Smart Mirror

Group 8 – Fall ’16 / Spring ‘17
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Project Introduction

- The Smart Mirror is a mirror which displays information to the user such as:
  - Time, Weather, Social Media, News Feed, etc.
- Improves upon a popular DIY project
- Incorporates computer vision technologies

Motivations

- Create a device the team would be excited to use
- Interest in computer vision technologies
- Develop skills in schematic and PCB design
- Develop skills in software architecture design and computer vision

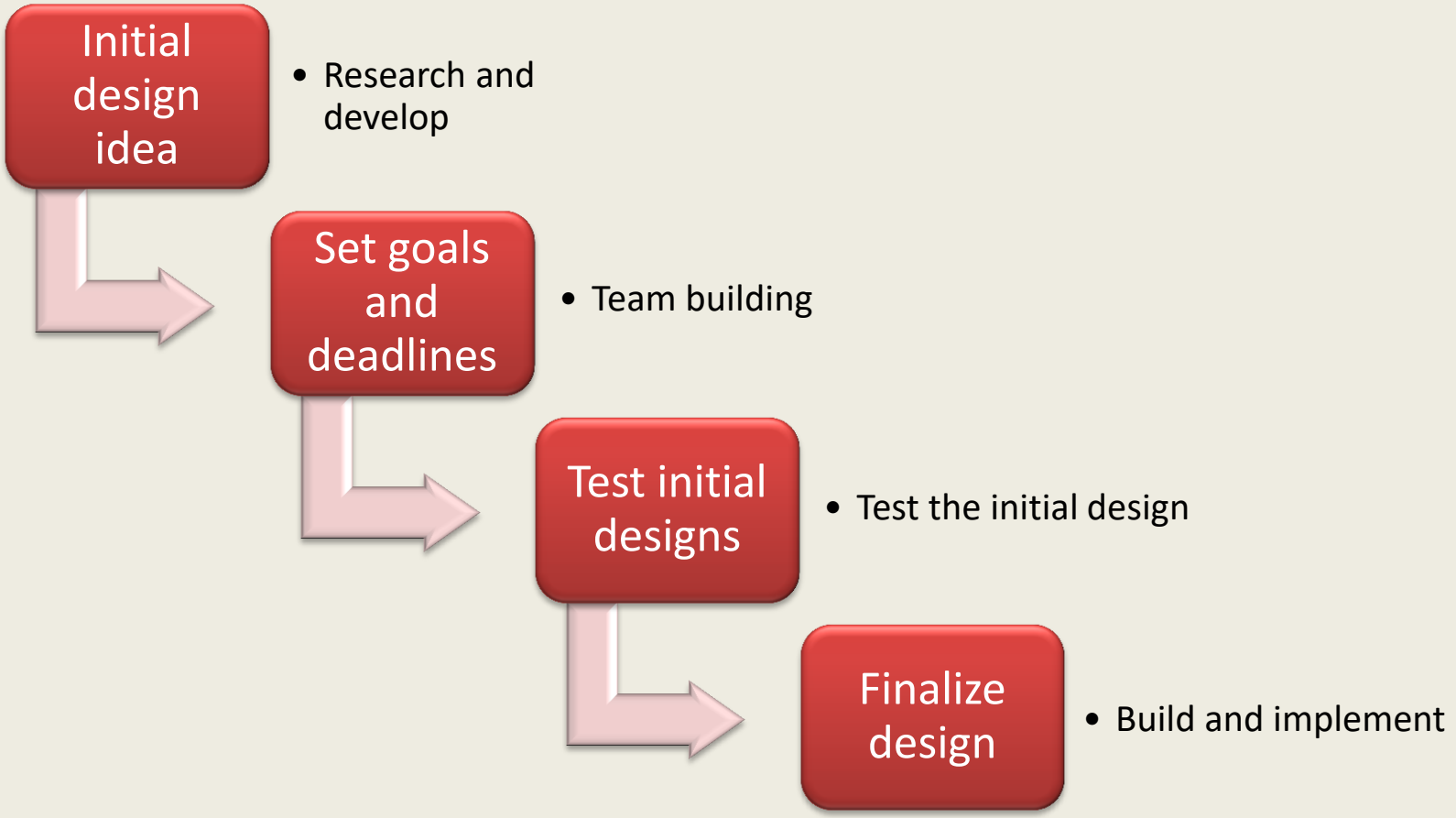
Goals and Objectives

- Design a mirror to provide information *relevant* to the user
- Implement facial recognition software to determine user, thus which info to display
- Create an *active* device rather than a *passive* one
- A more user friendly UI system
- Be as power efficient as possible

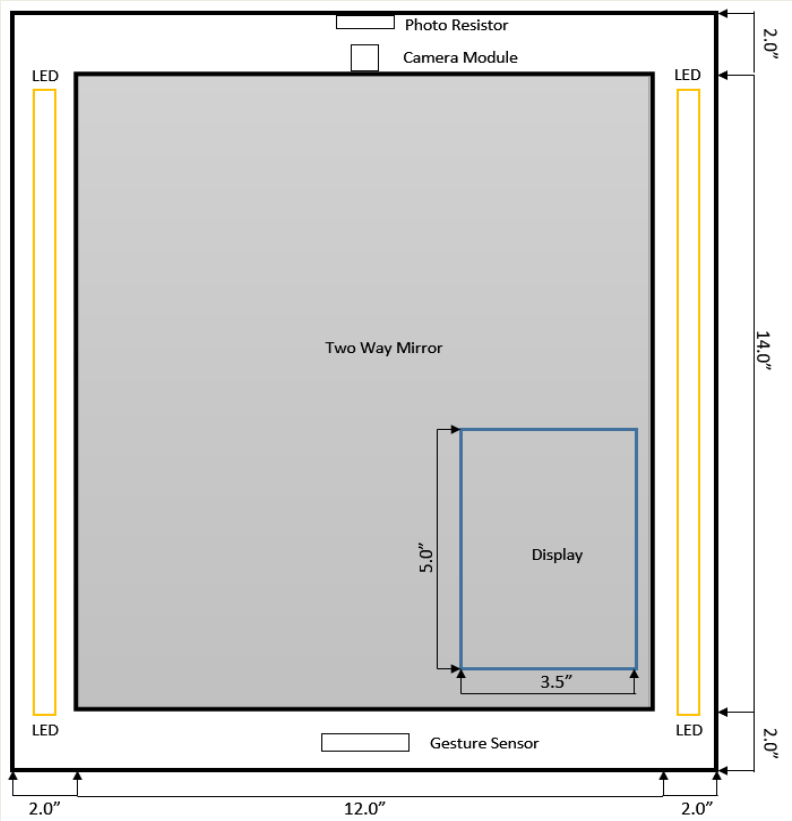
Project Specifications

Component	Parameter	Specification
Mirror	Weight	10 lbs. max
Information Modules	Amount	8
Power Supply	Input Voltage	12 Vdc
Facial Recognition	Recognize Time	5 seconds

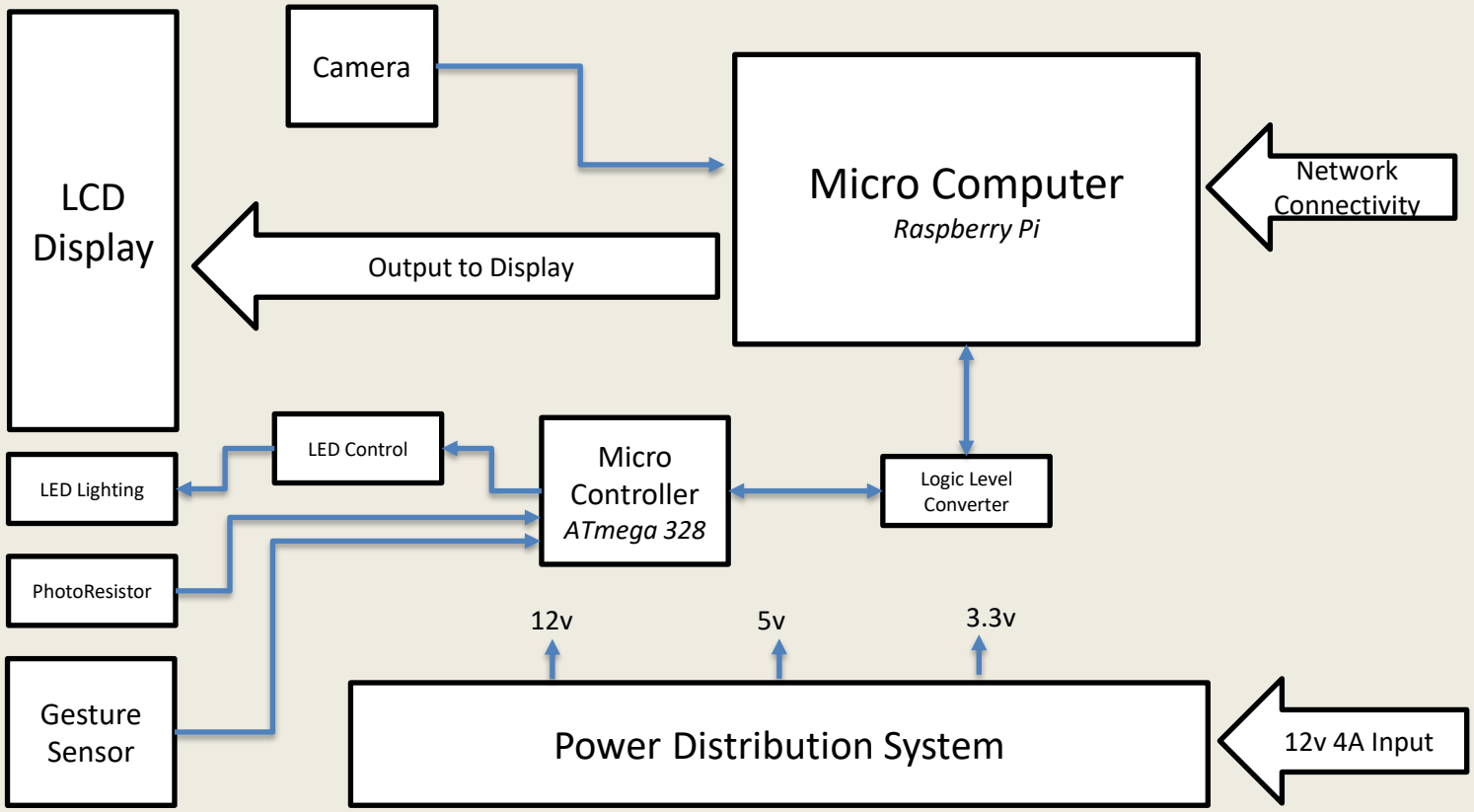
Project Design Approach



Physical Layout



Block Diagram



Power System

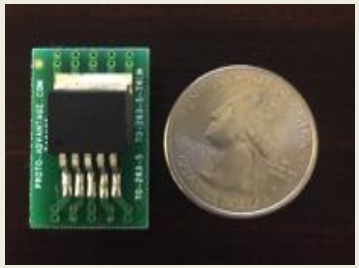
- Powered from AC power socket
  - Use an AC/DC wall plug converter for 12V input
- Needs to provide 3 rails: 12V, 5V, 3.3V
  - 12V: LED Strips
  - 5V: ATMega328, Raspberry Pi, Gesture Sensor, LLC
  - 3.3V: LLC Circuit for communication
- Efficient power usage

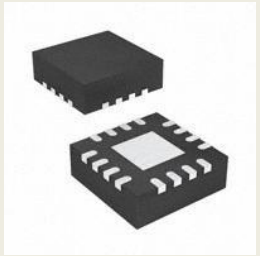
Switching vs Linear Regulator

- 5V rail is the most demanding, most components need 5V
- Linear regulator would cause upwards of 14W of power
- Switching Regulator is a more efficient solution

Regulator Selection

Parameter	LM2596 (Switching)	TPS6213 (Switching)	L78S05 (Linear)
Vin	4.5V-40V	3V-17V	10V-35V
Iout	3A	3A	2A
Efficency	80%	82%	42%
Supporting Circuit Complexity	Medium	High	Low
Cost	$4.91	$2.51	$0.68
Size	14mmx10mm	3.1mmx3.1mm	10mmx29mm

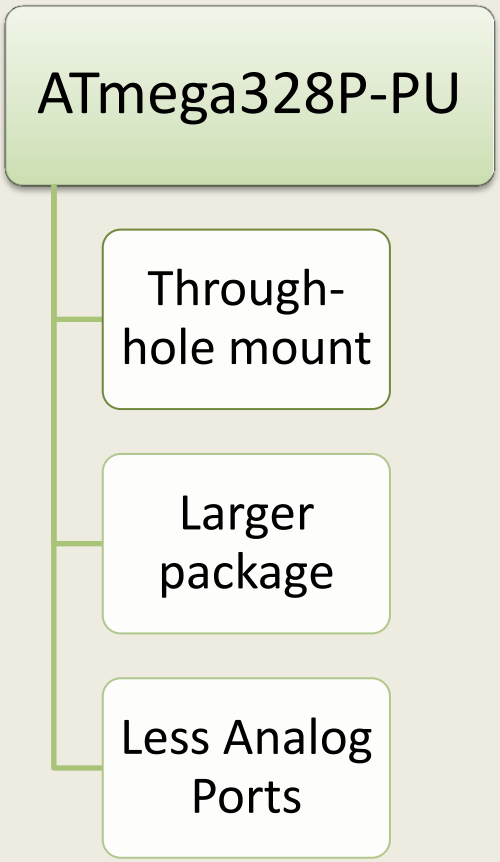




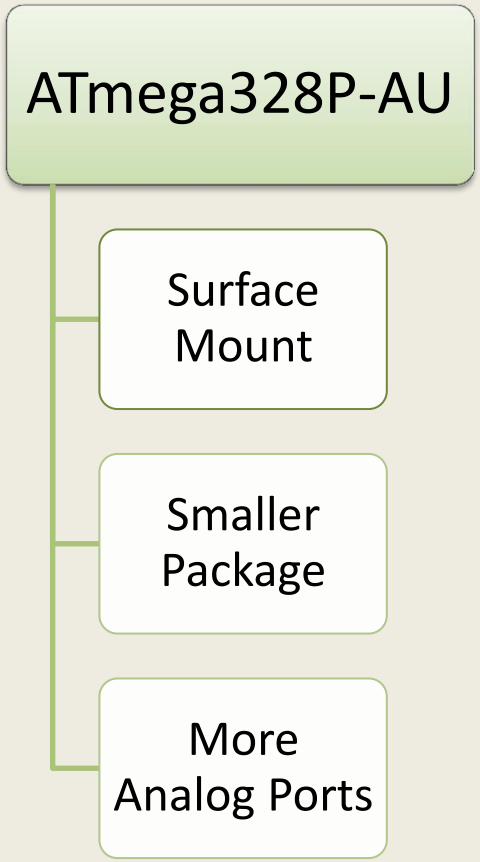
3.3V Regulator

- 3.3V rail only used for LLC circuit, very low current draw and voltage difference
- Chose the MCP1700T Linear Regulator
- Smaller, cheaper, easier to
- Size: 3mmx2.5mm

Design Considerations



- Microcontroller choice:
  - Atmega328P-PU
- Perfect use for this project due to its simplicity and low power usage
  - Microcontroller is used for led control and sensor input/output



LED Lighting

- LED Lighting
  - Enhances ambient lighting for facial recognition
  - Aesthetic purposes
- Power Saving
  - One of the most efficient options
  - Next closest had 300 lumens/m

	Adafruit DotStar Digital LED Strip	Standard Density LED Flex Strips	Cool White LED Flexi-Strip
Color:	RGB	White	White
Brightness:	~419 Lumens	~300 Lumens	~600 Lumens
Max Current Draw	~60mA (per RGB LED)	~20mA (per RGB LED)	~20mA (per RGB LED)

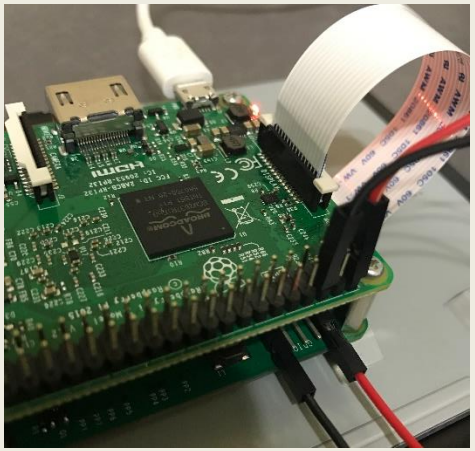
Microcomputer

- Raspberry Pi Model 3B
  - Powerful processor for facial recognition
- Display
  - Interfaces and powers display seamlessly

	TI Beaglebone Black	Raspberry Pi Model 2	Raspberry Pi Model 3B
Price:	$60.00	$35.00	$35.00
Processor:	AM3358 ARM Cortex A8 @ 1GHz	ARM Cortex-A7 @ 900MHz	LPDDR2 ARM Cortex A53 @ 1.2 GHz
GPIO Pins:	46	40	40

Display

- 7 inch LCD display unit
  - Compatible with the Raspberry Pi 3 Model B
- The Smart Mirror *shall* be powered via a single cord
- Interfaces seamlessly with existing components chosen
- Also helps minimize the overall weight of the system



	7” inch display for Raspberry Pi3	Secondhand Computer Monitor	13.3 inch widescreen HDTV
Cost:	$68.99	>$30	>$100
Size:	7-inch	Varies	13.3 inch
Power Source:	Raspberry Pi	External	External

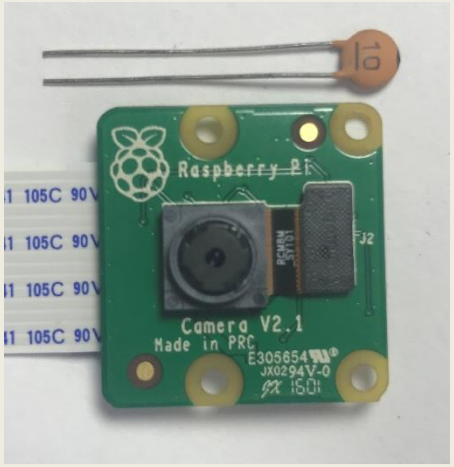
Presence Sensor Selection

- 5v Input
- Infrared Distance sensing
  - 1in to 2ft
- Gesture Sensing
  - Left, Right, Up
- I2C serial
  - Refresh rate every 20ms
  - Interrupts

	Ultrasonic Sensor HC-SR04	Passive IR Motion Sensor	ZX Distance Gesture Sensor
Price:	$15.00	$10.00	$25.00
Range:	13ft	20ft	2ft
Data:	Distance	True/False	Distance and Gestures

Camera Selection

- Used for face recognition
- Small footprint
- Adequate resolution



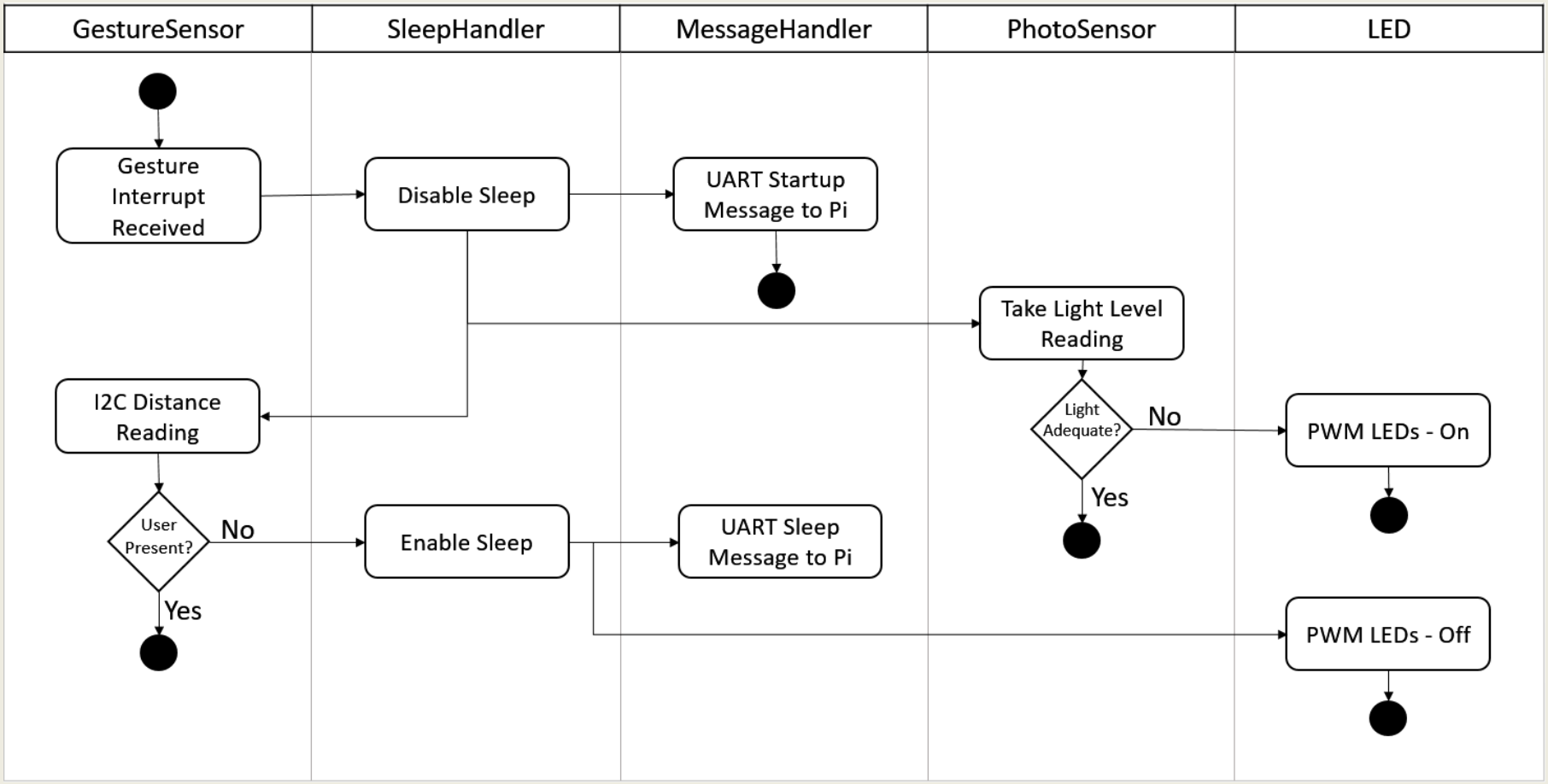
	C920 Webcam	HP2100 Webcam	Rpi Camera Module v2
Price:	$98.00	$30.00	$30.00
Resolution	15MP	8MP	8MP
Size:	7.5x2in	2.5x2.5in	25x25mm
Weight	450g	30g	3g

Load Sharing

- Sensor input
  - Gesture
  - Photoresistor
- LED Control
- Repeated polling

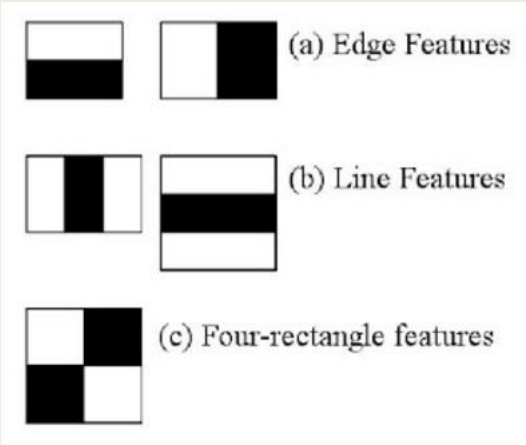
- Display
- Face Recognition
- Network Data

ATmega Activity Diagram



Face Recognition

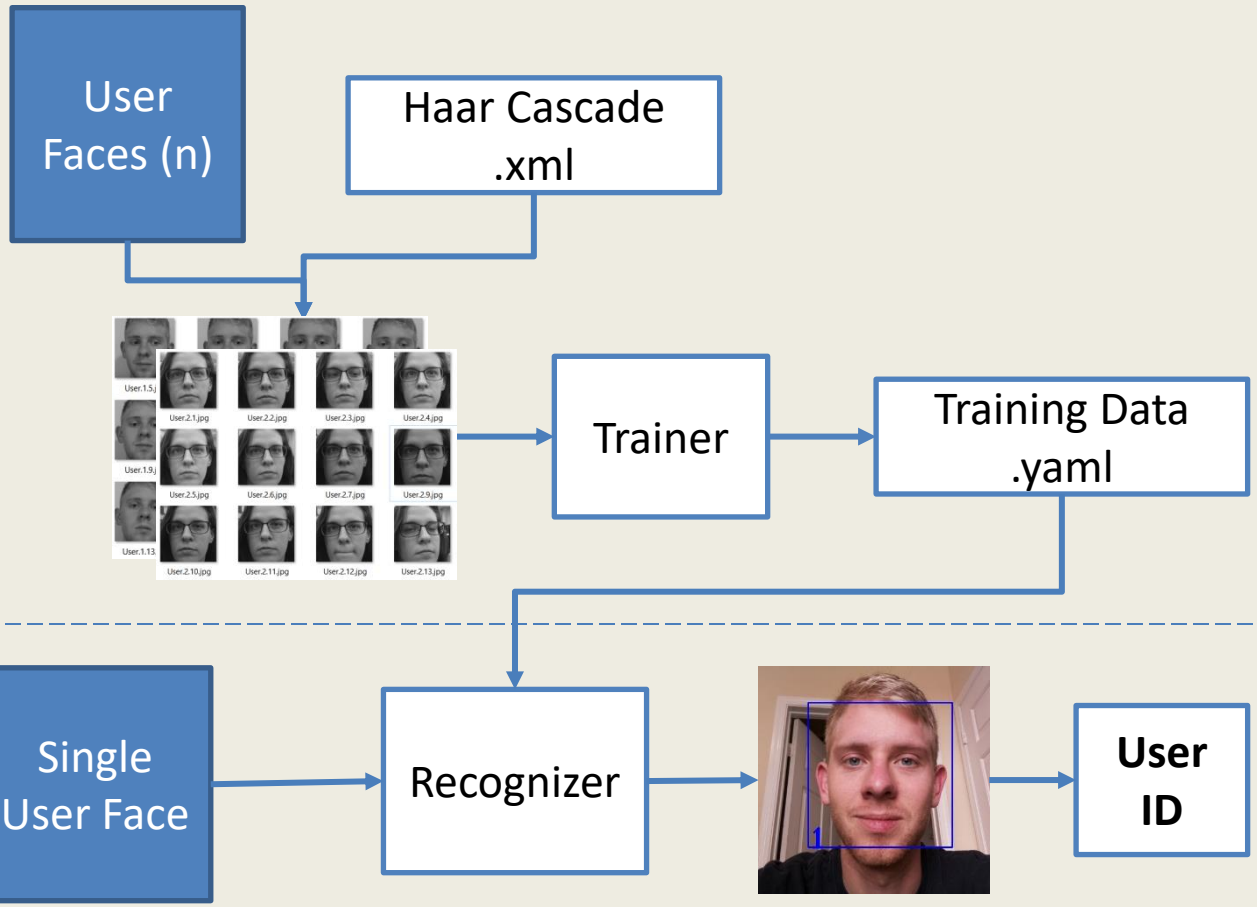
- Detect the current user
- OpenCV 2.4 and Python 2.7
- Three stage process
  - Detect
  - Train
  - Identify/Recognize



Face Recognition

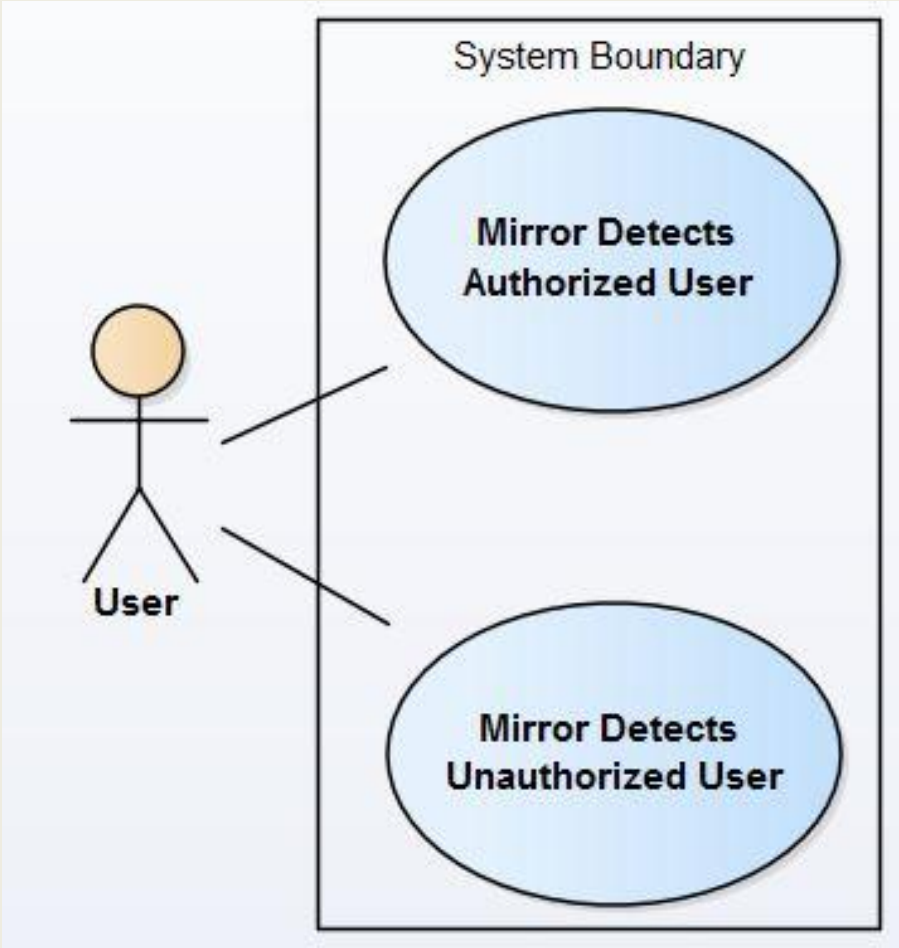
Single Execution Setup

Multiple Iteration Verification

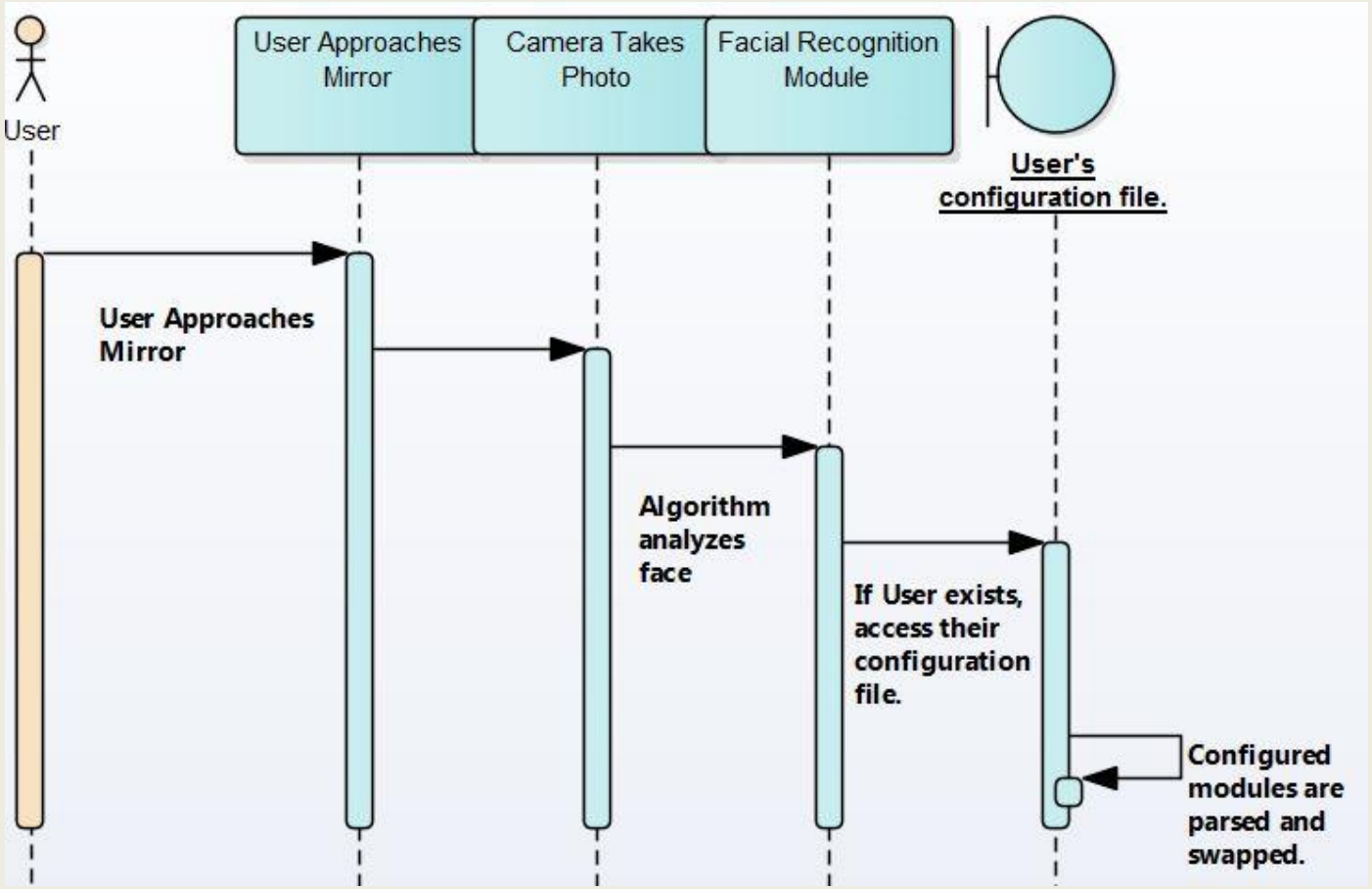


User Story

- As a user, I wish to view:
  - Time & Date
  - News/Social Feed
  - Calendar
  - Current Weather
  - Weather Forecast



Authorized User Use-Case



Node.Js

- Utilizes the V8 Javascript Engine
- Event-Driven Architecture
- Good for persistent connections
- Allows code to be shared between browser and back-end

Node Package Manager

- Easily shares Node.JS modules
- Node Package Manager handles nested dependencies
- Most commonly used with Node.JS runtime environment

Angular 2

- Open sourced front-end web application framework
- Angular2 was released in May 2016
  - Good for small scale applications
  - Utilizes Typescript
  - Allows for dynamic loading

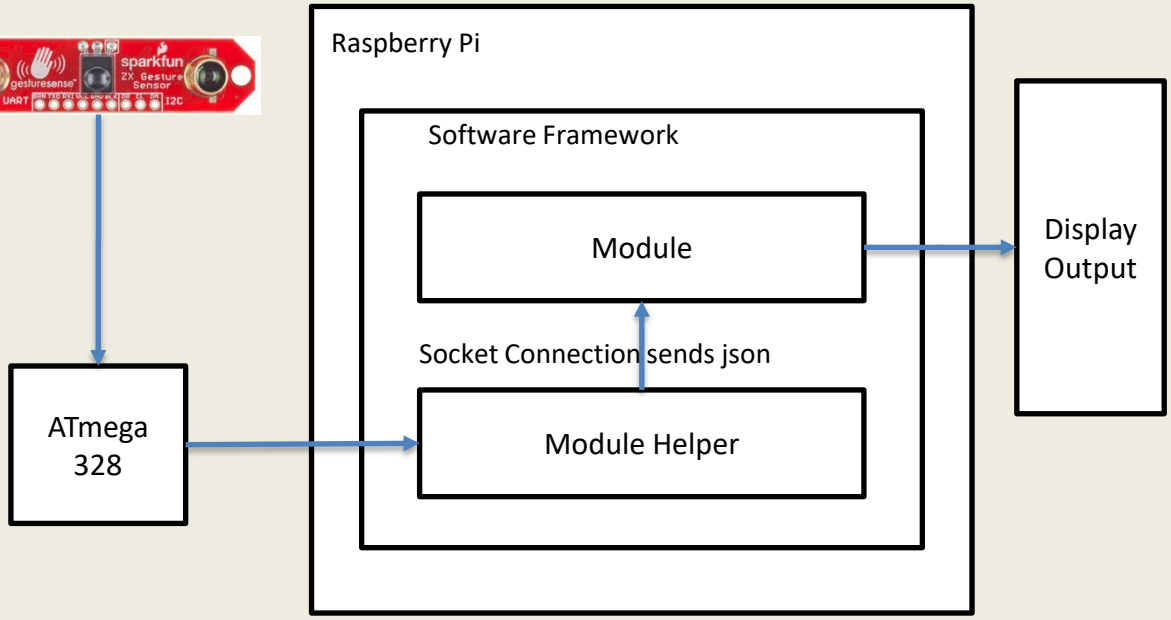
Module Swapping

- Provides a solution to user privacy
  - Swaps out modules that do not belong to the current user
- Allows user to have more control over what they view via gestures
- Saves space on the current 7 in. display
  - Swapping current modules available

News Feed/Twitter Feed

- Mirror shows headlines based on RSS feed
- Shows recent tweets
- User may be able to switch between headlines or tweets with gesture sensor capability

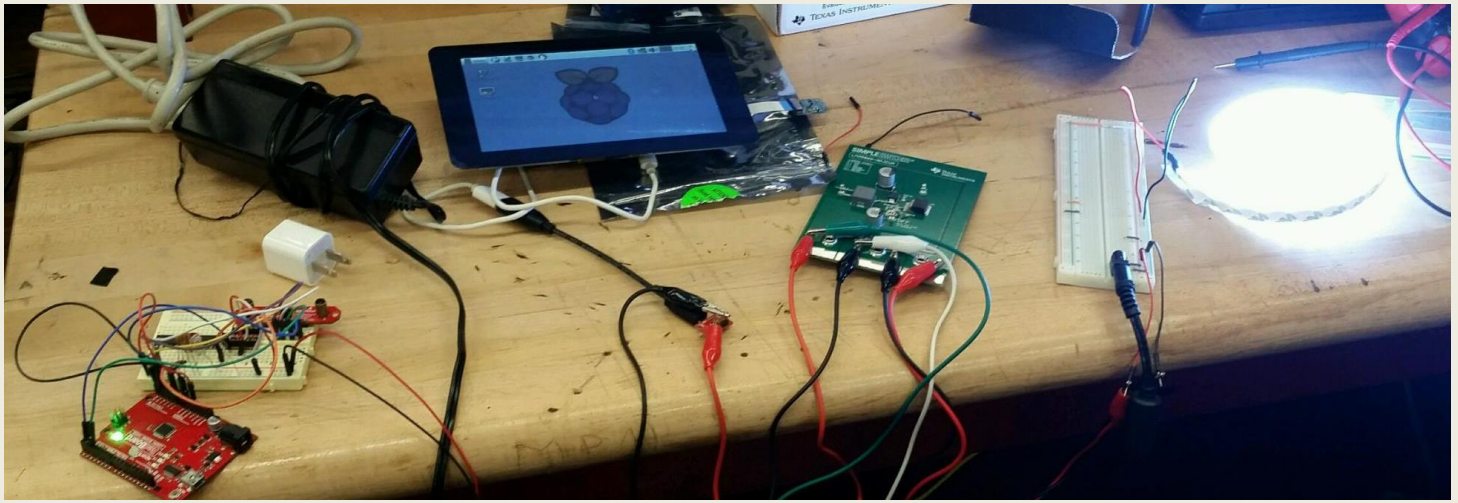
Message Datapath

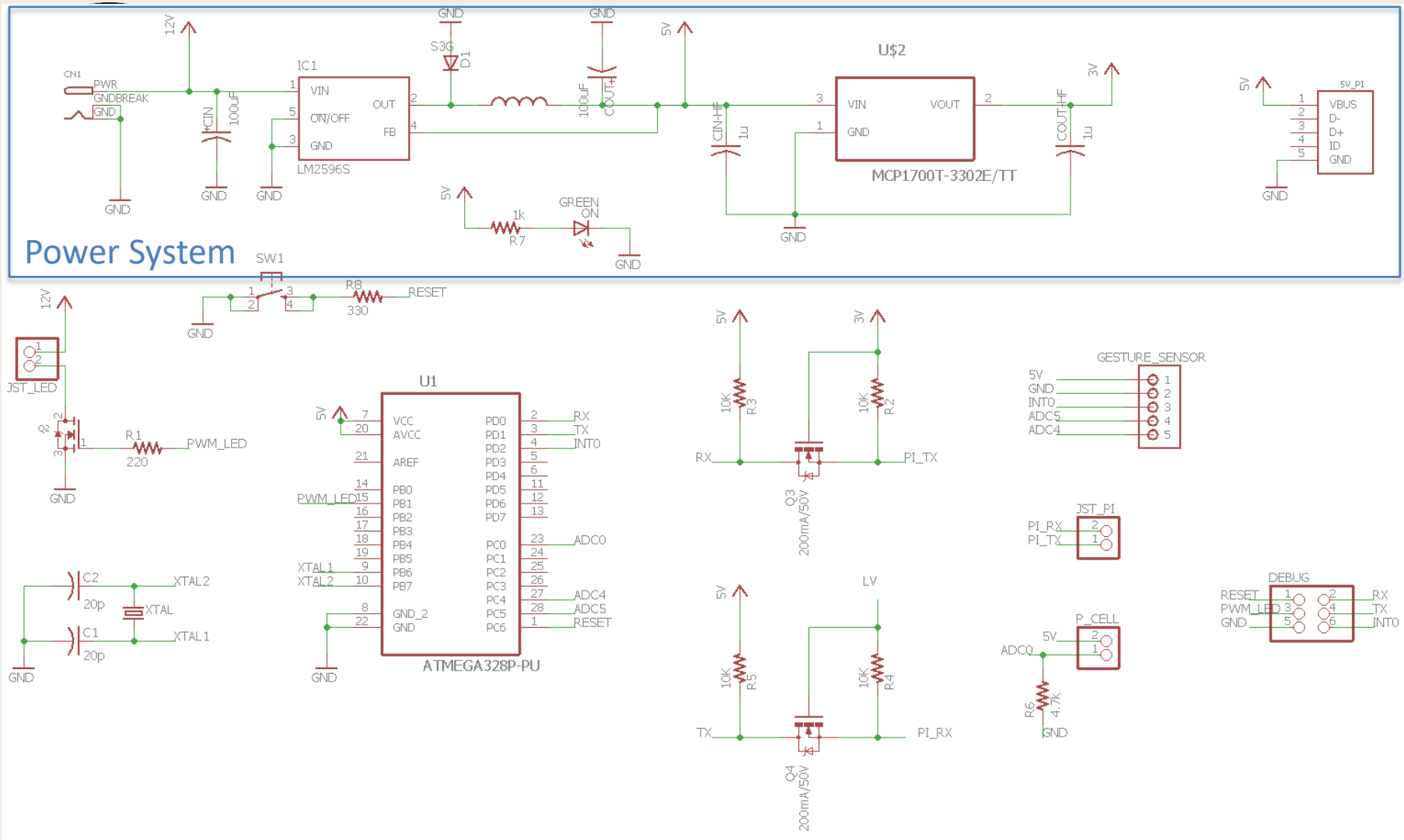


- The Module runs the logic
- The Helper runs data acquisition scripts
- Response Time
  0.5-1.0 sec
- Similar data path for camera

Breadboard Testing

- Tested to ensure each subsystem function separately first, then began combining them together
- Operate all subsystems at same time to ensure no power or communication issues

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S3G
D1
100uF
5V
U$2
VIN
VOUT
GND
MCP1700T-3302E/TT
3V
5V_PI
VBUS
D-
D+
ID
GND
CN1
PWR
GNDBREAK
IC1
VIN
ON/OFF
GND
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FB
LM2596S
CIN
COUT
CIN-HF
COUT-HF
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SW1
R8
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RESET
JST_LED
Q2
R1
220
PWM_LED
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XTAL
10K
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R2
Q3
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PI_RX
GESTURE_SENSOR
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ADC5
ADC4
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R5
R4
Q4
P_CELL
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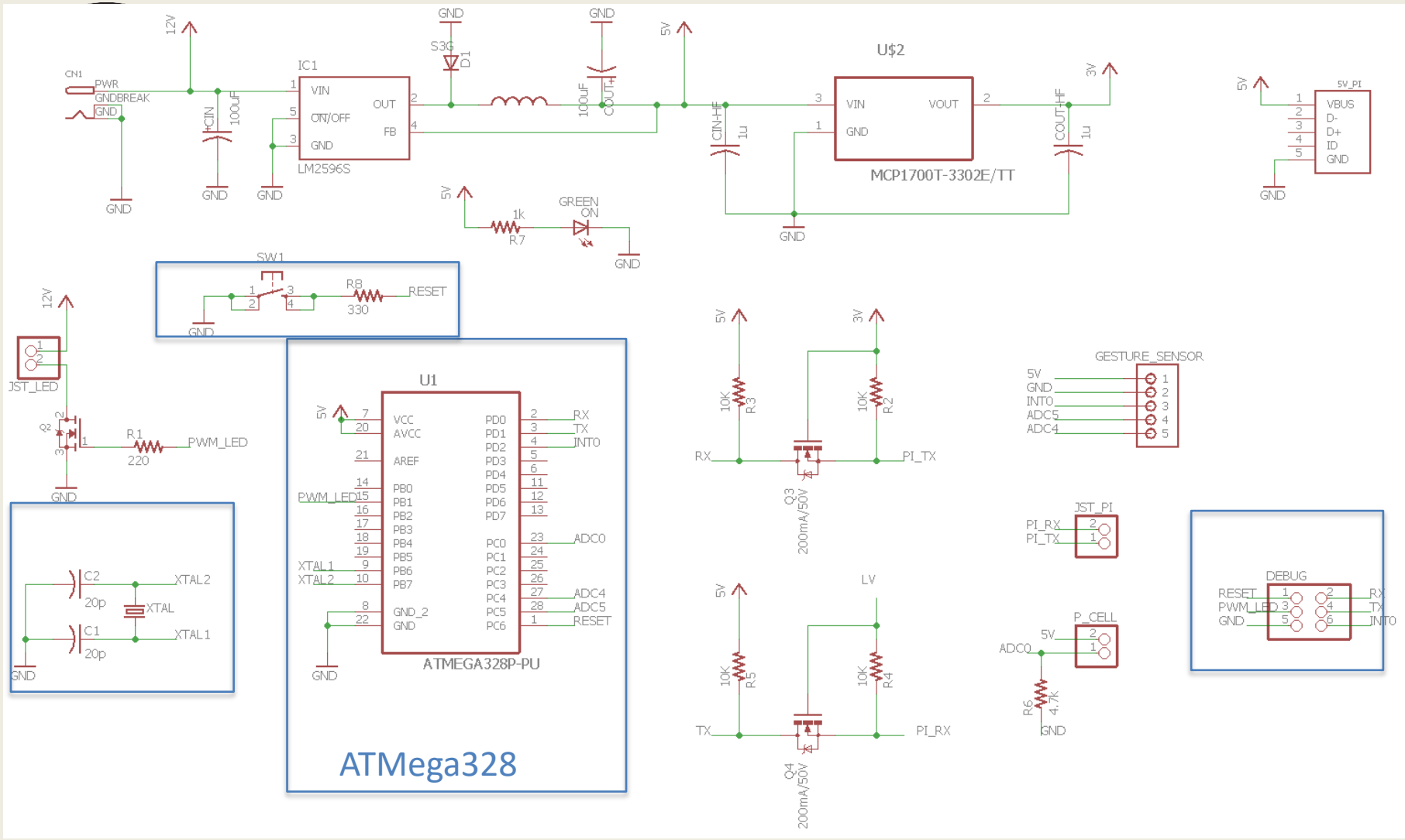
4.7k
DEBUG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200mA/50V
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PI_RX
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ADC4
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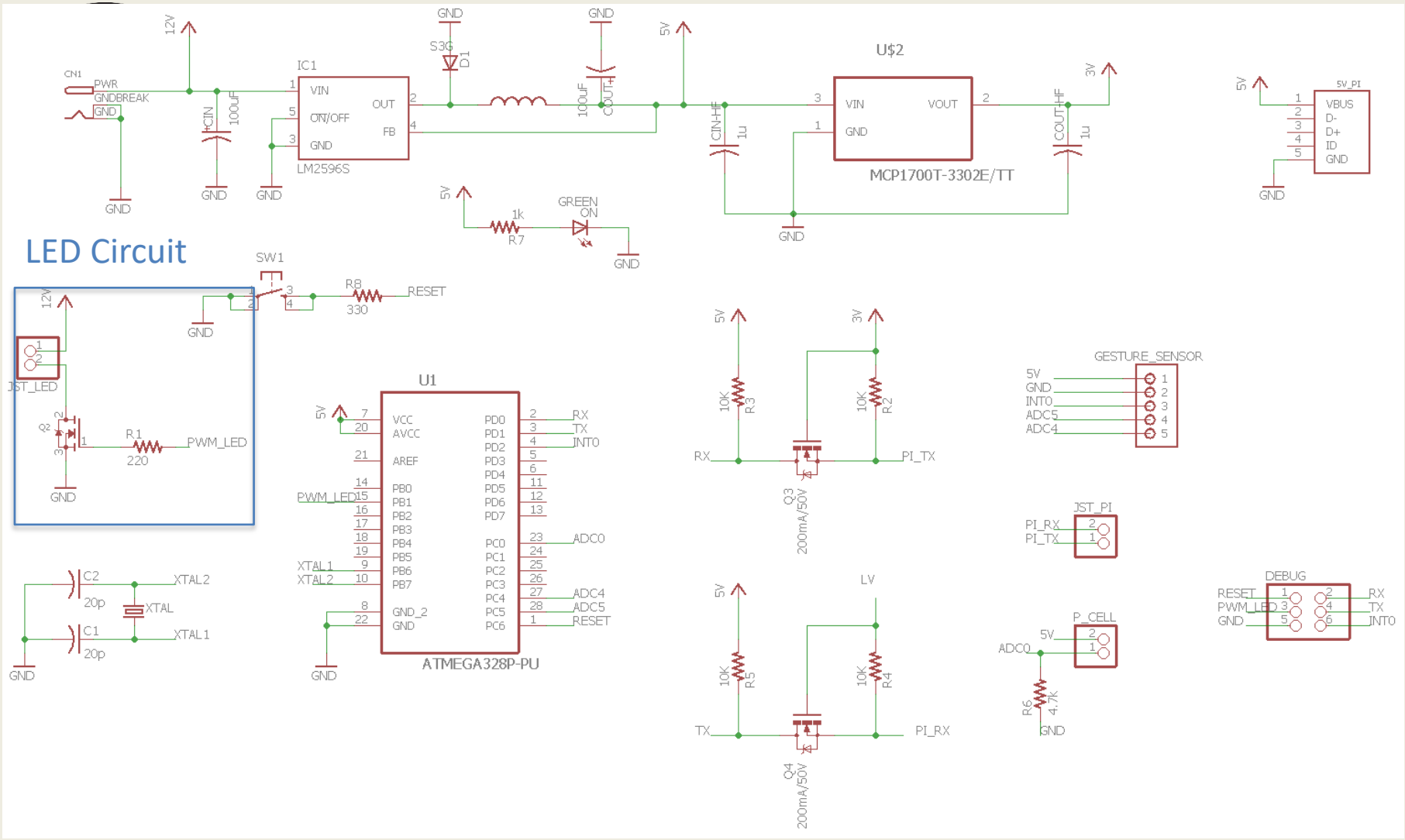
P_CELL
R6
4.7k
DEBUG
LV
R5
R4
Q4

LED Circuit


12V
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100uF
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VIN
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COUT+
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VIN
GND
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CIN-HF
COUT-HF
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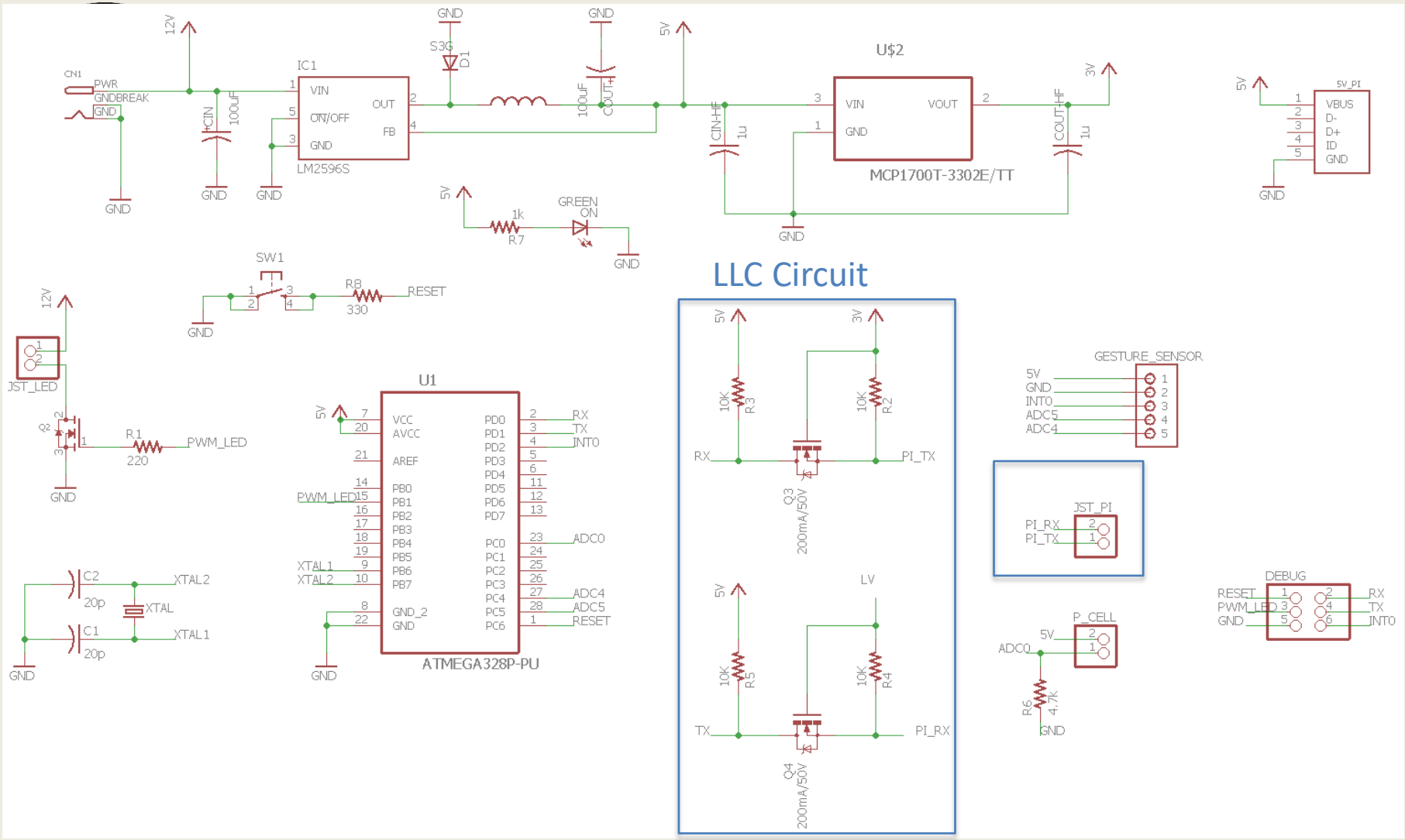
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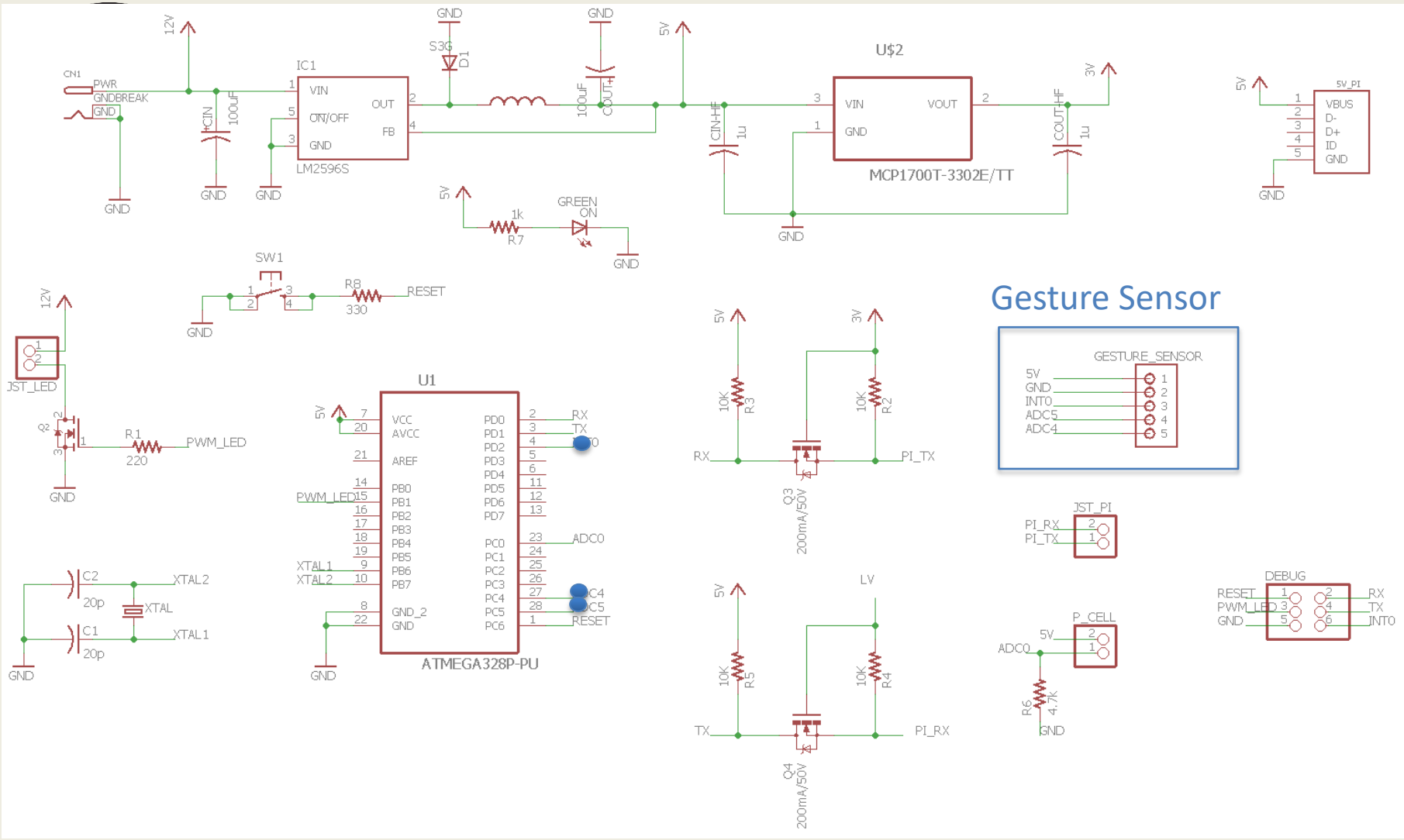
GREEN
LV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S3G
D1
100uF
COUT+
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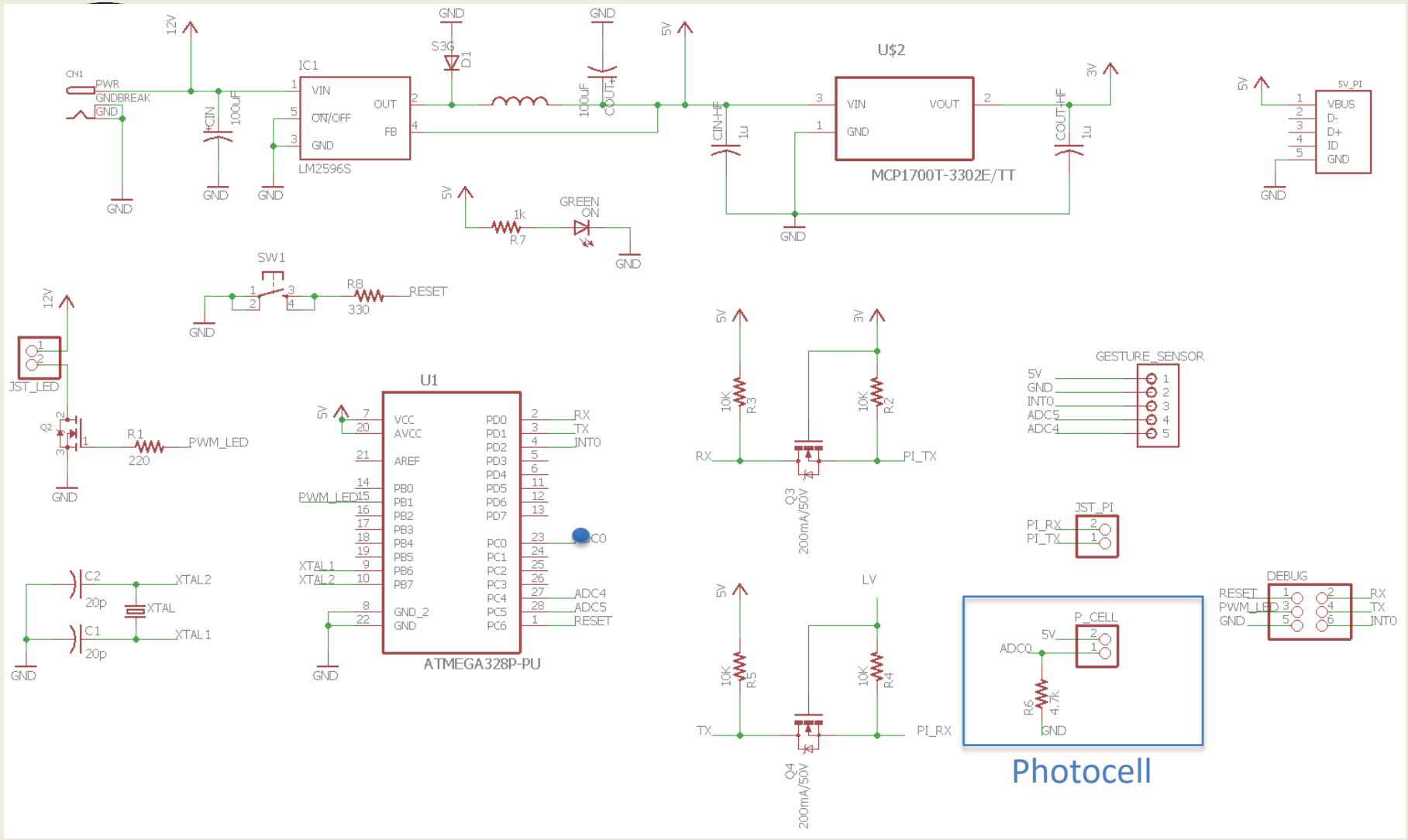
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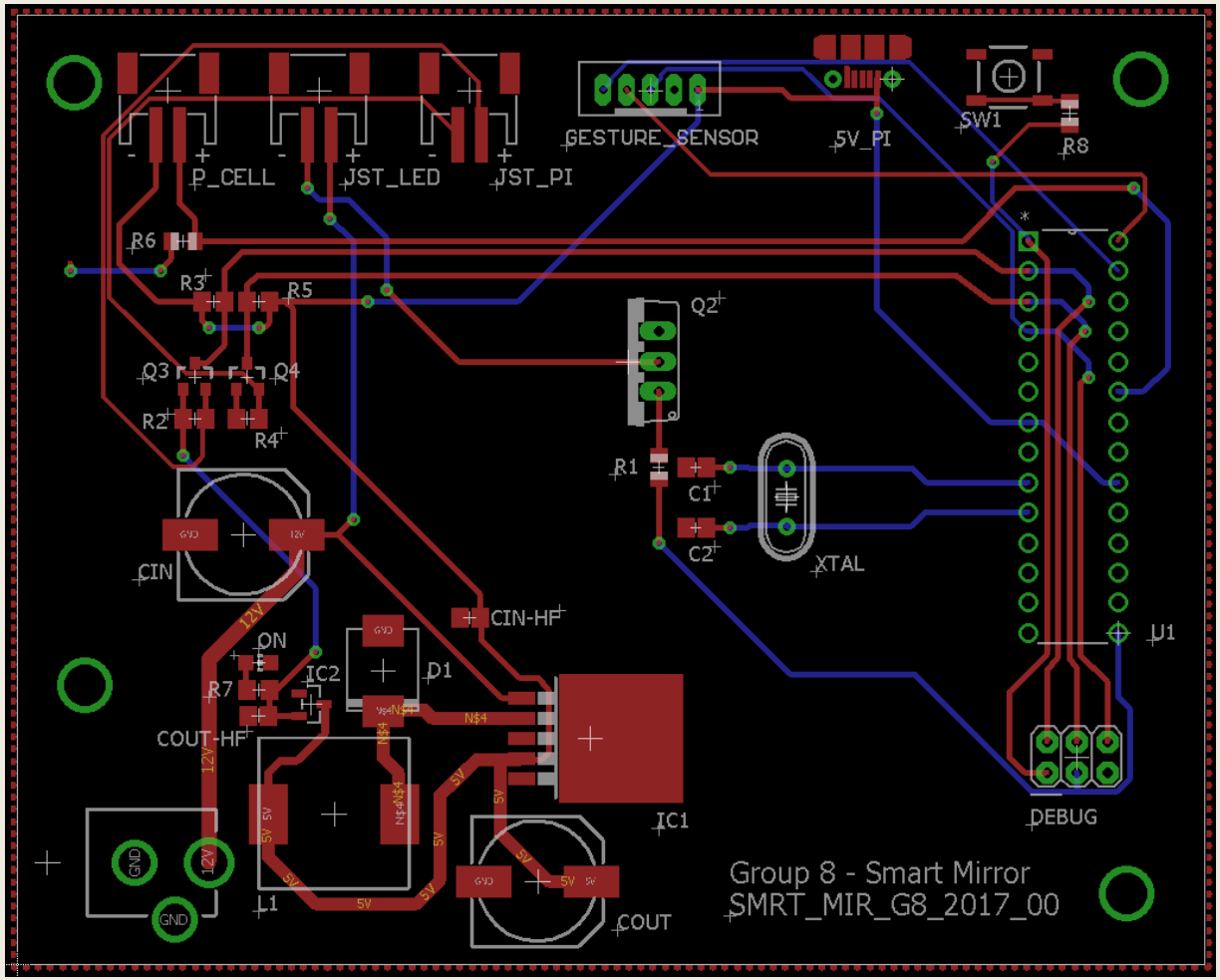
Photocell

PCB Layout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JST_PI
GESTURE_SENSOR
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R6
R3
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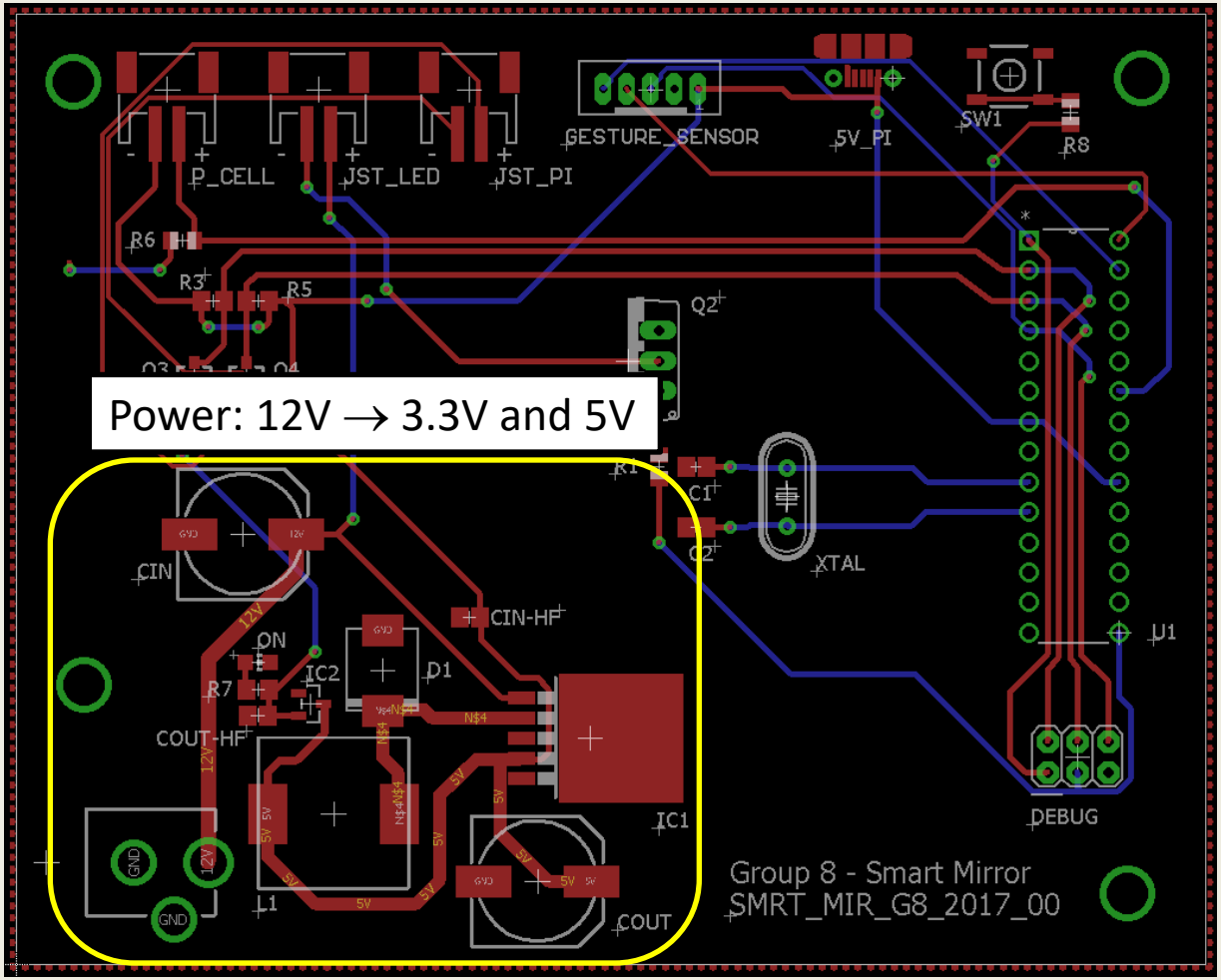
R2
R4
R1
C1
C2
XTAL
CIN
CIN-HF
ON
IC2
D1
R7
COUT-HF
IC1
U1
DEBUG
L1
COUT
Group 8 - Smart Mirror
SMRT_MIR_G8_2017_00

PCB Layout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JST_PI
GESTURE_SENSOR
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R8
R6
R3
R5
Q2
Power: 12V → 3.3V and 5V
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XTAL
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IC2
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R7
COUT-HF
IC1
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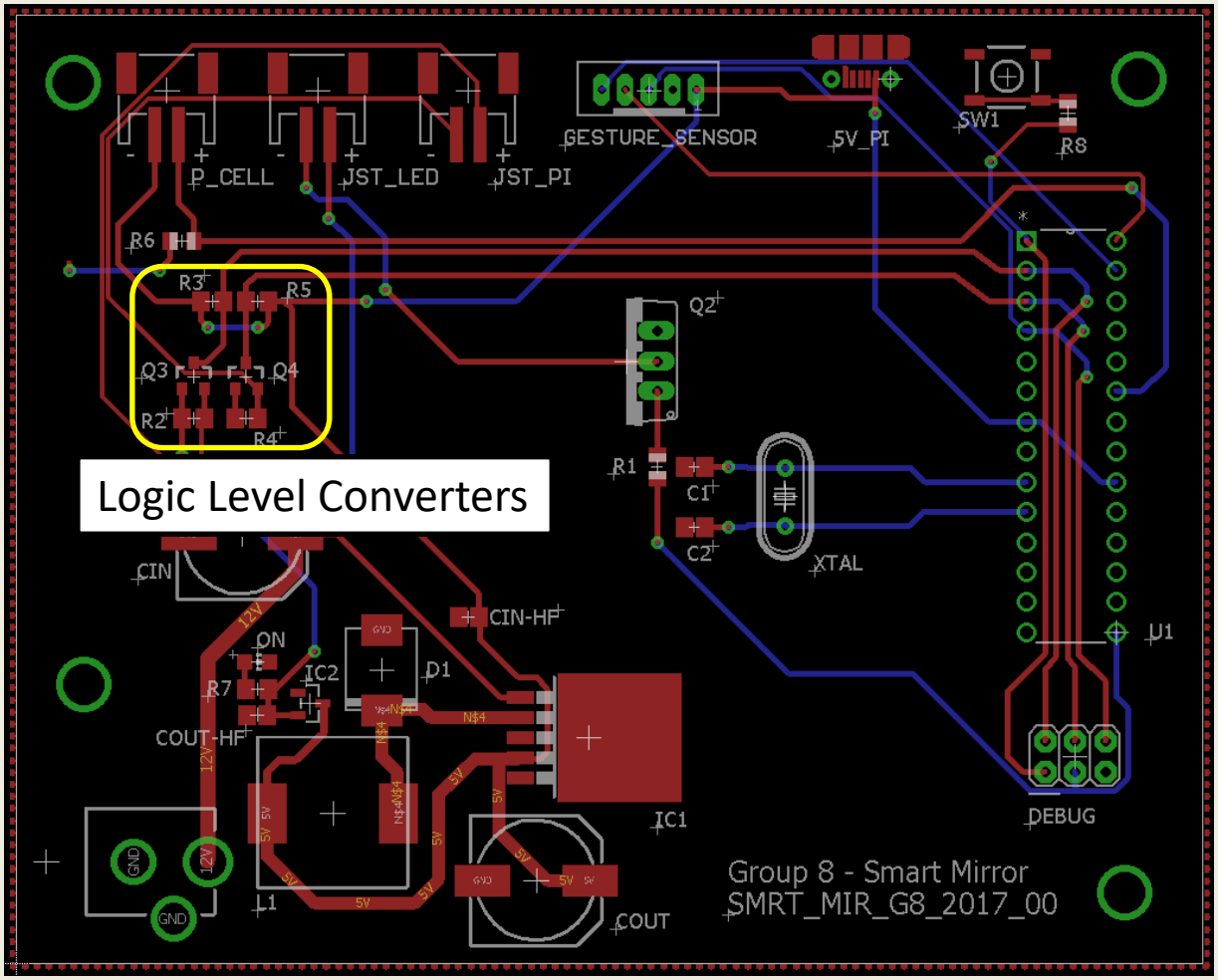
DEBUG
L1
COUT
Group 8 - Smart Mirror
SMRT_MIR_G8_2017_00

PCB Layout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JST_PI
GESTURE_SENSOR
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Q2
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XTAL
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Logic Level Converters
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COUT-HF
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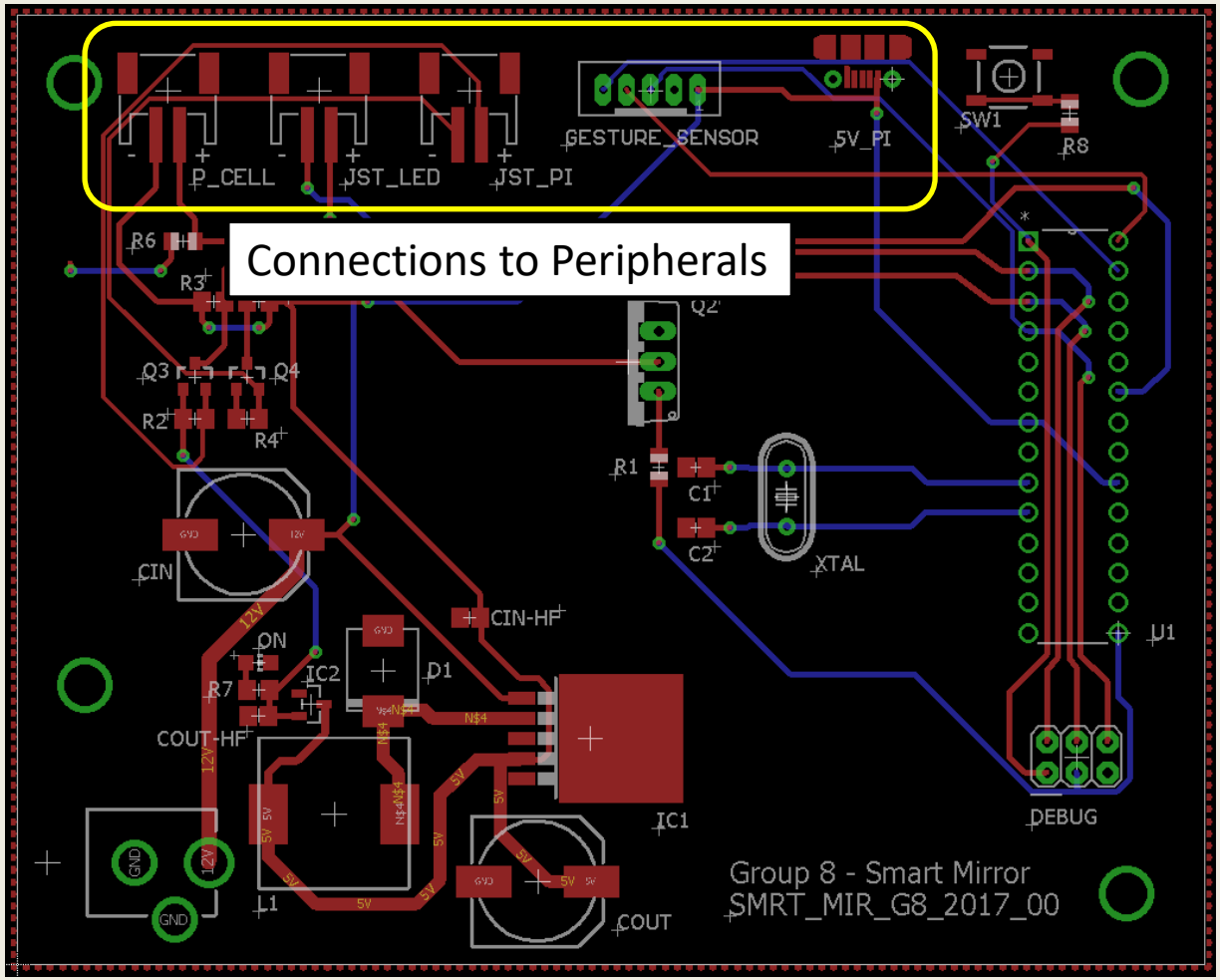
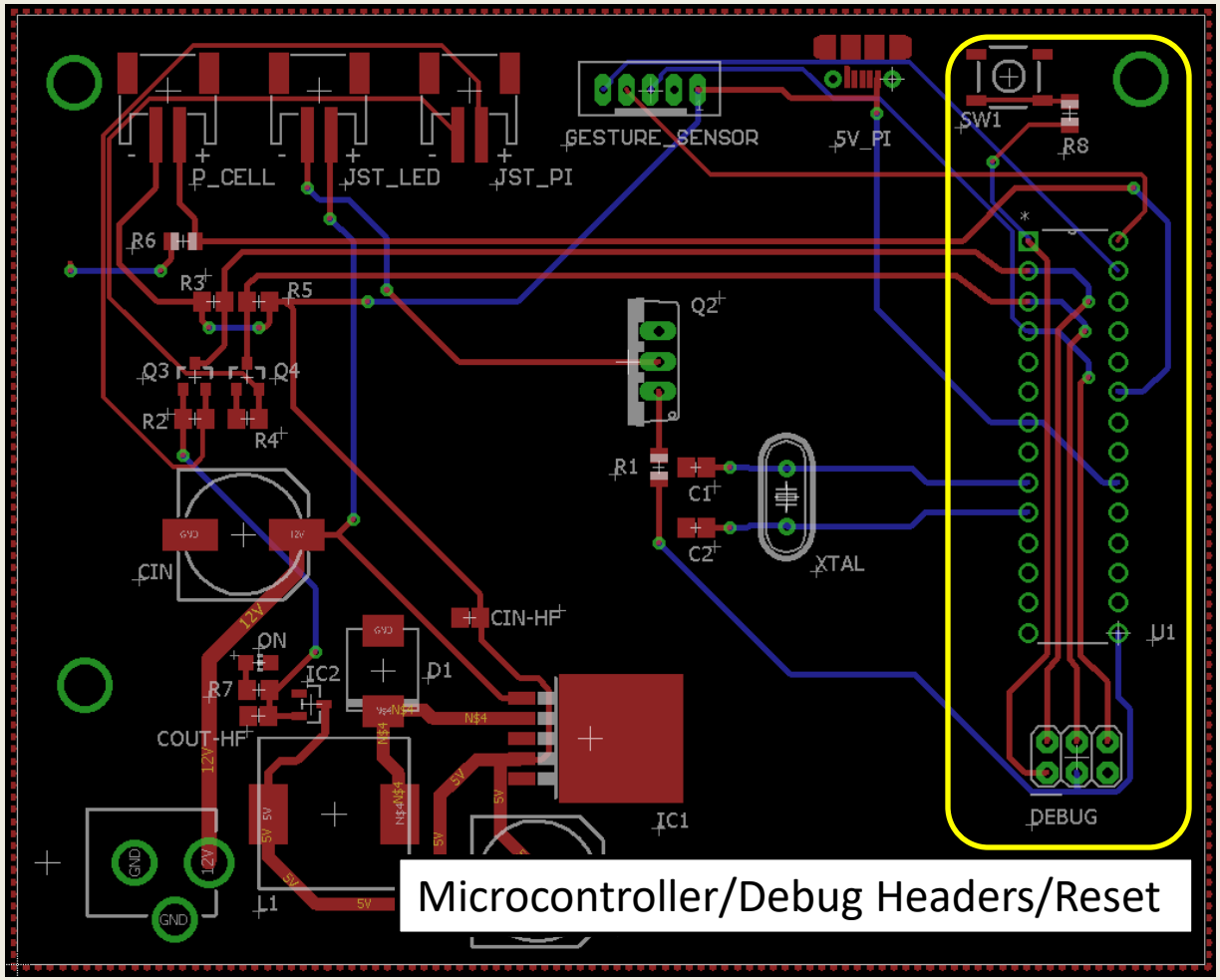
DEBUG
L1
COUT
Group 8 - Smart Mirror
SMRT_MIR_G8_2017_00

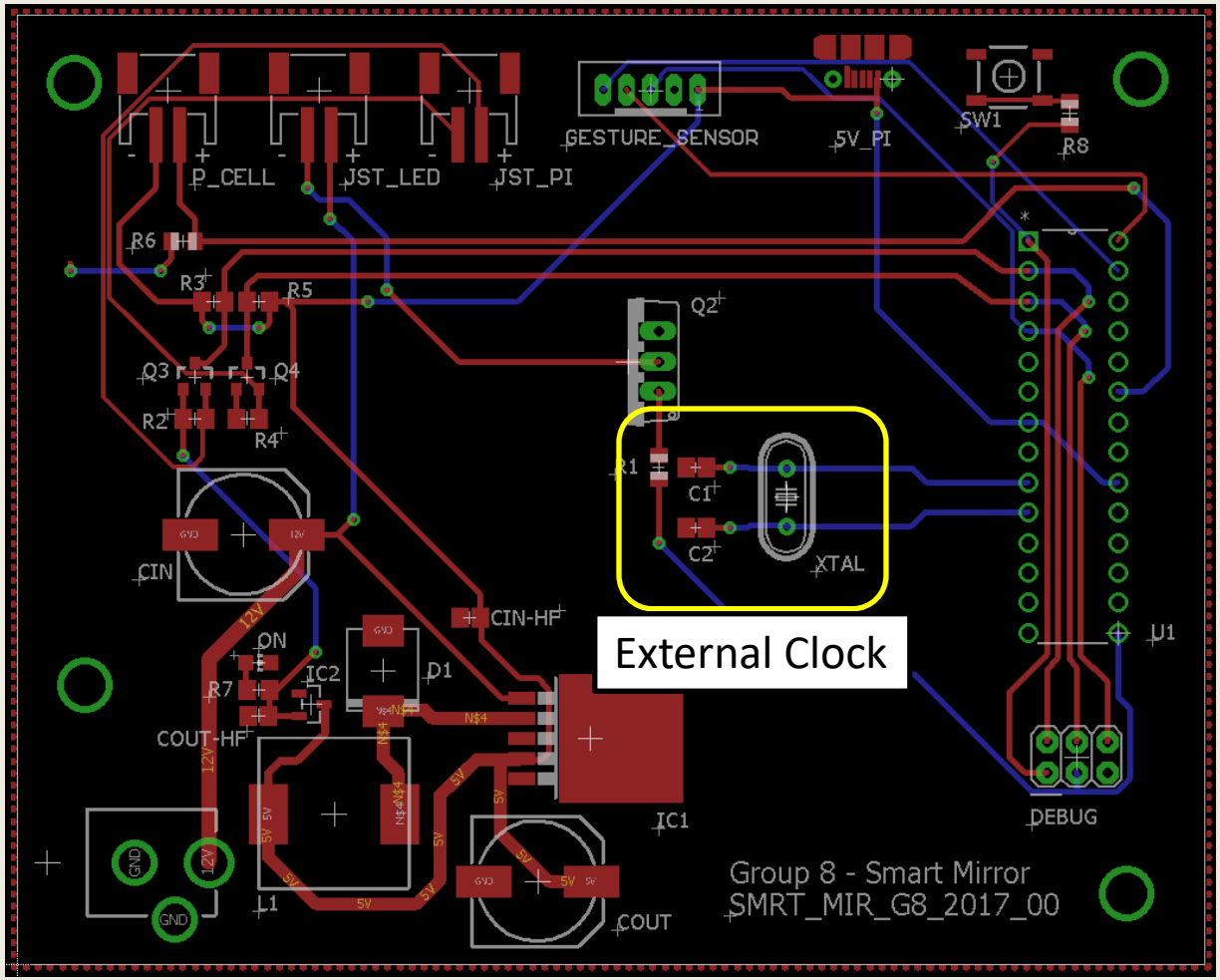
PCB Layout


P_CELL
JST_LED
JST_PI
GESTURE_SENSOR
5V_PI
SW1
R8
R6
R3
Connections to Peripherals
Q2
Q3
Q4
R2
R4
R1
C1
C2
XTAL
CIN
CIN-HF
ON
IC2
D1
R7
COUT-HF
IC1
U1
DEBUG
L1
COUT
Group 8 - Smart Mirror
SMRT_MIR_G8_2017_00

PCB Layout

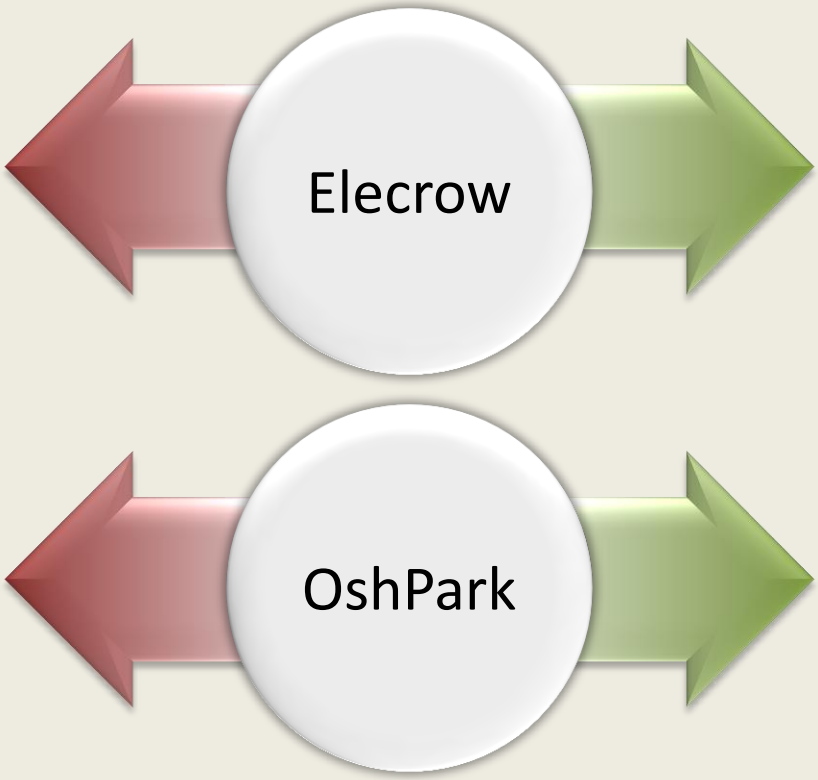

P_CELL
JST_LED
JST_PI
GESTURE_SENSOR
5V_PI
SW1
R8
R6
R3
R5
Q2
Q3
Q4
R2
R4
R1
C1
C2
XTAL
CIN
CIN-HF
ON
IC2
D1
R7
COUT-HF
IC1
U1
DEBUG
L1
GND
12V
5V
Microcontroller/Debug Headers/Reset

PCB Layout


P_CELL
JST_LED
JST_PI
GESTURE_SENSOR
5V_PI
SW1
R8
R6
R3
R5
Q2
Q3
Q4
R2
R4
R1
C1
C2
XTAL
CIN
CIN-HF
ON
IC2
D1
R7
COUT-HF
IC1
J1
DEBUG
L1
COUT
External Clock
Group 8 - Smart Mirror
SMRT_MIR_G8_2017_00

PCB Order

- Not in the U.S.



- 4-7 days to ship
- 5 boards for one price

- 20% Quality Issues
- 3 boards

- 12 days to ship
- Price per sq. in.

Budget

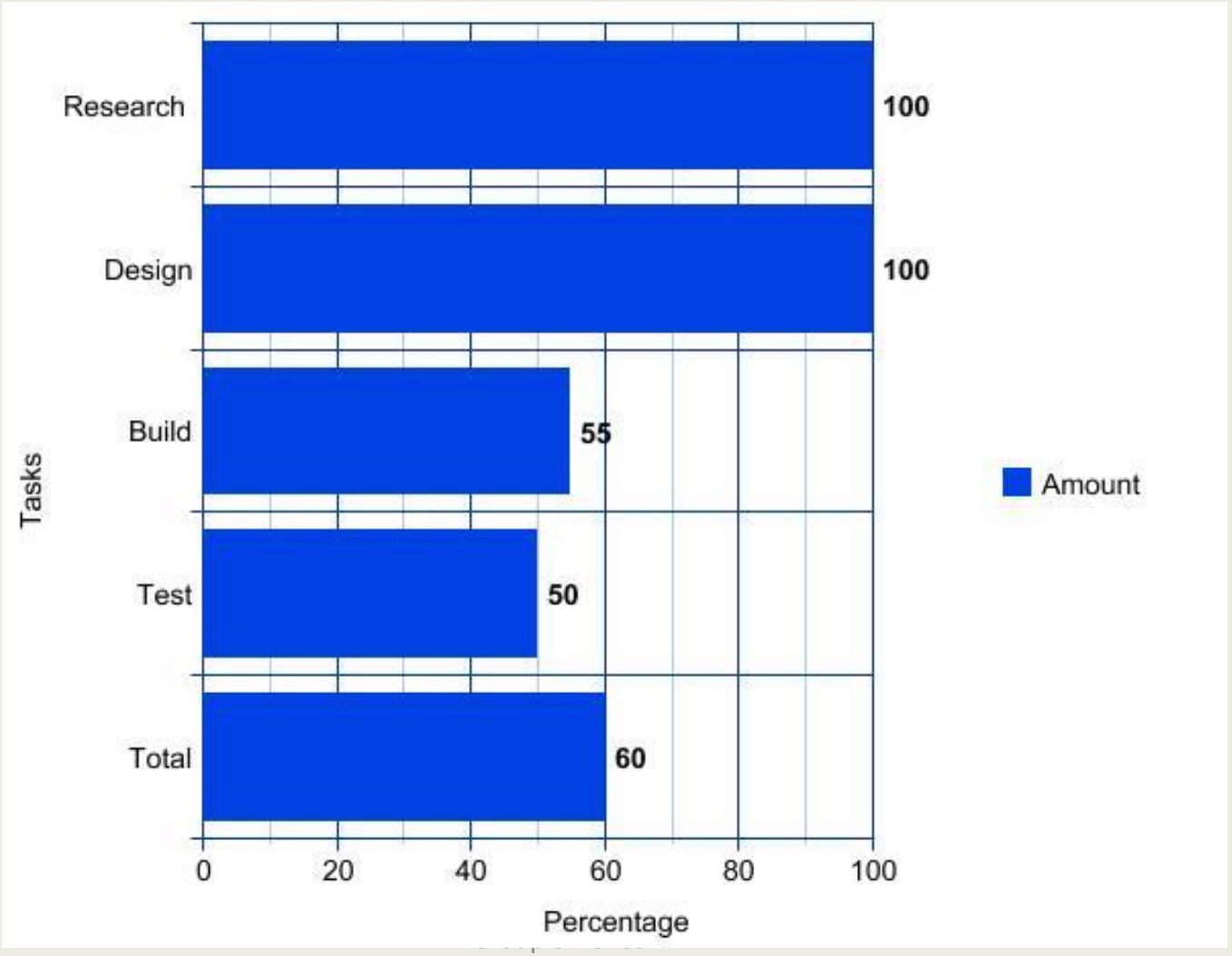
PART	VENDOR	PRICE
Raspberry Pi	Amazon	$ 35.70
Two Way Mirror	TWM LLC	$ 68.43
7" LED Display	Amazon	$ 68.99
Camera Module	Amazon	$ 25.74
ZX Gesture Sensor	Sparkfun	$ 24.95
ATmega328	Amazon	$ 2.23
LED Strip	Adafruit	$ 19.95
N-Channel MOSFET	Digikey	$ 1.75
5v Switching Regulator	Digikey	$ 5.72
3.3 Linear Regulator	Digikey	$ 1.76
PCB Printing	Elecrow	$ 27.55
Extra Peripherals	Varied	$ 10.00
Framing Materials	Home Depot	$ 25.00
	Total	$ 317.77

Work Distribution

	Austin	Daniel	Kat	Reid
Power System	P	S		
LED system	S	P		
Sensor Input			S	P
Face Recognition			S	P
Architecture			P	S
Schematic	P	S		
PCB Design	S	P		
Physical Design			P	S

P = Primary
S = Secondary

Current Progress



Future Plans

- Software:
  - Review current functionality
  - Integrate and test facial recognition with current architecture
- Hardware:
  - Test and debug PCB
  - Review existing PCB design
  - Assembly

Questions?