assistant	Amazon Alexa
Speech Recognition	Yes	Yes
Google Services	Yes	No
Amazon Services	No	Yes

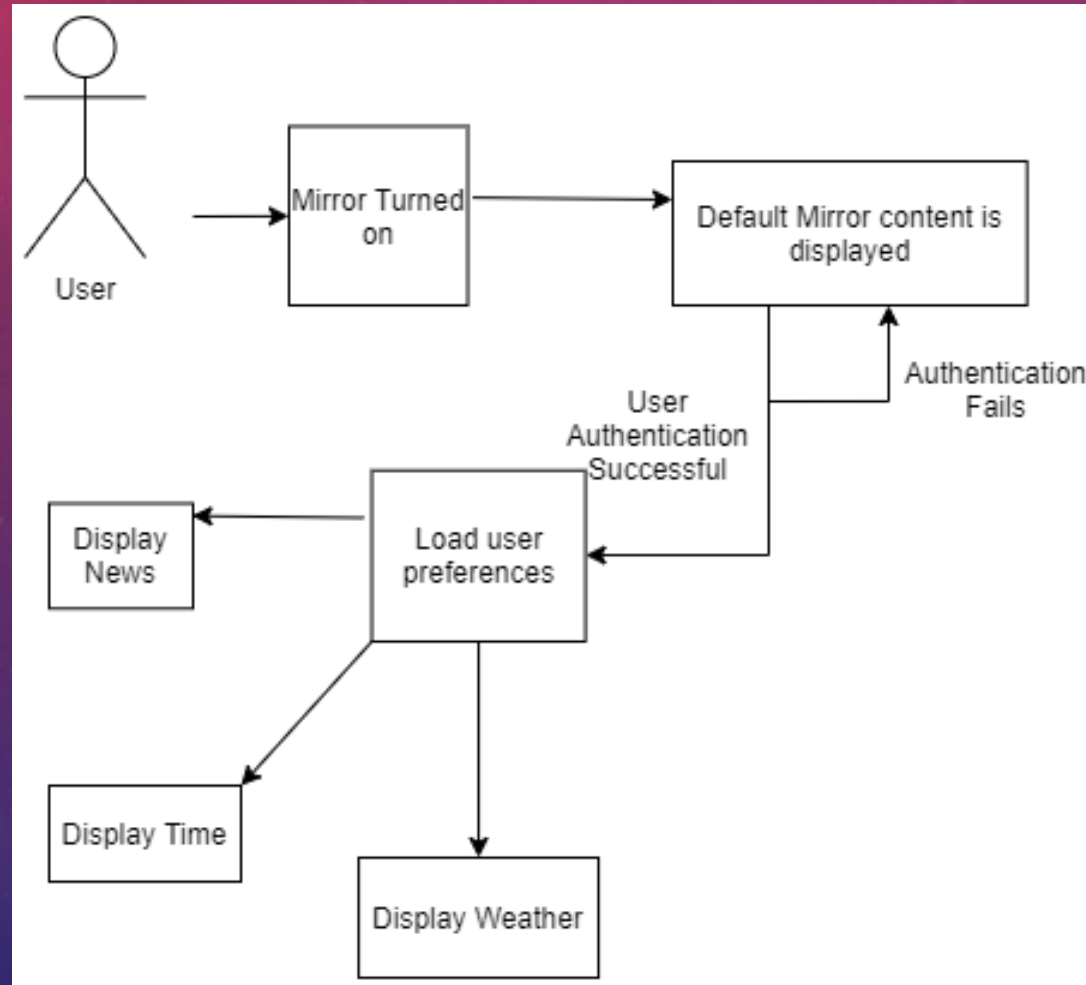
- Google services such as Maps, YouTube, web search, etc. Is more valuable than Amazon services for a device such as the smart mirror.
- Alexa has an edge in buying products from Amazon seamlessly. This is not an advantage for this product over what can be provided by Google Assistant.

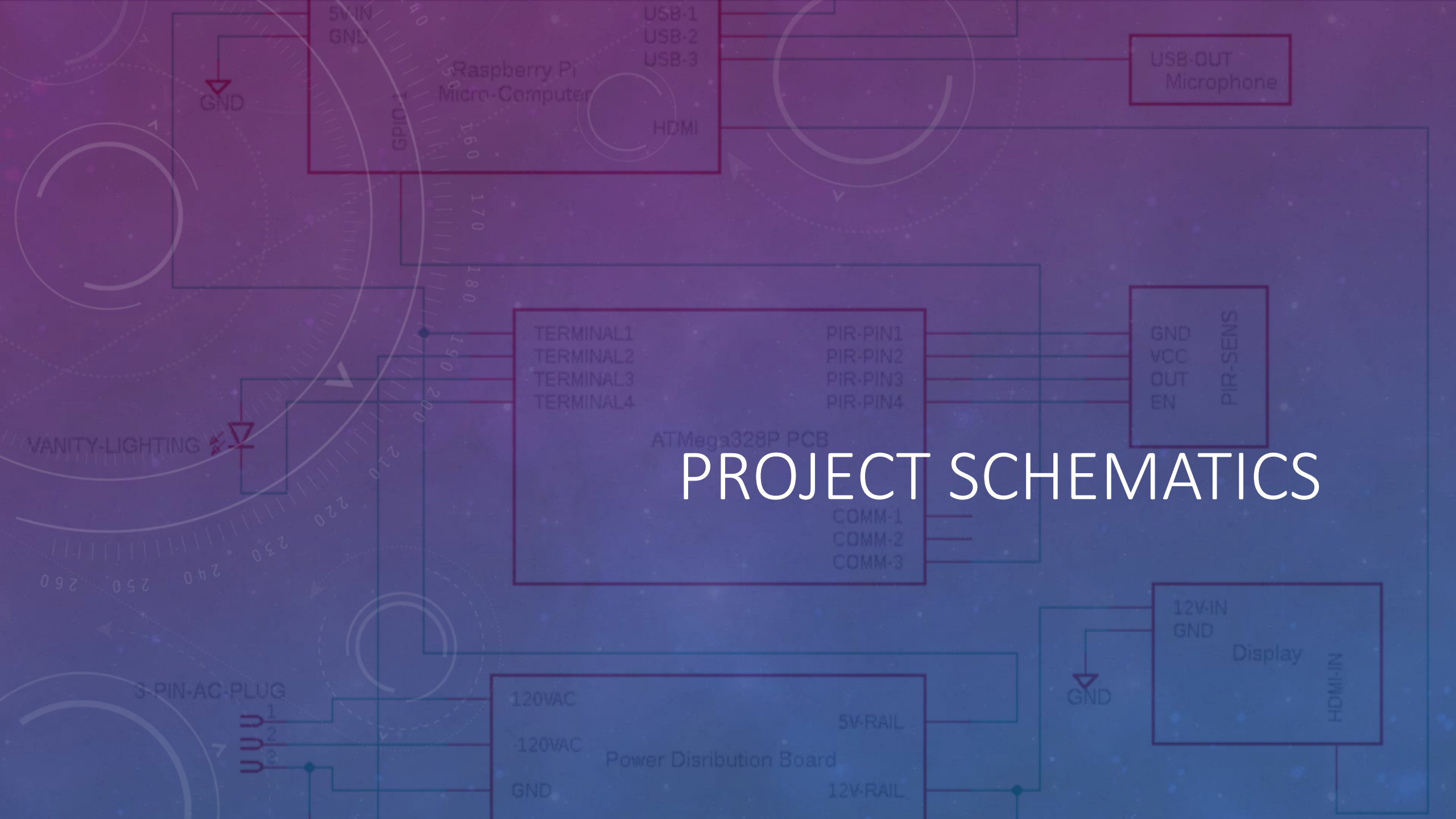


# SPEECH RECOGNITION FLOWCHART



# AUTHENTICATION FLOWCHART

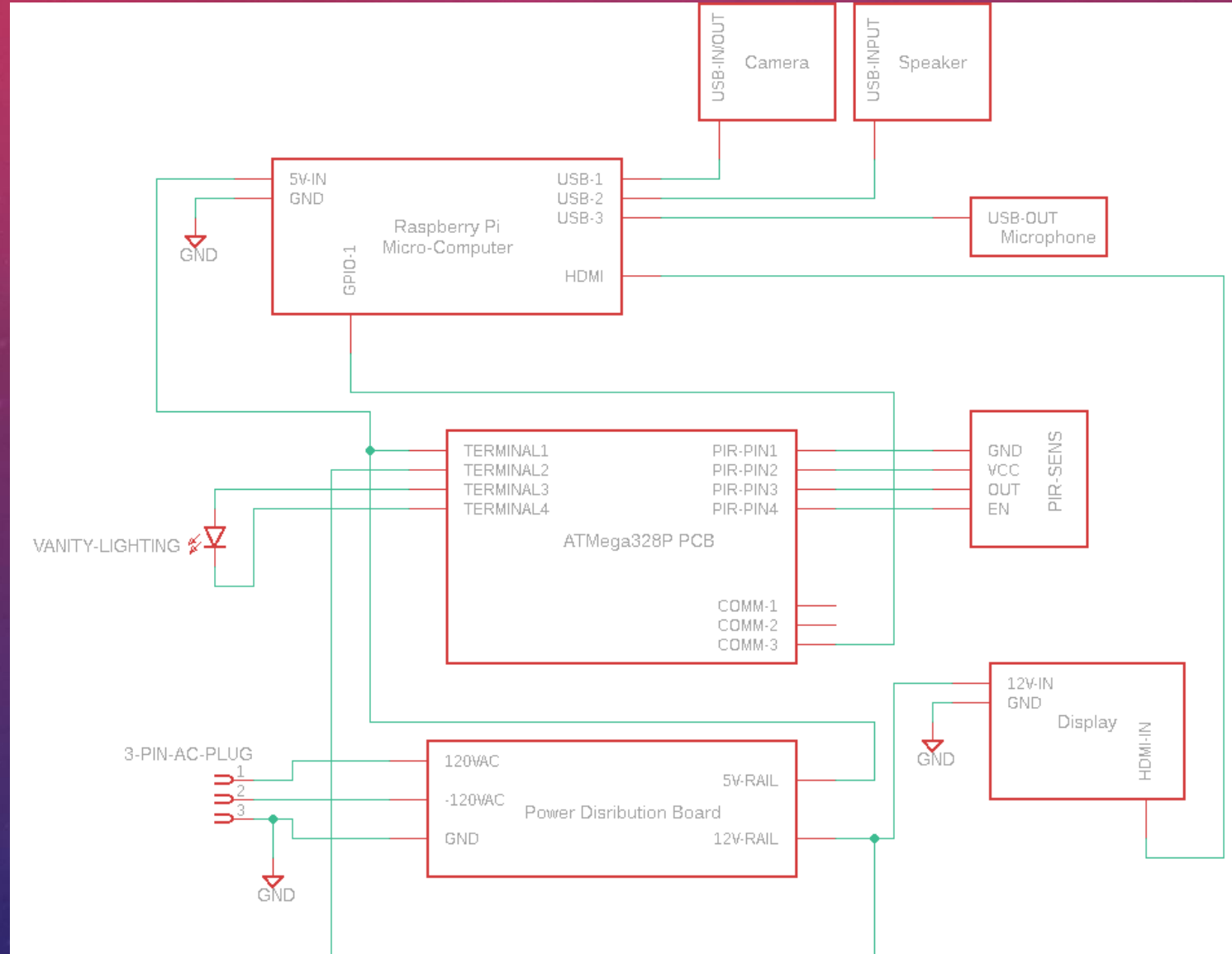




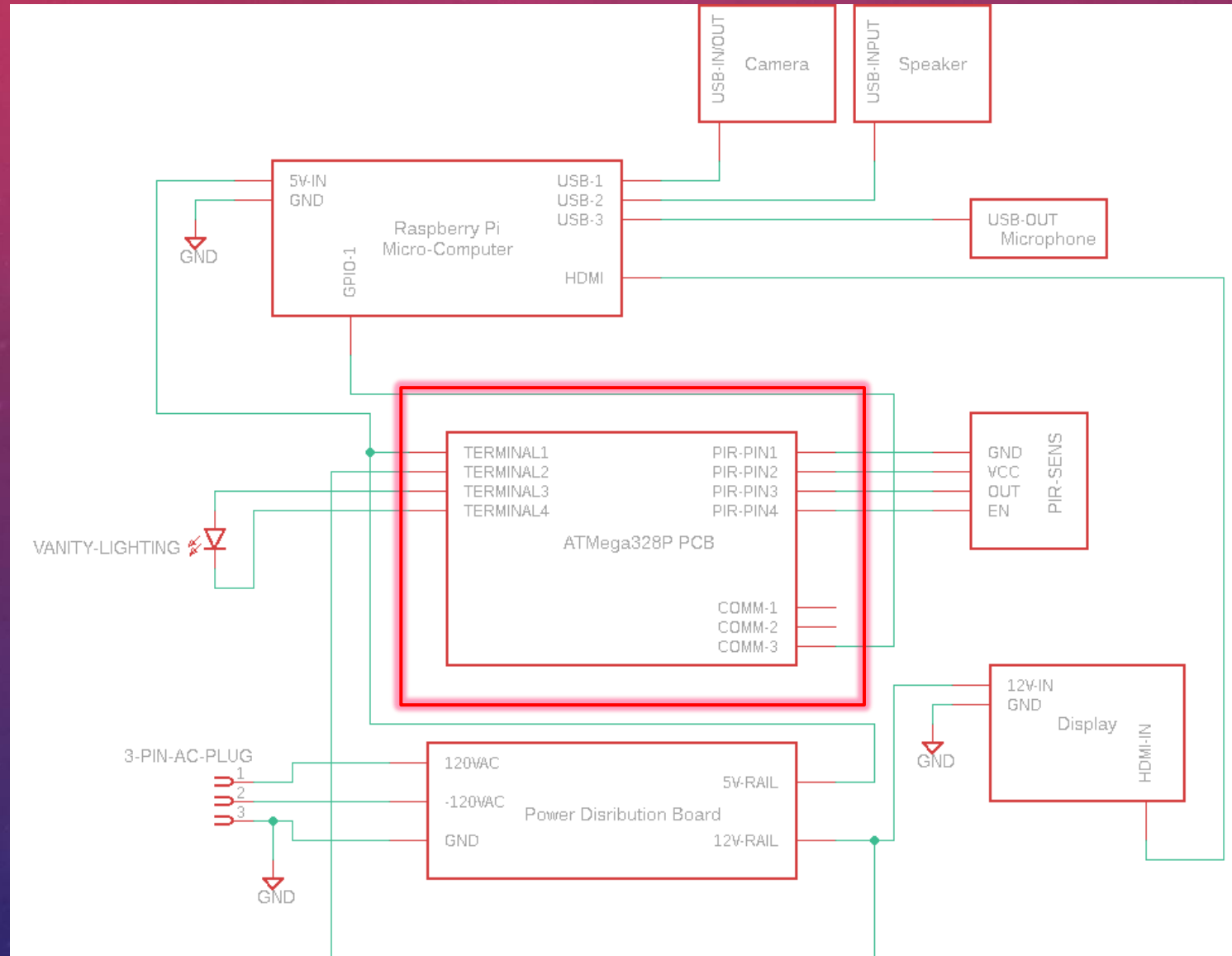
# PROJECT SCHEMATICS



# MODULE CONNECTION SCHEMATIC

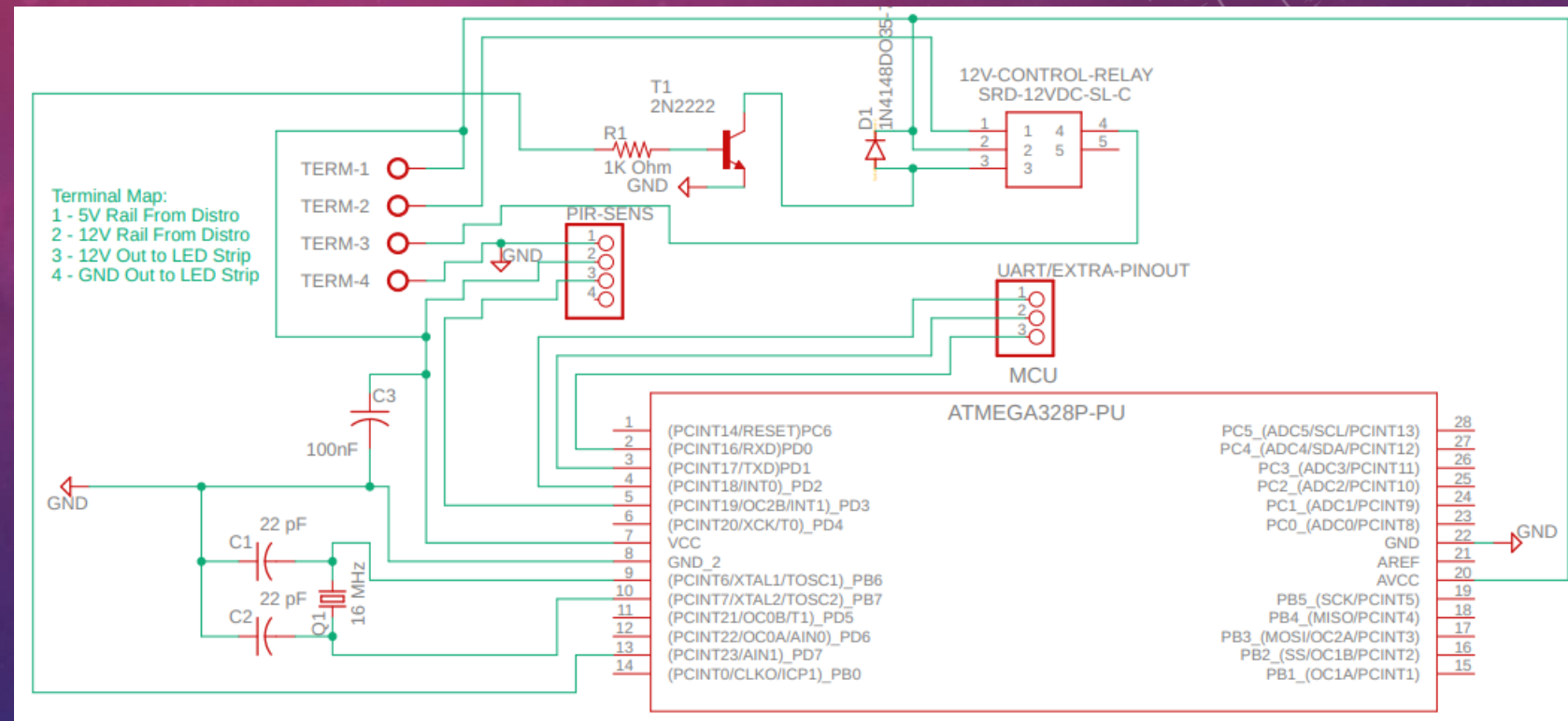


# MODULE CONNECTION SCHEMATIC



# MICRO-CONTROLLER PCB SCHEMATIC

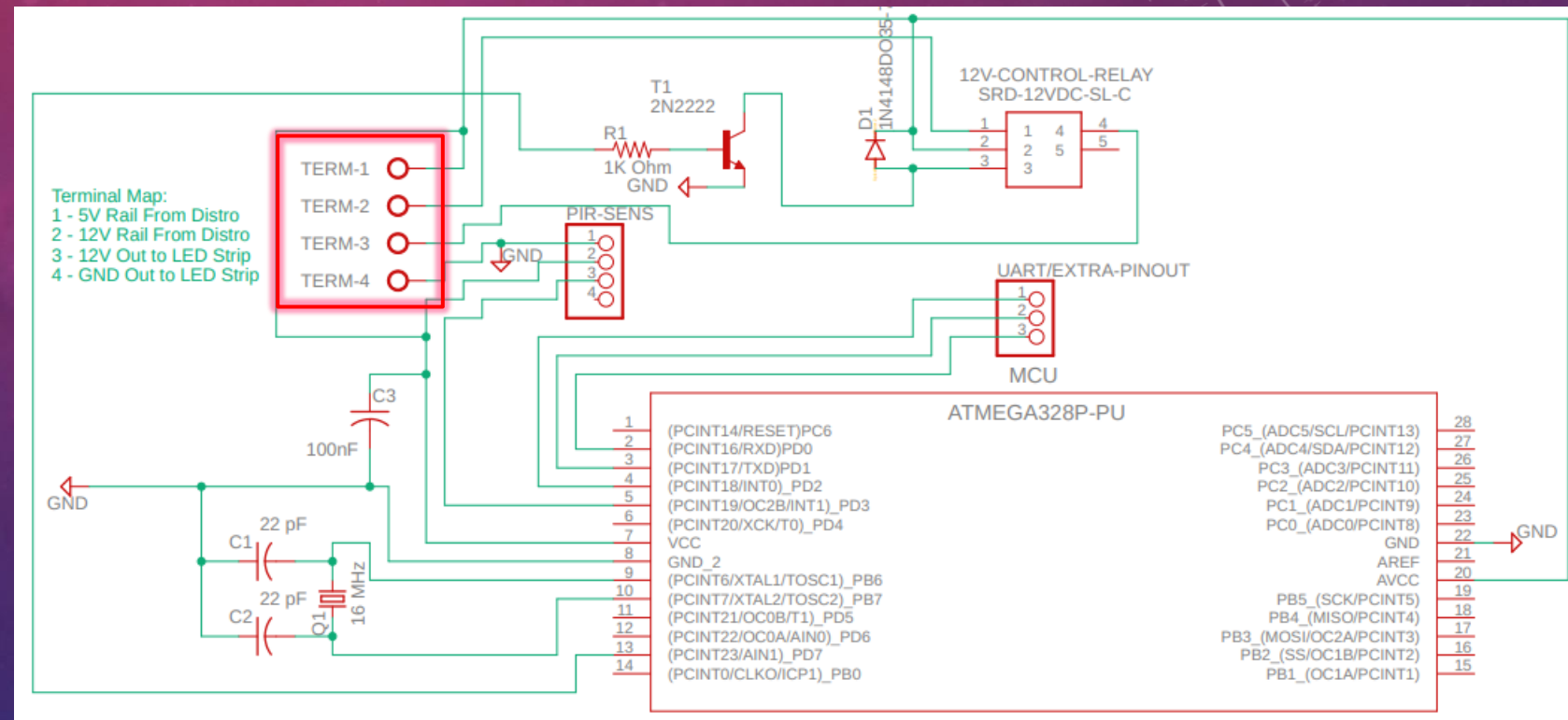
- 4 Terminal connection for power input and output
- 4-Pin header for presence sensor
- 3-Pin header for UART and MCU pin
- External 16MHz crystal
- Transistor and diode for relay control to protect MCU





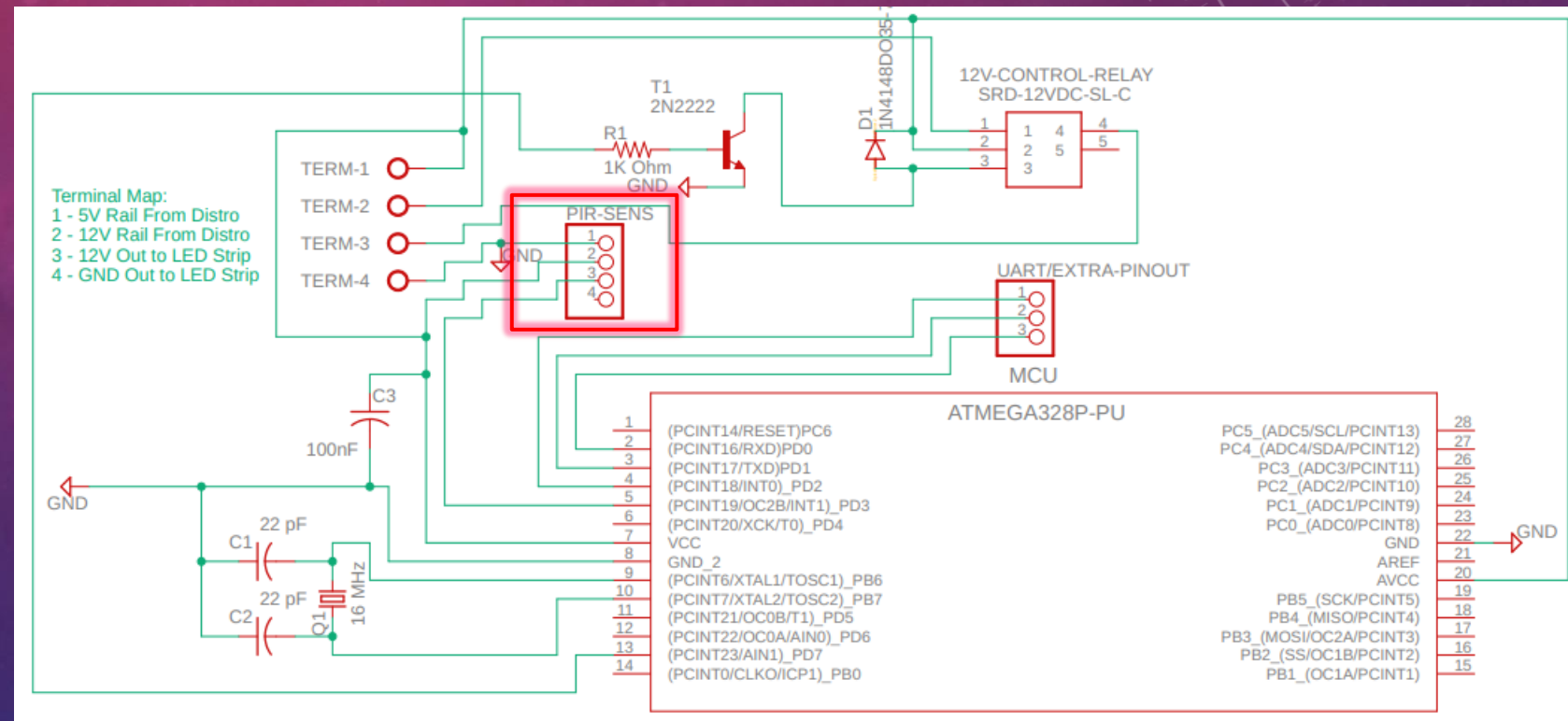
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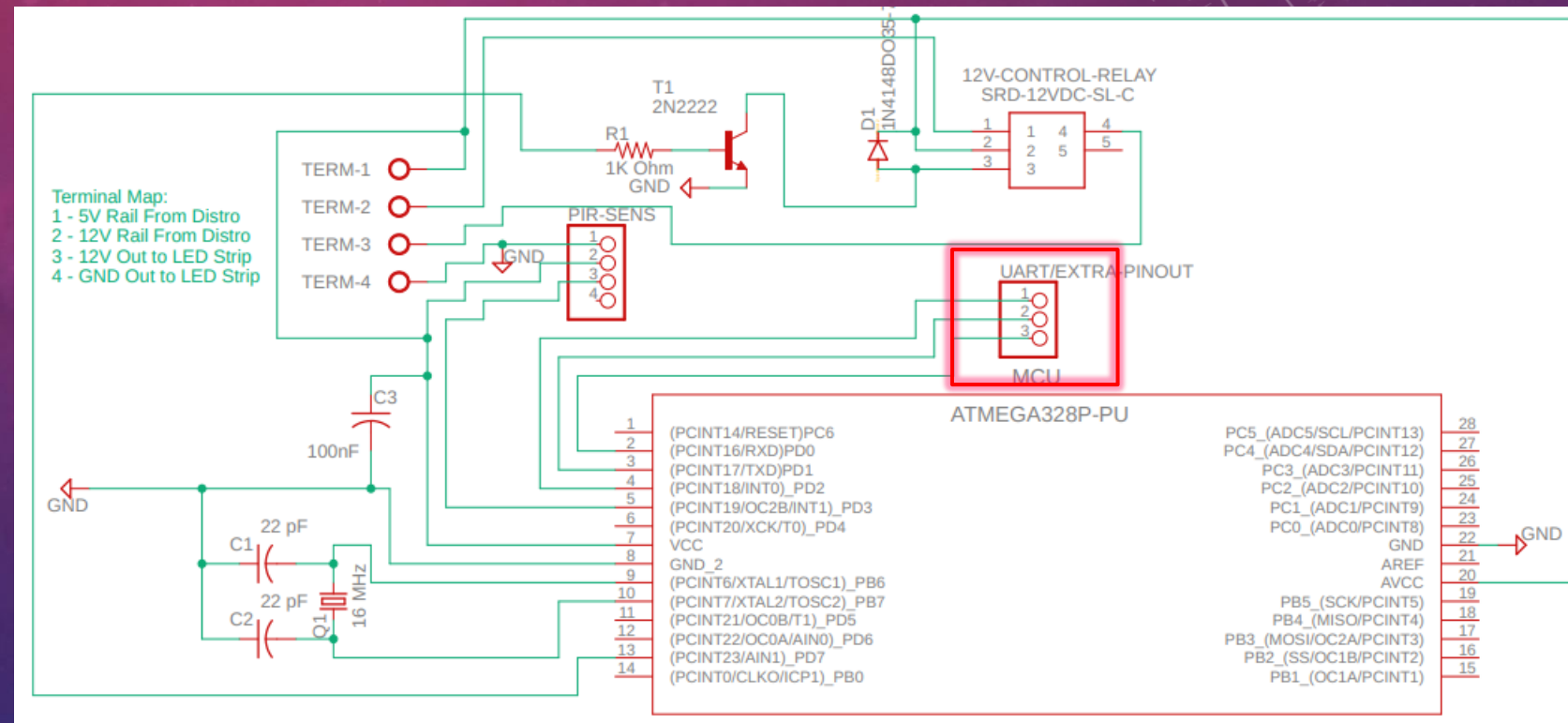
# MICRO-CONTROLLER PCB SCHEMATIC

- 4 Terminal connection for power input and output
- **4-Pin header for presence sensor**
- 3-Pin header for UART and MCU pin
- External 16MHz crystal
- Transistor and diode for relay control to protect MCU



# MICRO-CONTROLLER PCB SCHEMATIC

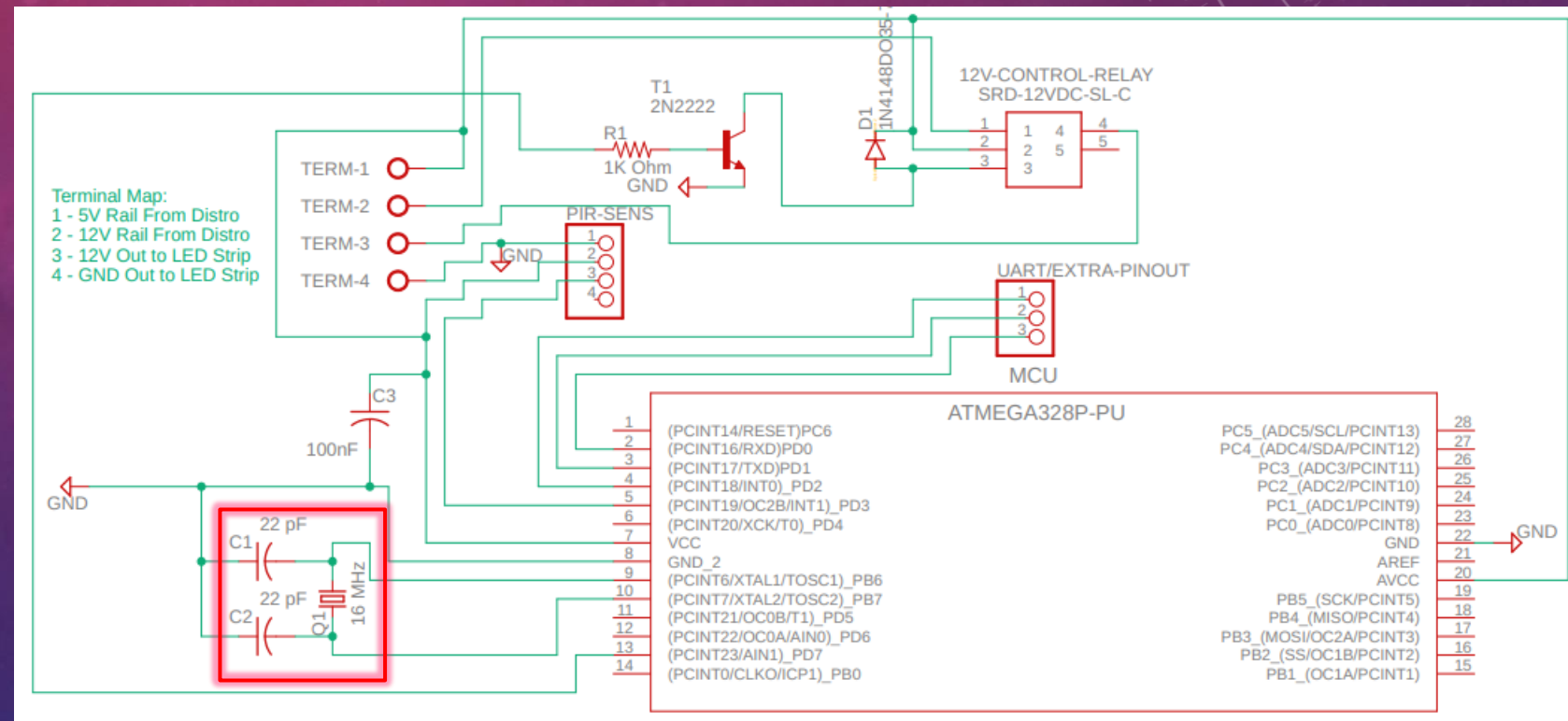
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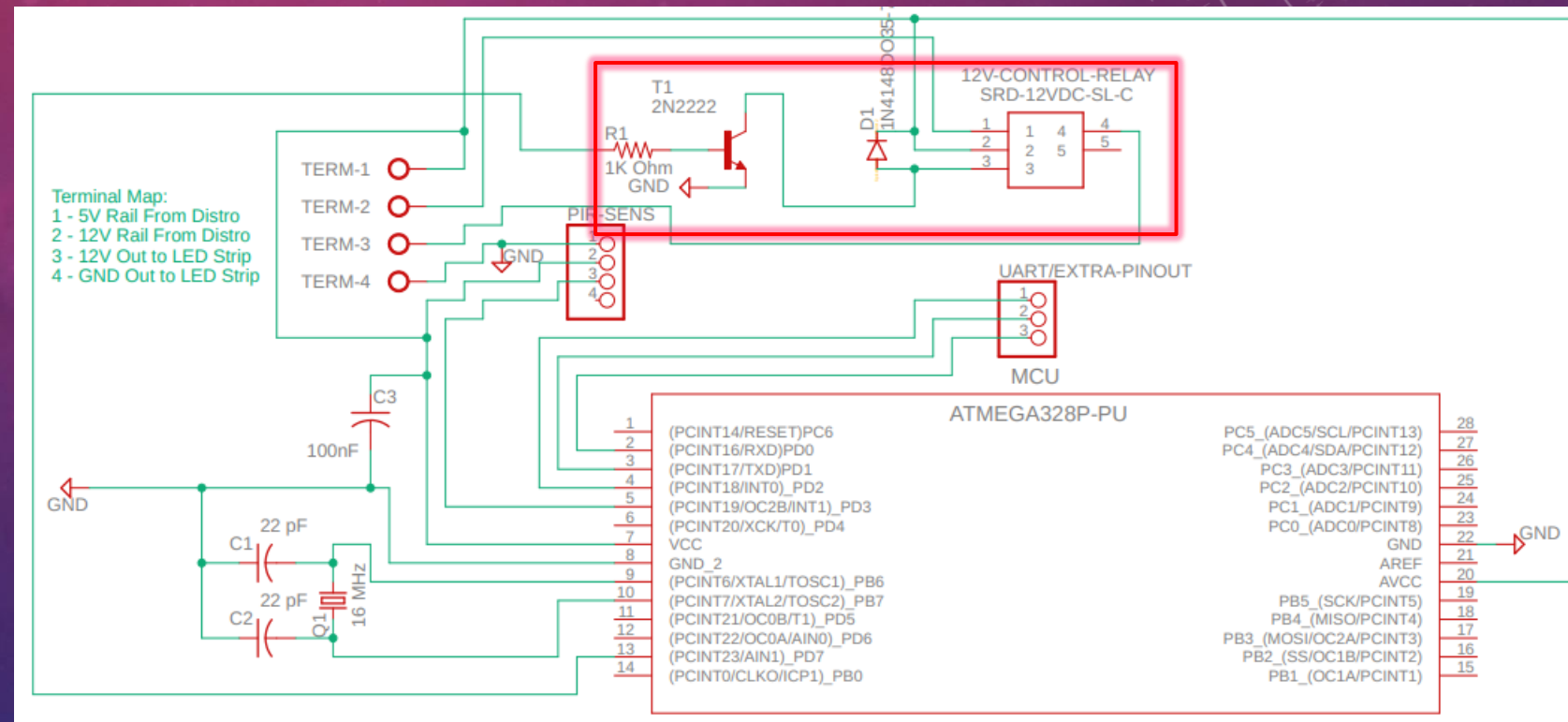
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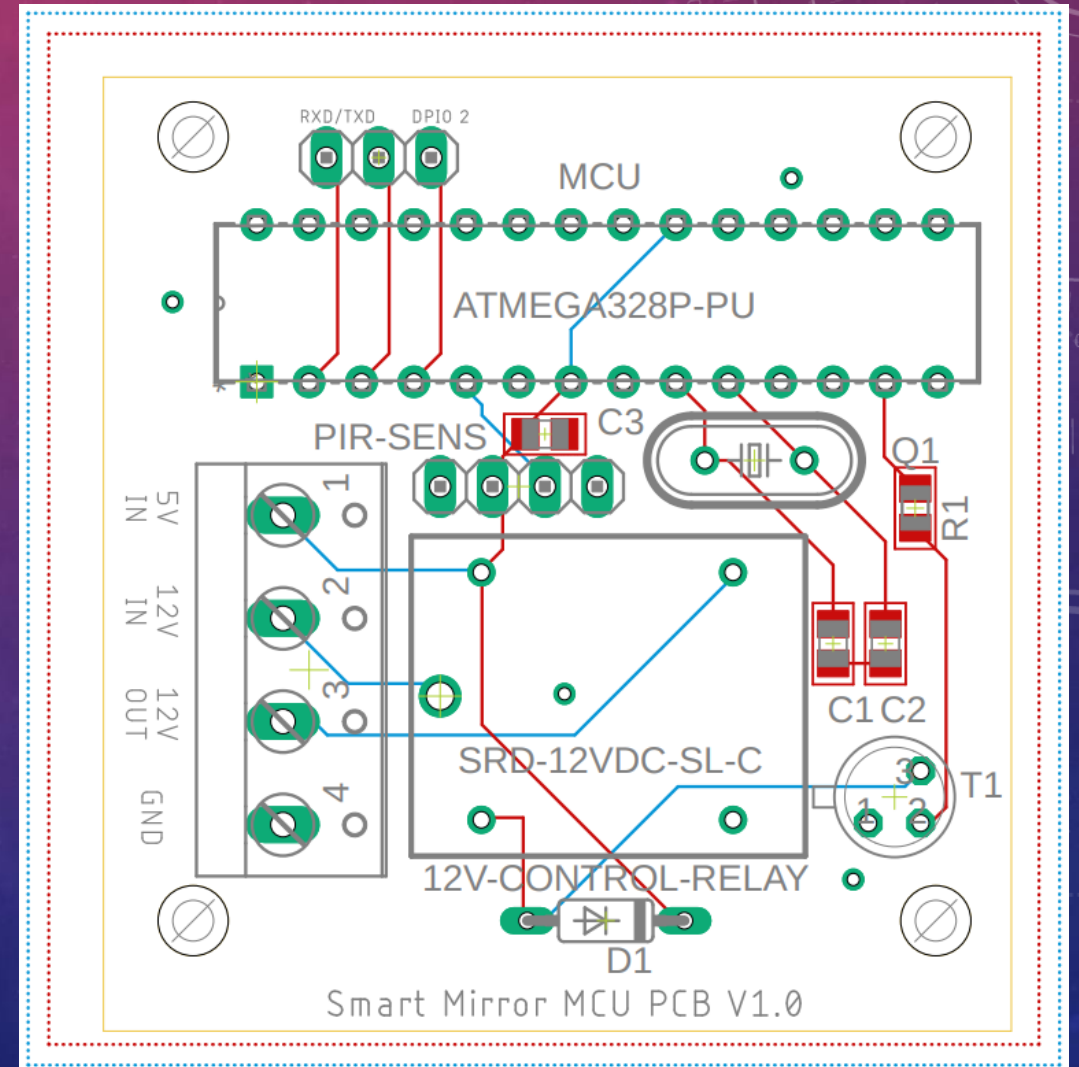
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# MICRO-CONTROLLER PCB DESIGN

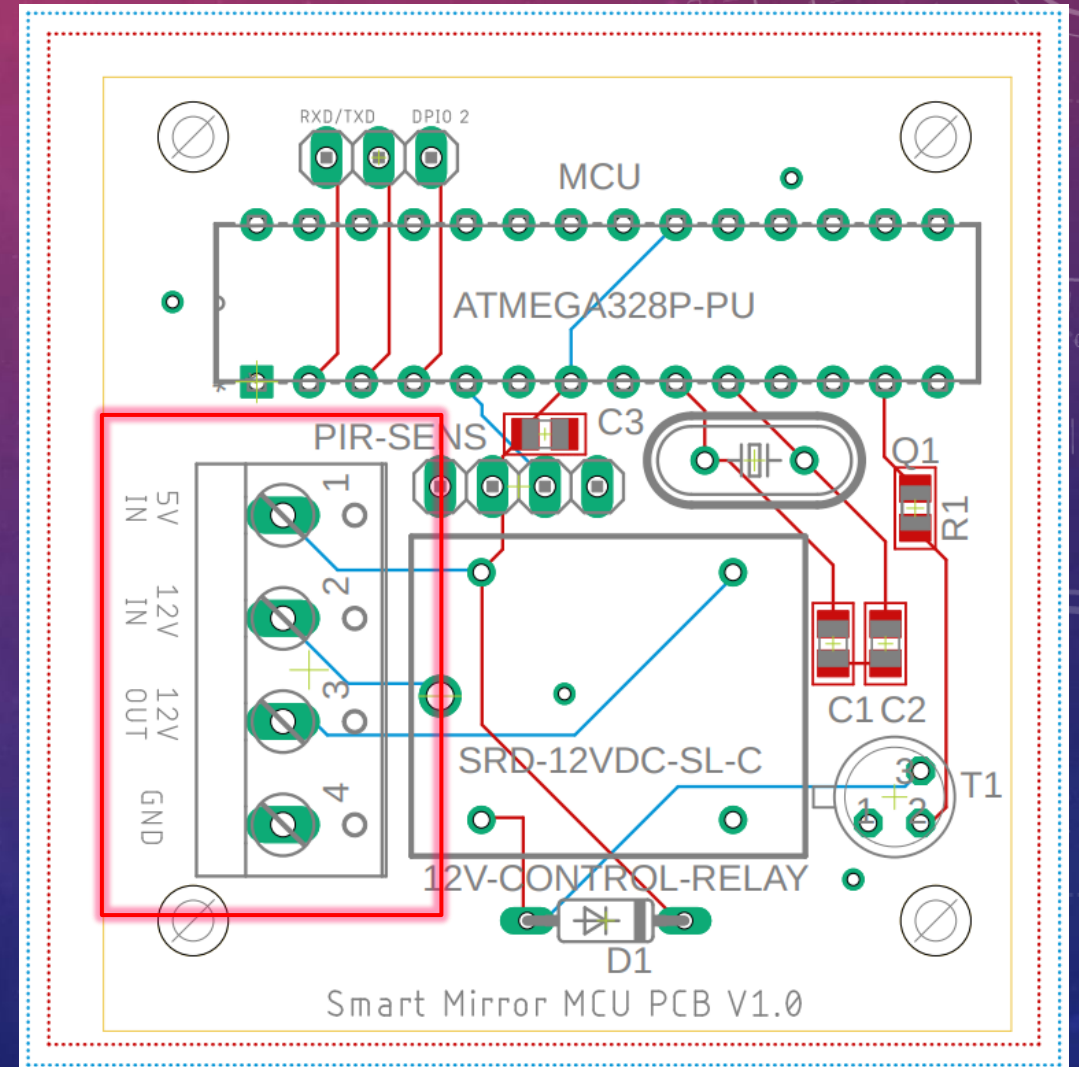
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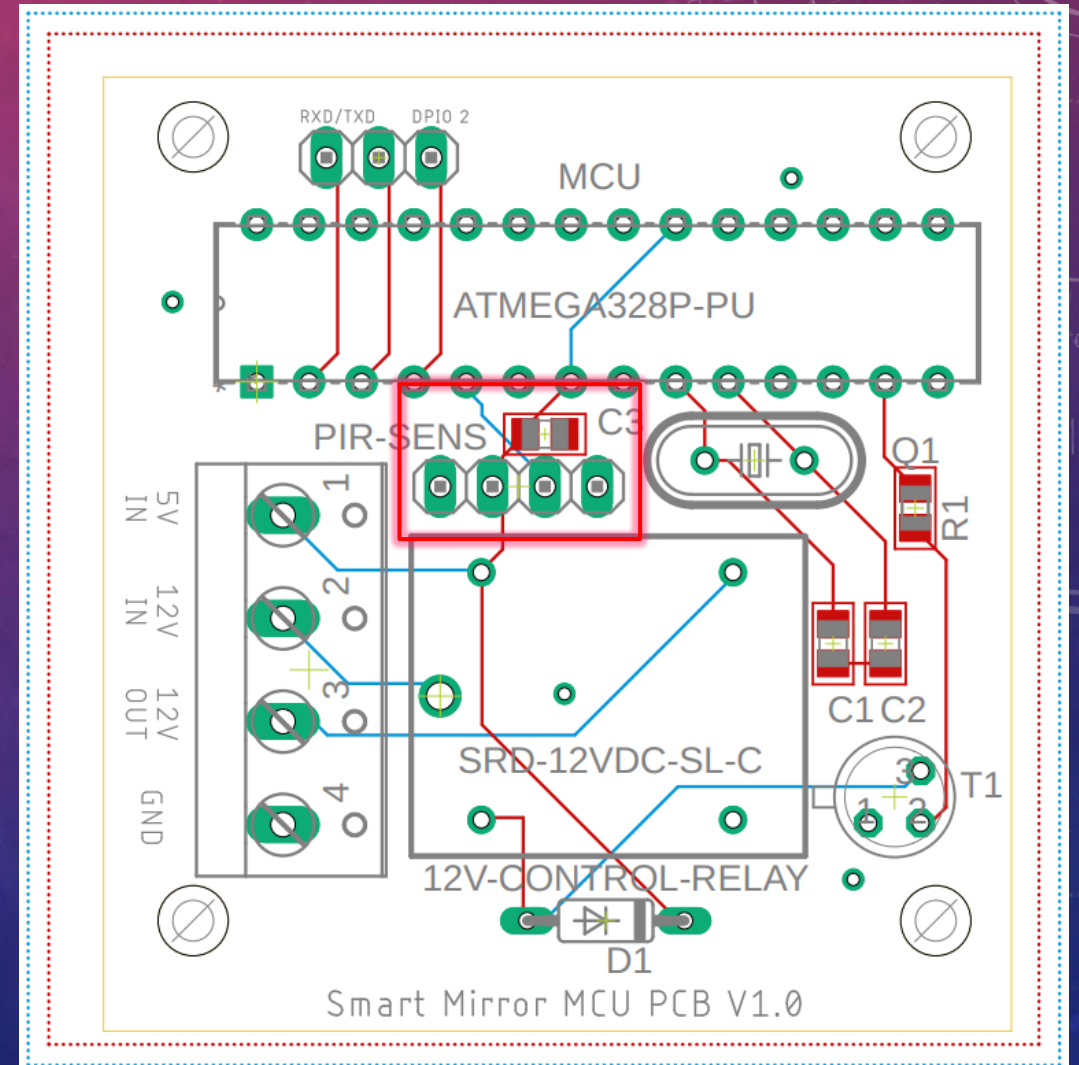
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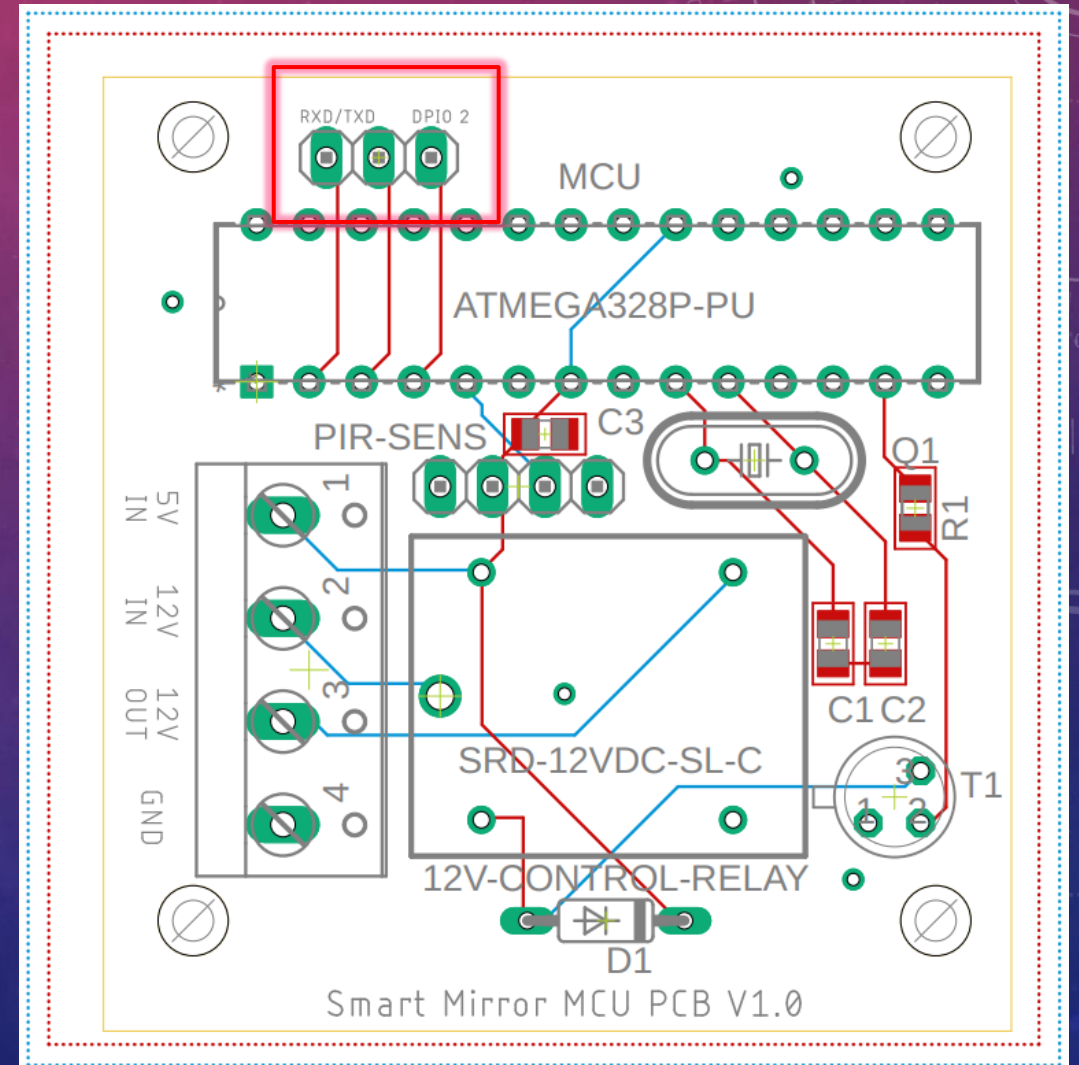
# MICRO-CONTROLLER PCB DESIGN

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- **4-Pin header for presence sensor**
- 3-Pin header for UART and MCU pin
- External 16MHz crystal
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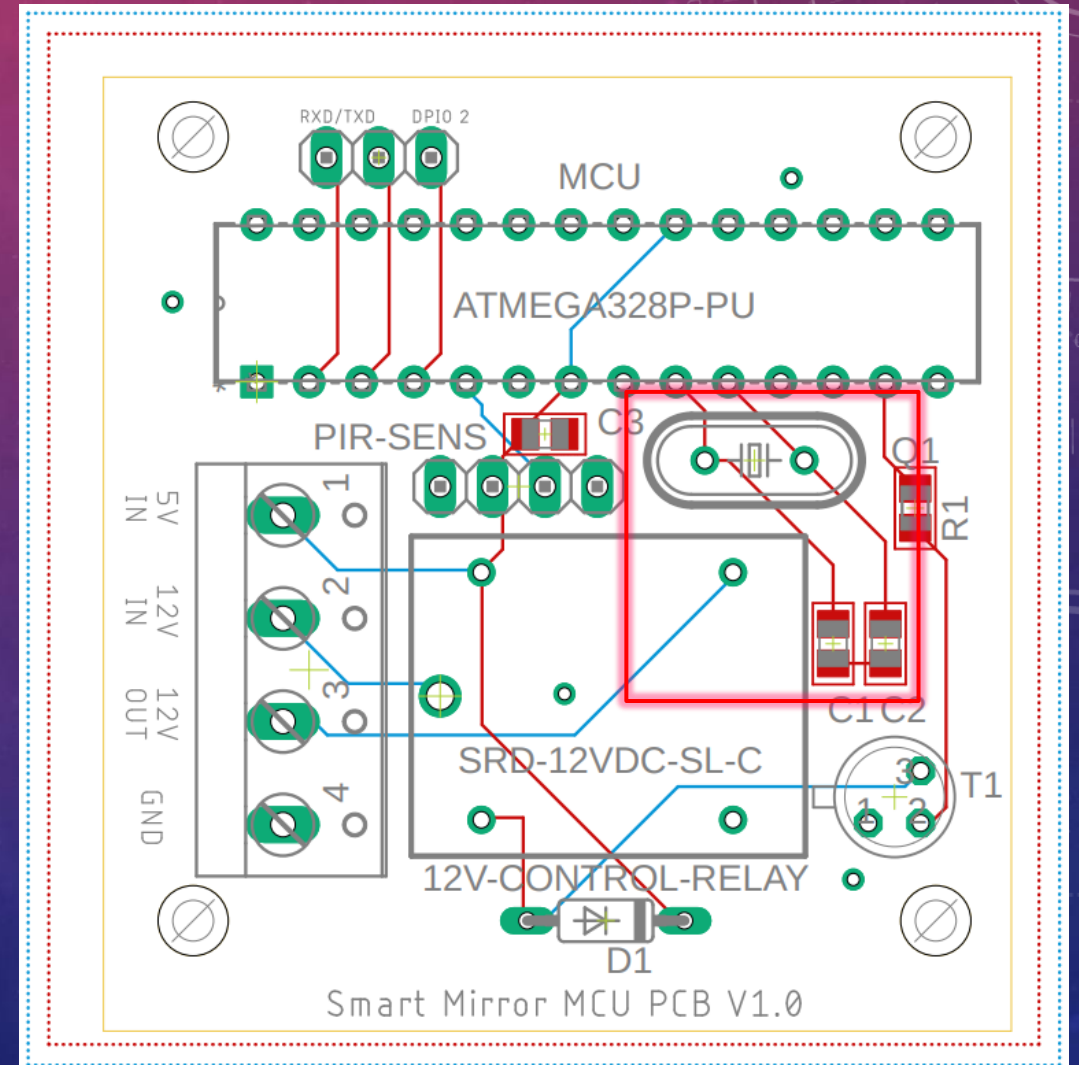
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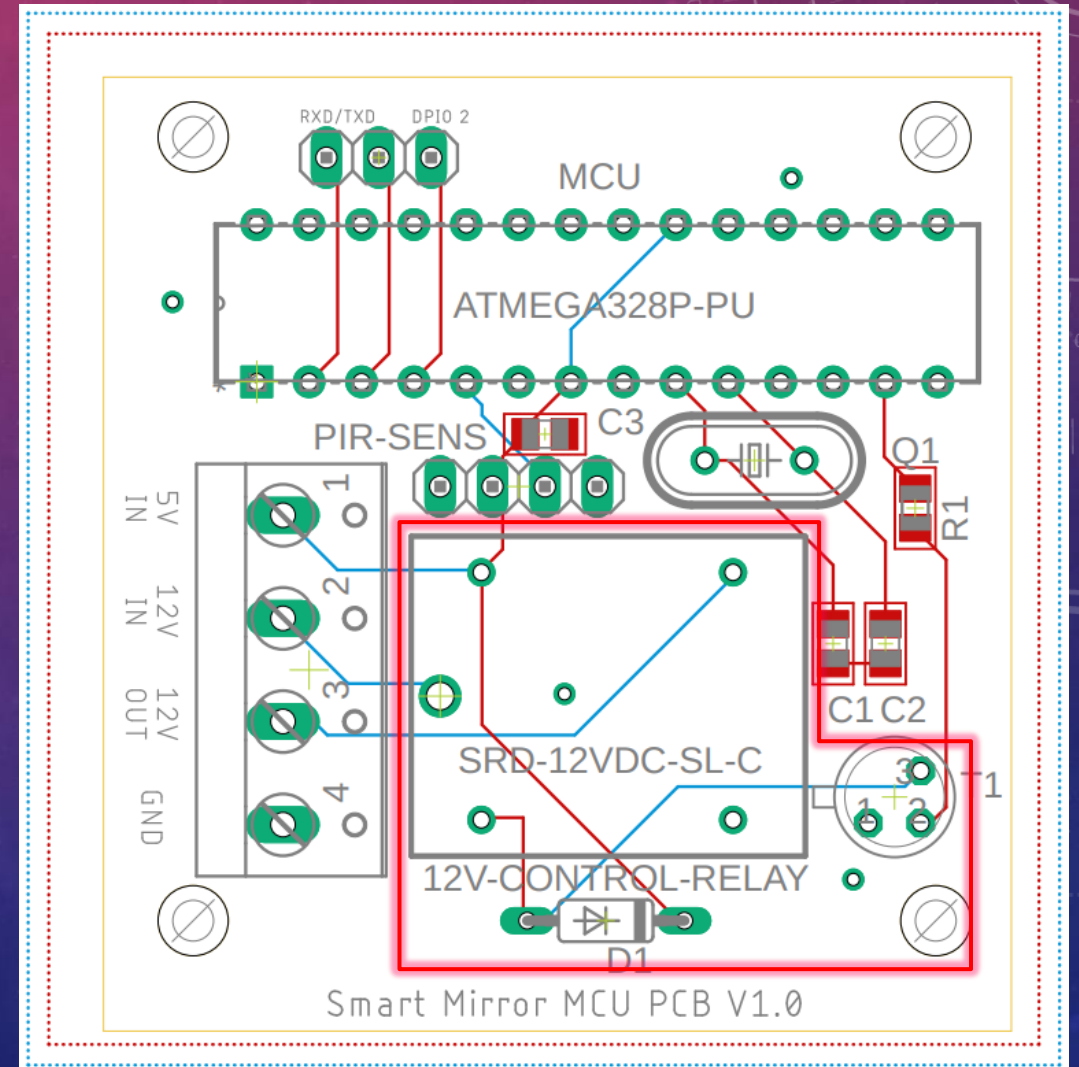
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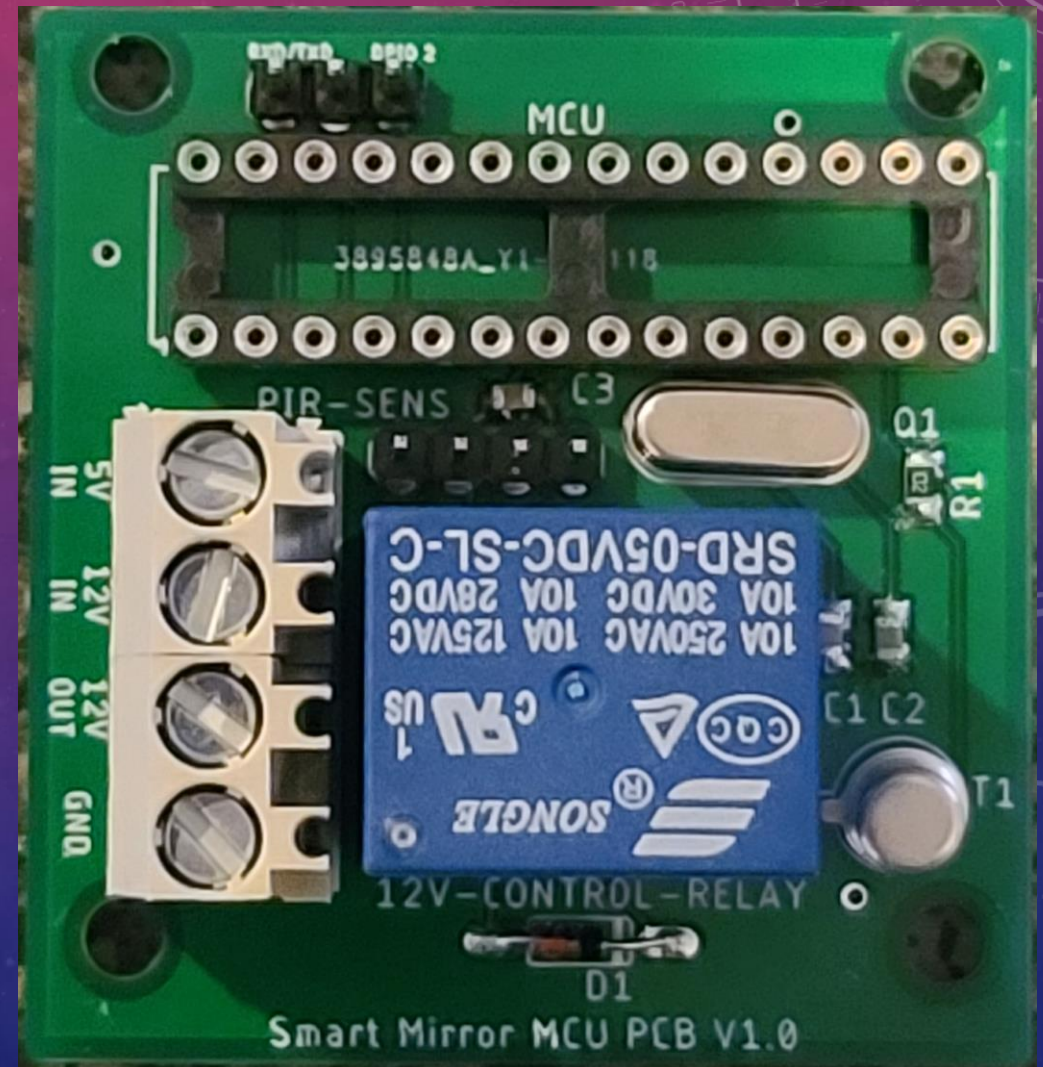
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# MICRO-CONTROLLER PCB DESIGN

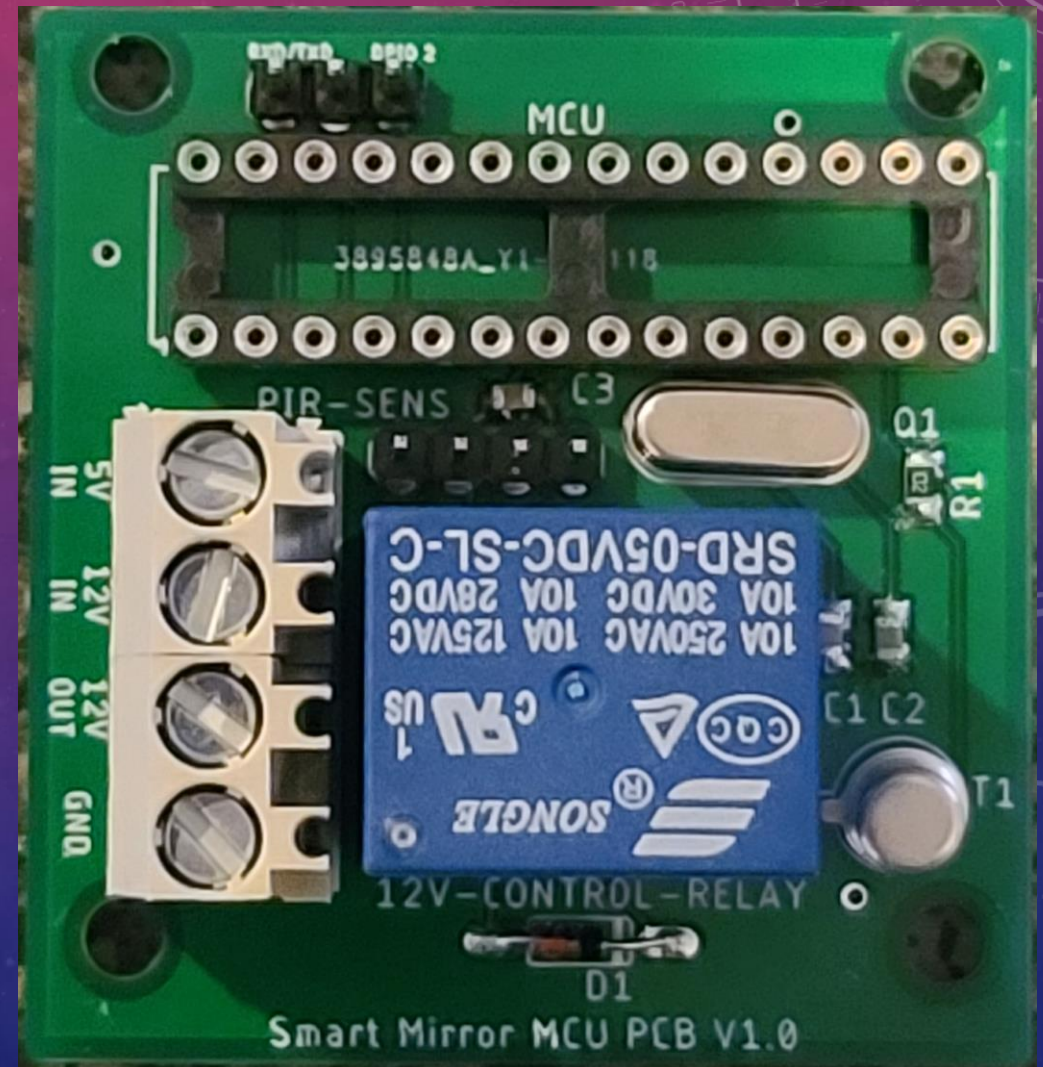
- 4 Terminal connection for power input and output
- 4-Pin header for presence sensor
- 3-Pin header for UART and MCU pin
- External 16MHz crystal
- Transistor and diode for relay control to protect MCU



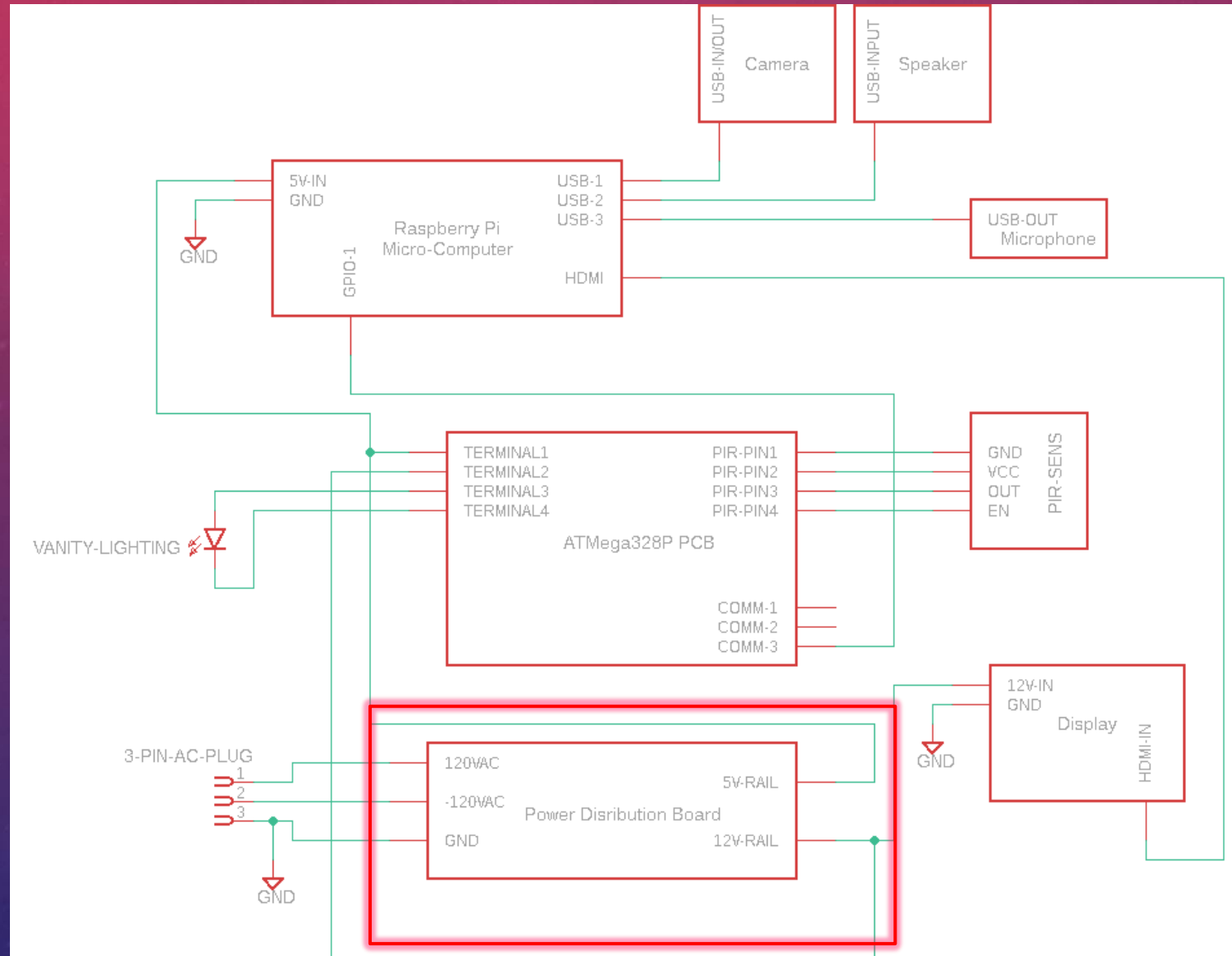


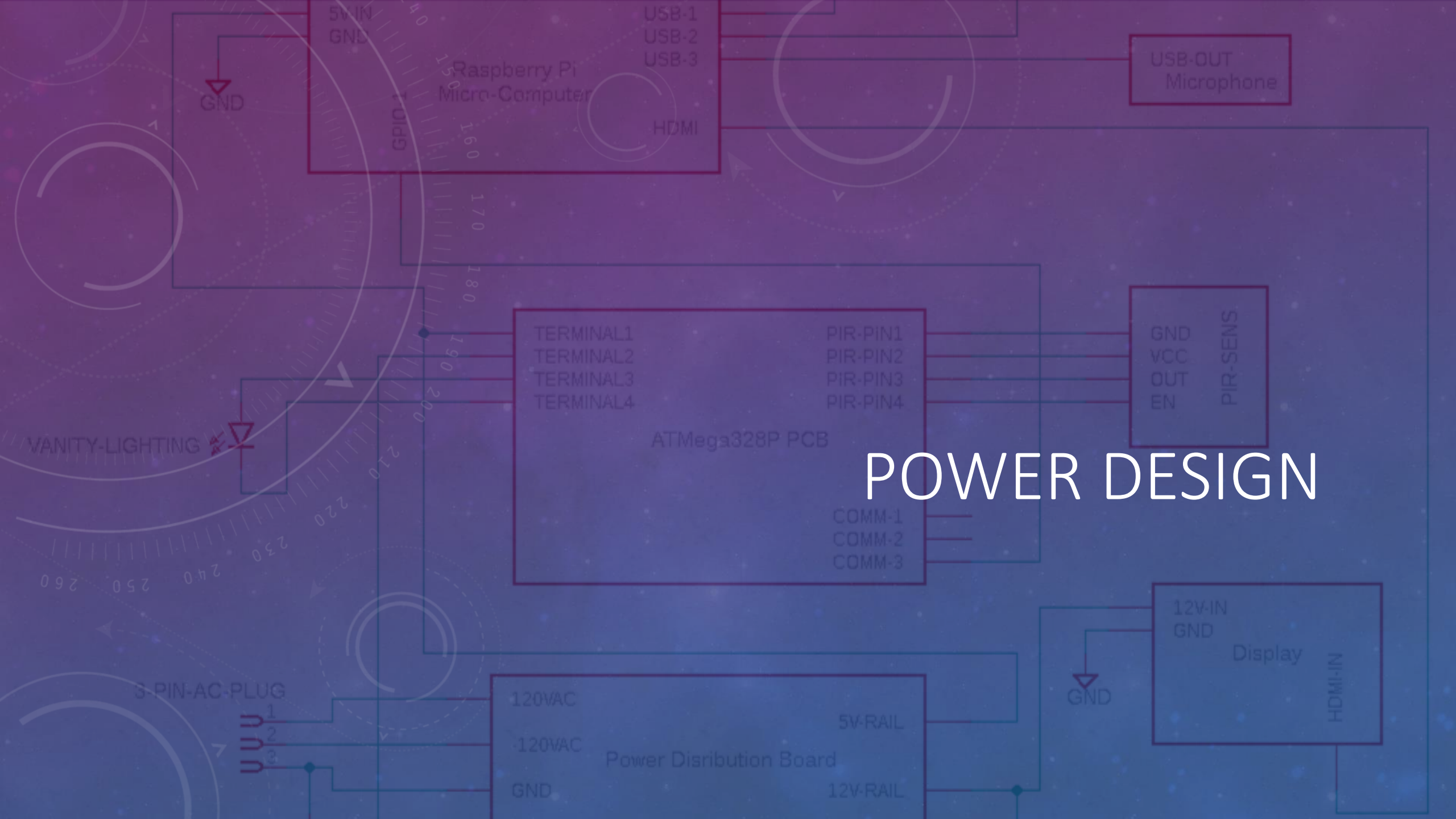
# MICRO-CONTROLLER PCB DESIGN

- Final design includes DIP-28 connector so ATmega328P is removable
- Final size is almost half the size of the Arduino development board
- All non-essential elements removed from development board for efficiency
- Essential things like external clock and decoupling capacitor included in new design



# MODULE CONNECTION SCHEMATIC





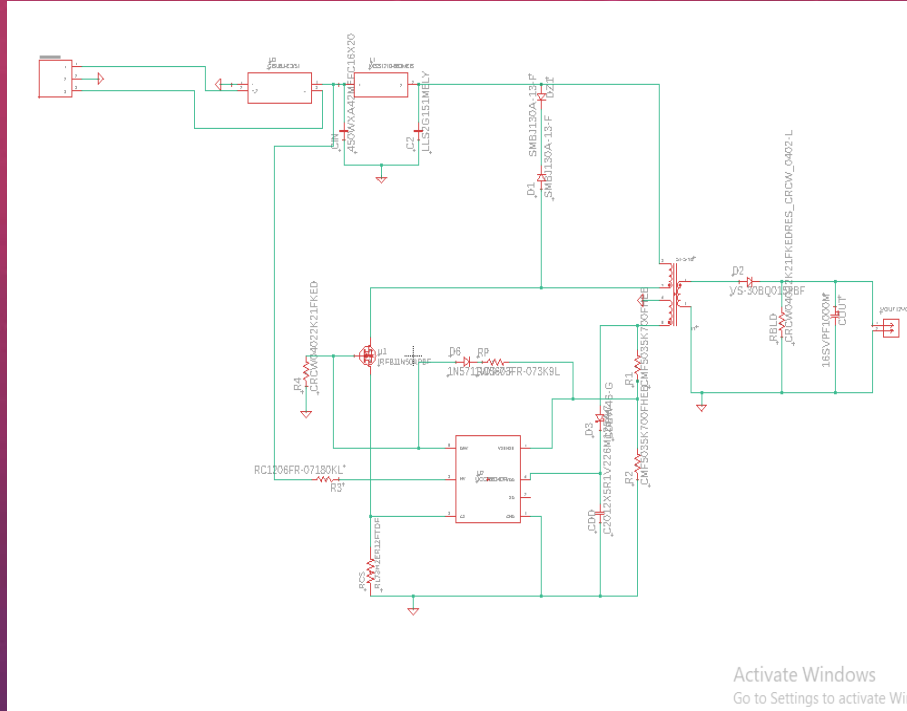
# POWER DESIGN



# POWER CONSUMPTION

Device	Voltage (volts)	Current Amps	Power Max Watts
Raspberry Pi 4 Model B	5	3	15
ATMega328P	2.7 to 5.5	2mA	0.011
Monitor	12	2.5-3A	36
Led Lights	12	3	36
Total Power			87.011

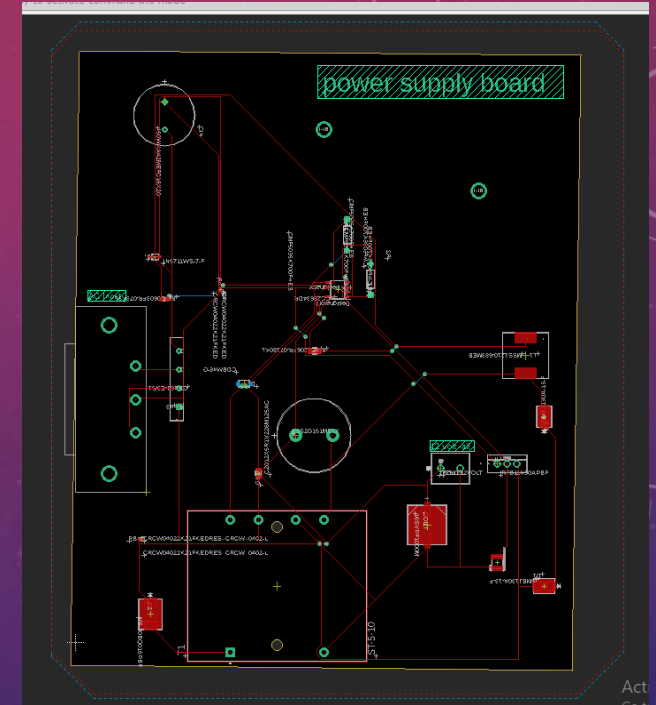
# POWER SUPPLY



UCC2863x, High-Power Flyback Controller

- The primary is isolated from the output.
- Capable of supplying multiple output voltages, all isolated from the primary.
- Ability to regulate the multiple output voltages with a single control.

dd text



- Overbudget at \$70-\$80
- 20 items on board some were back ordered

# POWER SUPPLY

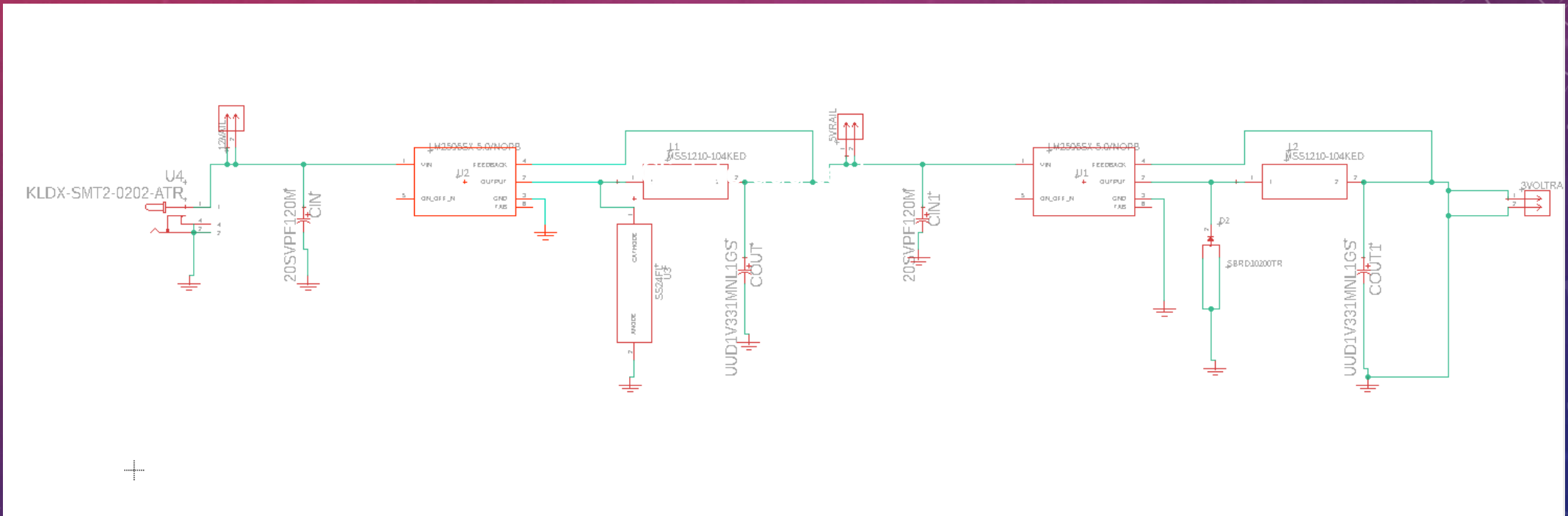


input: AC 100 - 240V, 50 / 60Hz ; Output: DC 12V, Max 10A, 120W ; Output DC tip size is 5.5mm x 2.5mm, compatible with 5.5mm x 2.1mm.

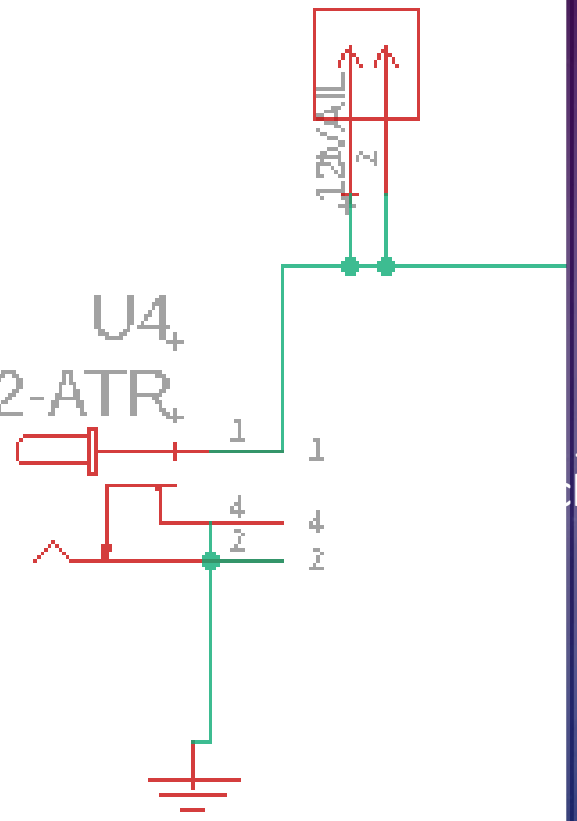
- Certified by FCC CE ROHS. No noise, low temperature operation stable output. Automatic overload cut-off, over voltage cut-off, automatic thermal cut-off, short circuit protection.



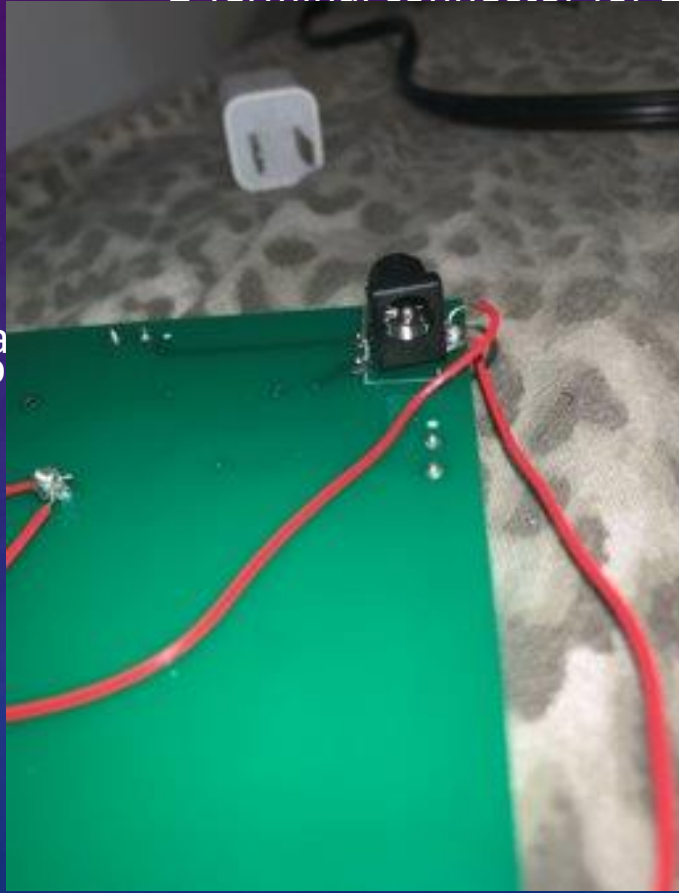
# POWER DISTRIBUTION PCB SCHEMATIC



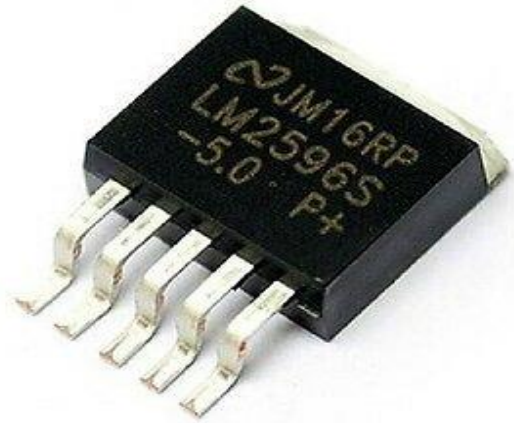
U4  
KLDX-SMT2-0202-ATR



- Power Barrel Connector jack
- 2 Terminal connector for 12 volt output



to a  
ck to



# VOLTAGE REGULATOR

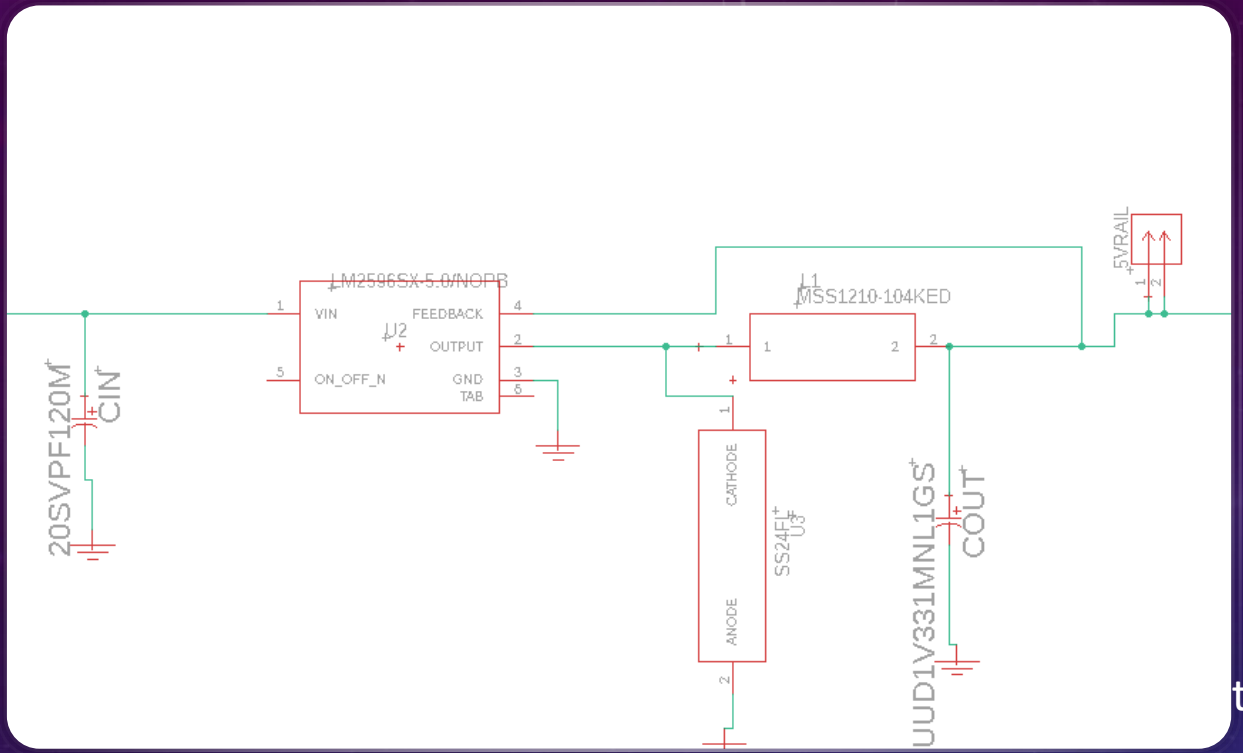
a step-down (buck)  
switching regulator

80% efficiency  
Thermal shutdown and  
current-limit protection

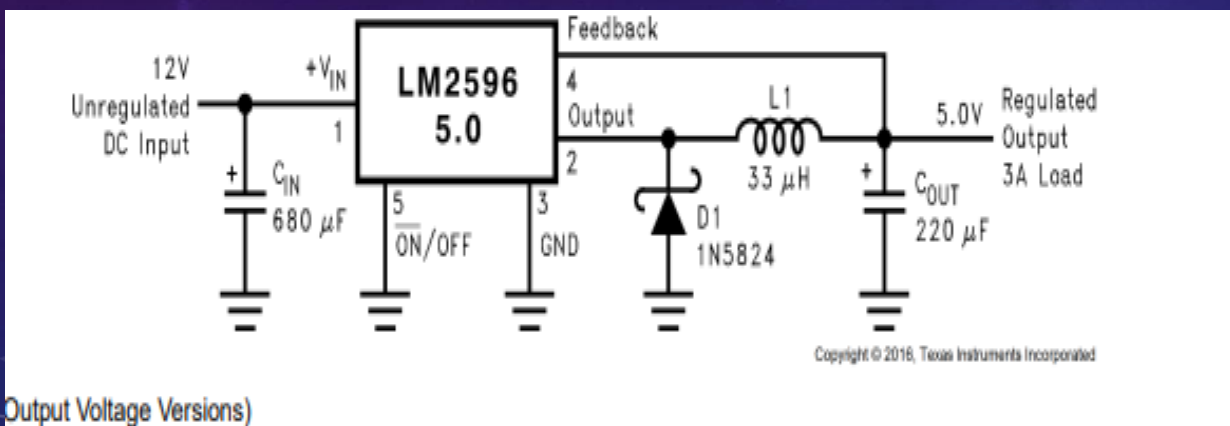
- Low heat generation

<b>series</b>	LM2596
Manufacturer	TI
Input Voltage	40V
Output Voltage	5volt
Output Current	3amps
frequency	150-kHz Fixed- frequency internal oscillator
Price	\$6.99





- LM2596S 5 volt Voltage regulator output
- Designed using the Data sheet
- 2 Terminal connector for 5 volt output

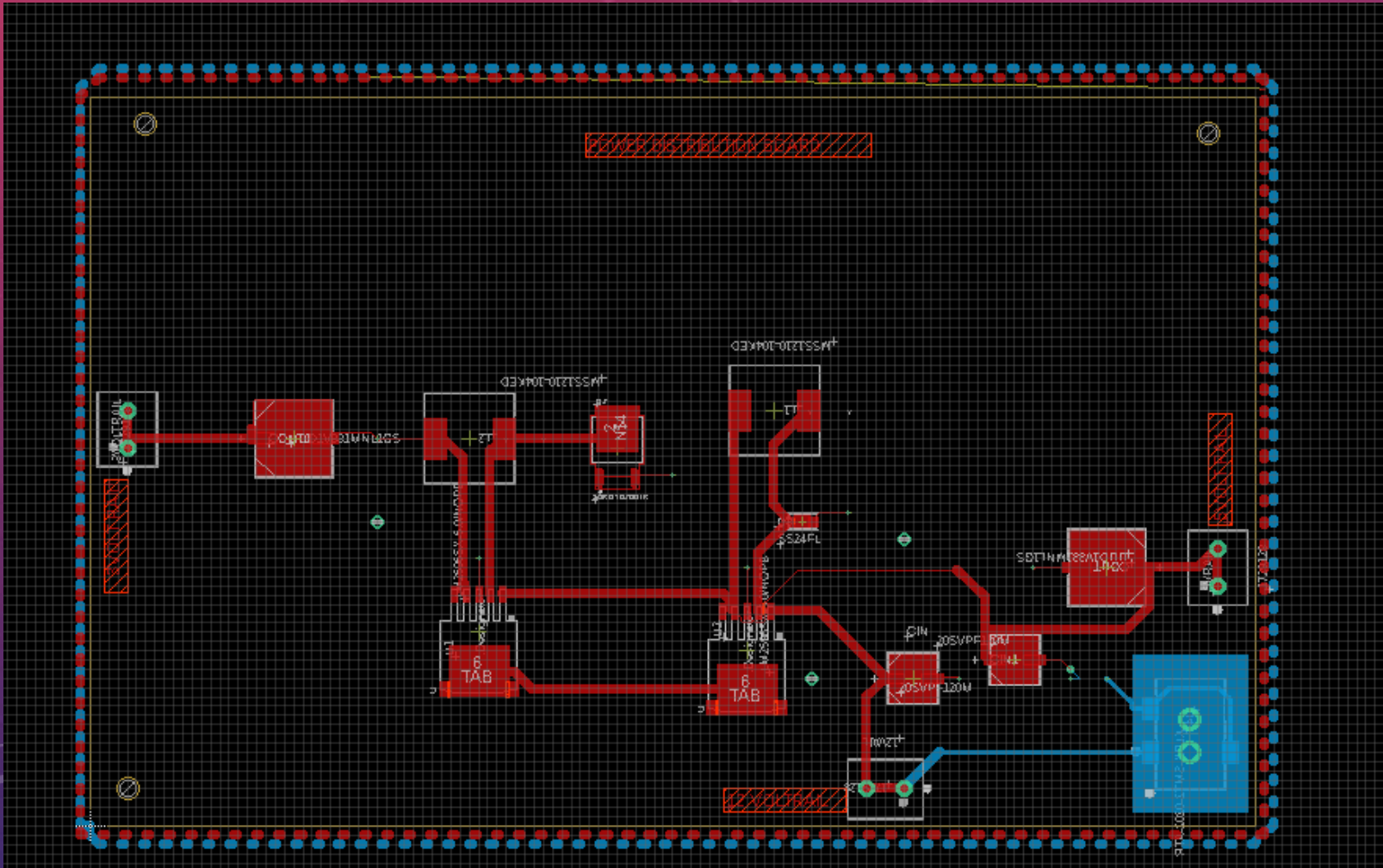


Output Voltage Versions)

$$V_{OUT} < V_{IN} \quad V_{OUT} = D * V_{IN}$$

•the switch is controlled by a pulse width modulator, the switch remaining on of longer as more current is drawn by the load and the voltage tends to drop and often there is a fixed frequency oscillator to drive the switching.

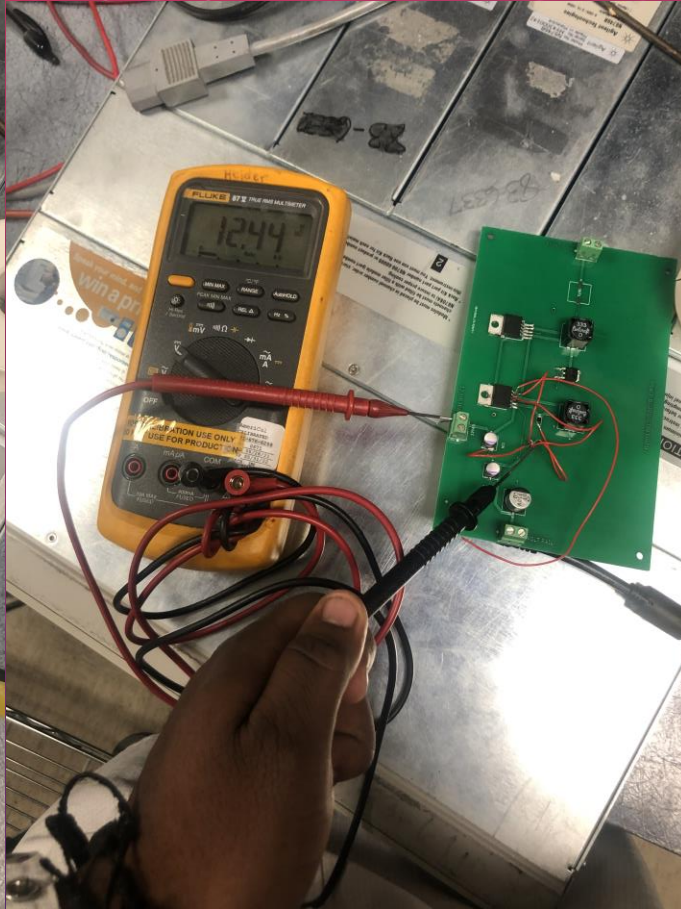
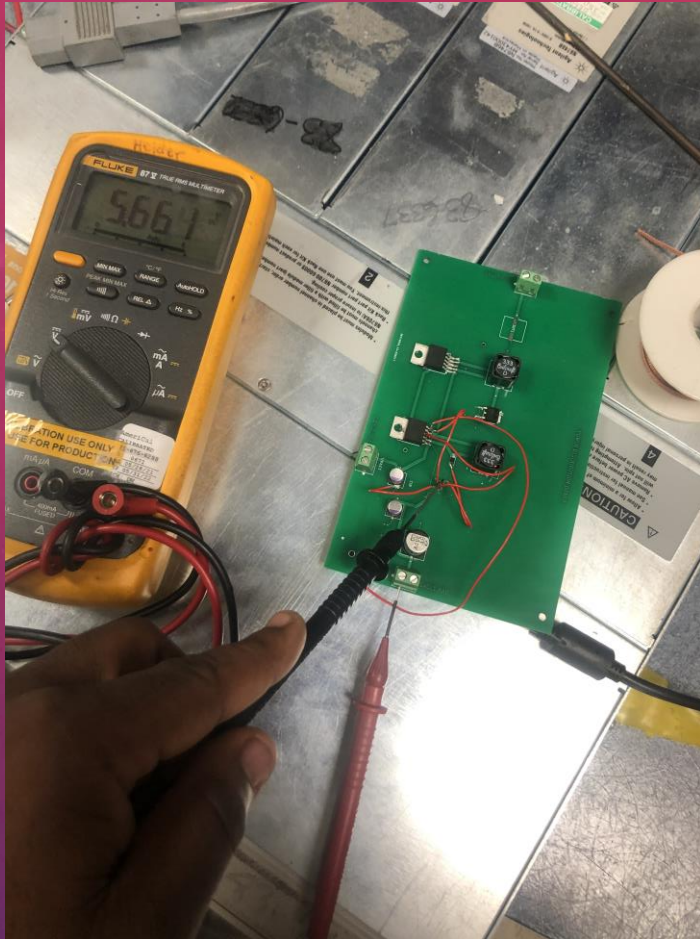
# POWER DISTRIBUTION PCB DESIGN



1.27MM Trace width for high 3 amp current flow



## Testing



$12.44/5.6 = .45$   
Duty cycle=45%

16 AWG to MCU  
USB C to PI  
Barrel connector to  
display







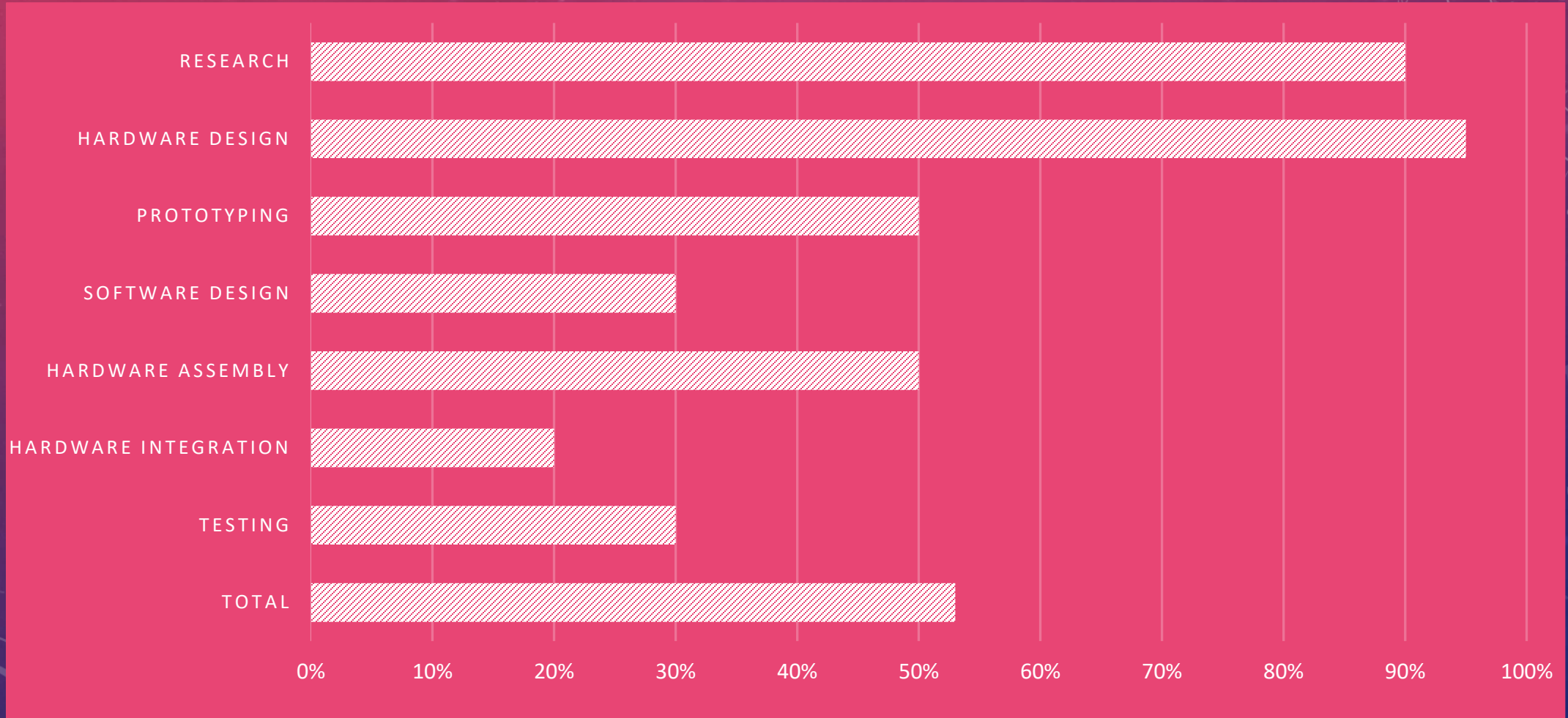
# ADMINISTRATIVE CONTENT



# BUDGET

Item	Cost
MCU PCB/ Components	\$50
Micro Computer	\$62
Display	\$100
Camera	\$30
SD Card	\$9
PIR Sensor	\$13
LED Lighting	\$13
2-Way Acrylic	\$25
Wood Stain	\$10
AC/DC Converter	\$20
Power Distro PCB/ Components	\$50
Speakers	\$20
Frame Wood	\$30
<b>Total:</b>	<b>\$432</b>

# PROGRESS





# WORK ASSIGNMENTS

	Tyler Newman	Axel Ortega	Jonathan Martin	Jacob Williams-Moore
MCU Software	P	S		S
MCU Circuit/PCB Design	P		S	
Raspberry Pi Software		P		P
Power Distro Circuit/ PCB Design	S		P	
API Integration		P		P
Project Testing	P	P	P	P
Frame Design/ Construction	S		P	



# Q/A SECTION