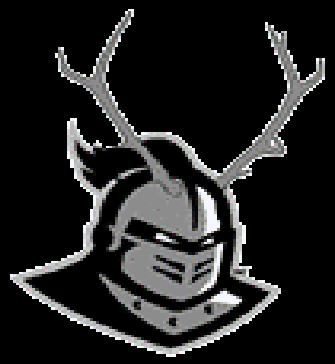
Autonomous Vehicle



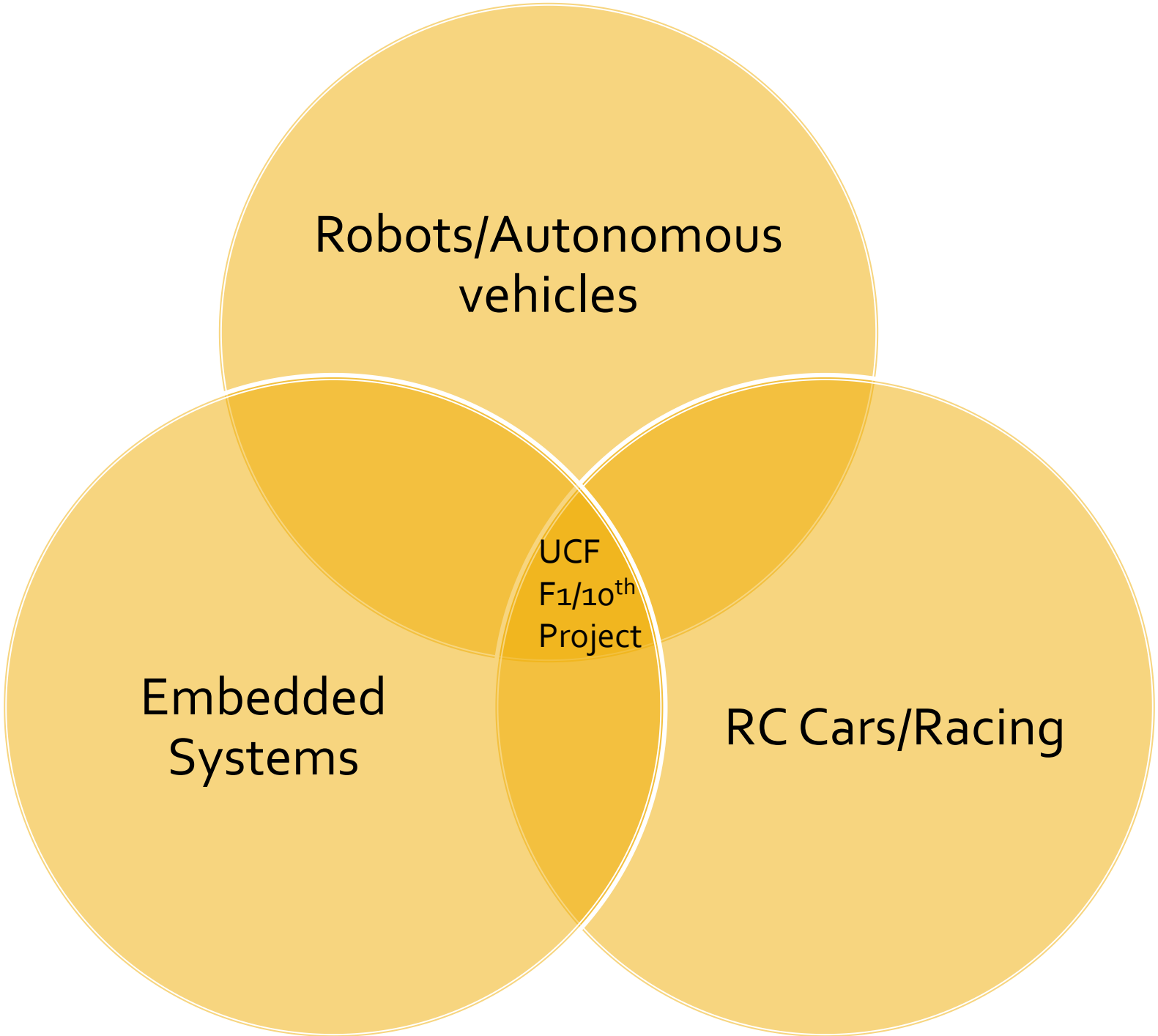
The Knights of Ni

Group 20 – Knights of N.I. (Navigation Independence)

James Beckett, E.E (Power)
Alexander Jenkel, E.E (Communications)
Juan Velasquez, E.E (Communications)

Motivation

- Work with robotics and future technology
- Research, development, and embedded systems applications
- Racing/RC Cars
- Autonomous vehicles are a proposed method for increasing automobile safety
- Project encompasses all related E.E tracks


Robots/Autonomous vehicles
Embedded Systems
RC Cars/Racing
UCF F1/10th Project

Description

- Vehicle can navigate a course without the aid of an end user
- Relies on Distance sensors, speed sensors, and 3D Camera
- Object detection and collision avoidance

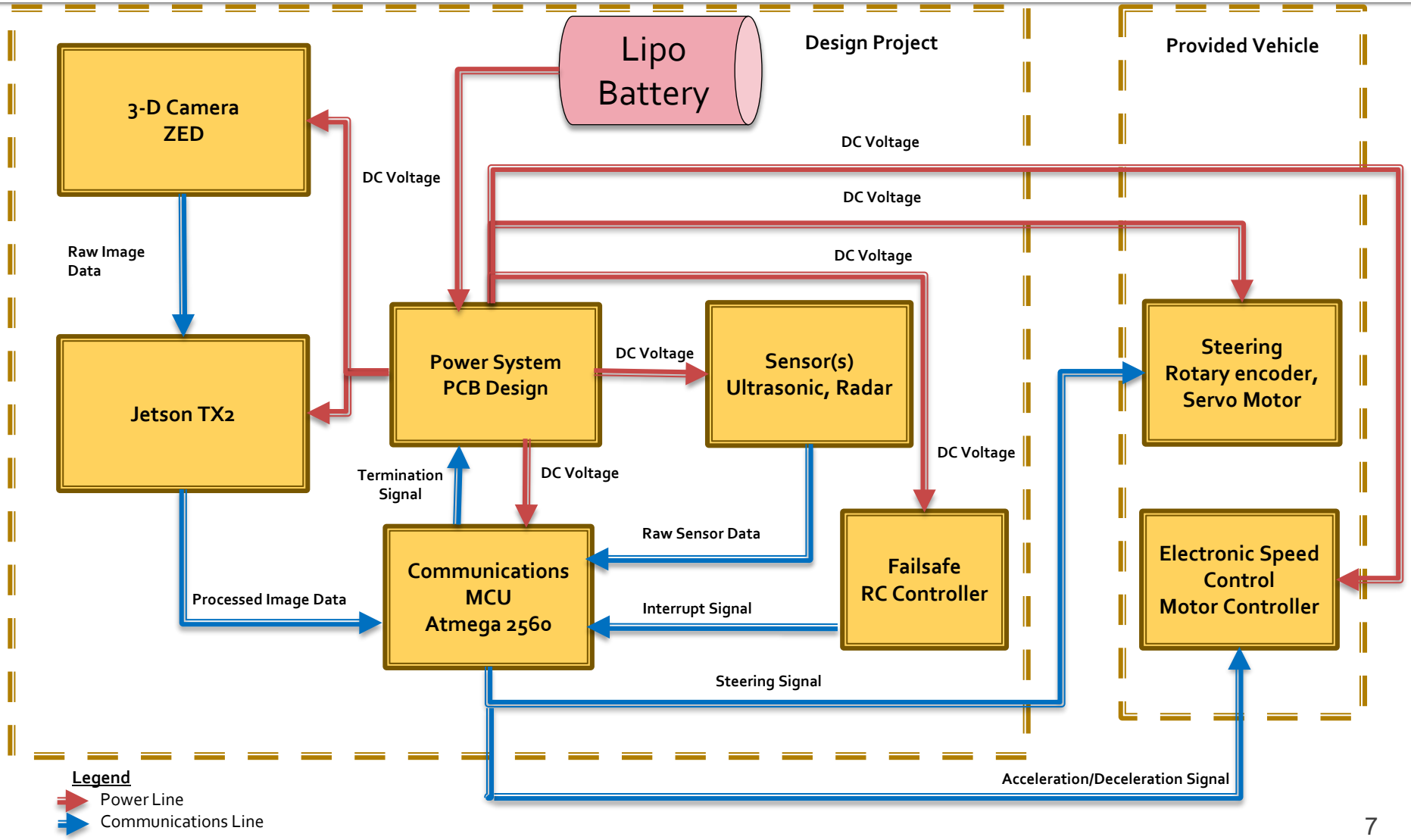
Goals & Objectives

- Achieve Level 4 automation
- Achieve a top speed of 5 mph
- Implement an emergency failsafe system to eliminate safety concerns associated with autonomous vehicles

Specifications & Requirements

Constraint	Definition	Quantity	Units
Size	Max height	1	ft
	Max weight	15	lb
Autonomous	Object size detection	6 x 12	in
	Object detection range	1	m
	Autonomy	4/3	SAE (Autonomy level)
Collision Avoidance	Object Detection Response	1	seconds
	Stopping distance	2	ft
	Object response distance	3	ft
	Minimum distance from object	6	in
Real Time Navigation	Max speed	5	mph
	Acceleration from rest	10	seconds
	Stop time from max speed	10	seconds

Block Diagram



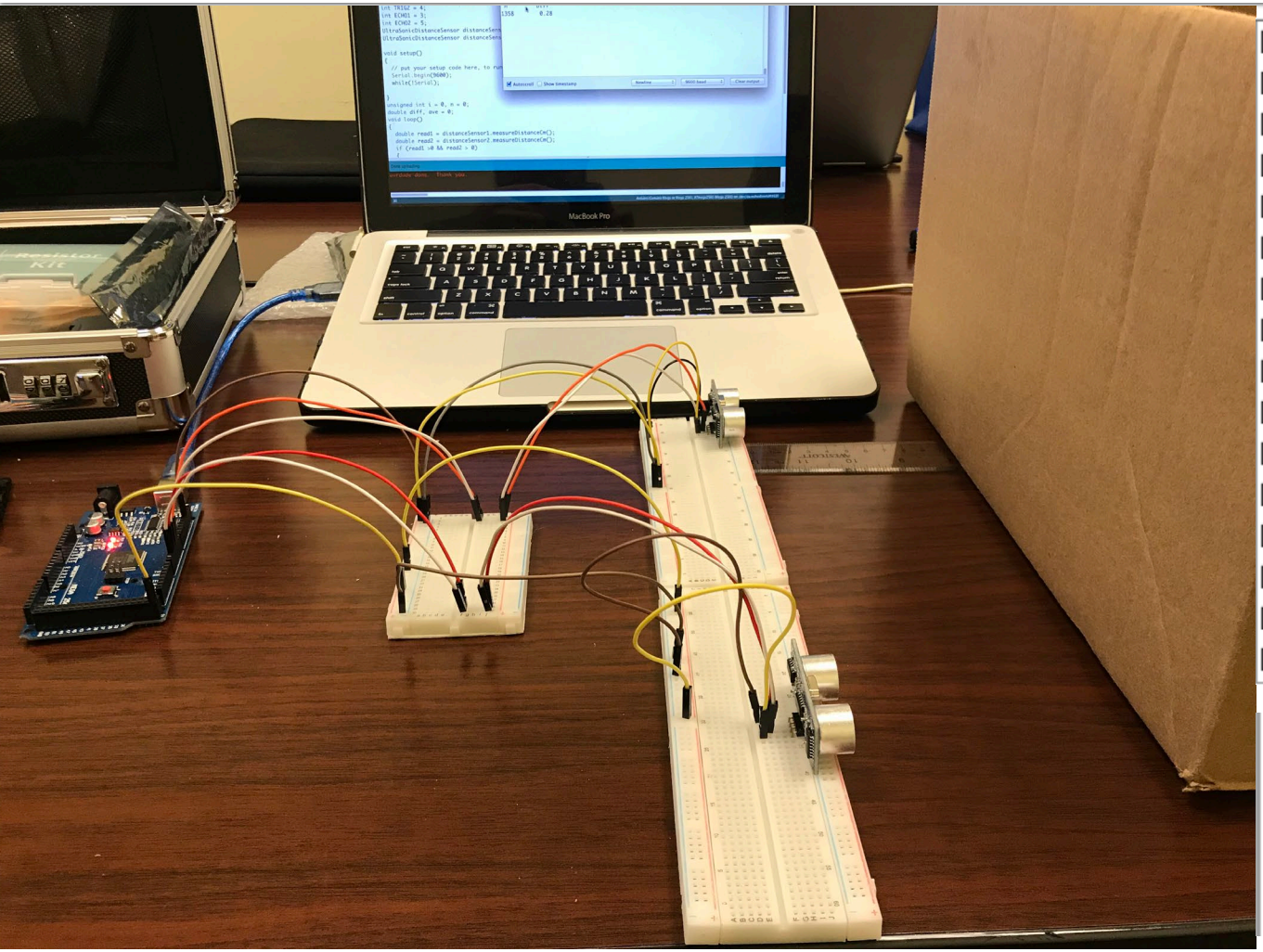
Work Distribution

	Type	James	Alex	Juan
PCB Design	Power	Primary	Secondary	Secondary
	Communications	Secondary	Primary	Secondary
Sensors	Radar	Secondary		Primary
	Ultrasonic		Secondary	Primary
Vehicle	Components	Primary		Secondary
Coding	Sensors		Primary	Secondary
	Jetson/Camera		Primary	Secondary
	Communication		Secondary	Primary

Distance Sensors

Type	Model	Cost	Range (cm)	Accuracy (cm)	Pros and Cons
Infrared	GP2Y0A41SK0F	$11.18	4 ~ 30		+ Fast/- Light
	VL53L1X	$7.07	0 ~ 400		+ Fast/ - Light
Ultrasonic	URM37	$14.04	5 ~ 500	1	+ Accuracy/ - Speed
	HC-SR04	$3.95	2 ~ 400	0.3	+ Accuracy/ - Speed
Radar	X-band	$39.99	200 ~ 900	1	+ Reliable/ - Limited
	XM-112	$62.92	0 ~ 200	0.1	+ Reliable/ -Limited
Lidar	HPS-3D160	$312	25 ~ 120		+ All in one/ - $$$
	SEN-14032	$131	5 ~ 400	2.5	+ All in one/ - $$$
Camera	ZED Stereo 3D	Sponsor	20 ~ 2500		+ 3D images/ - Data

Distance Sensor Testing



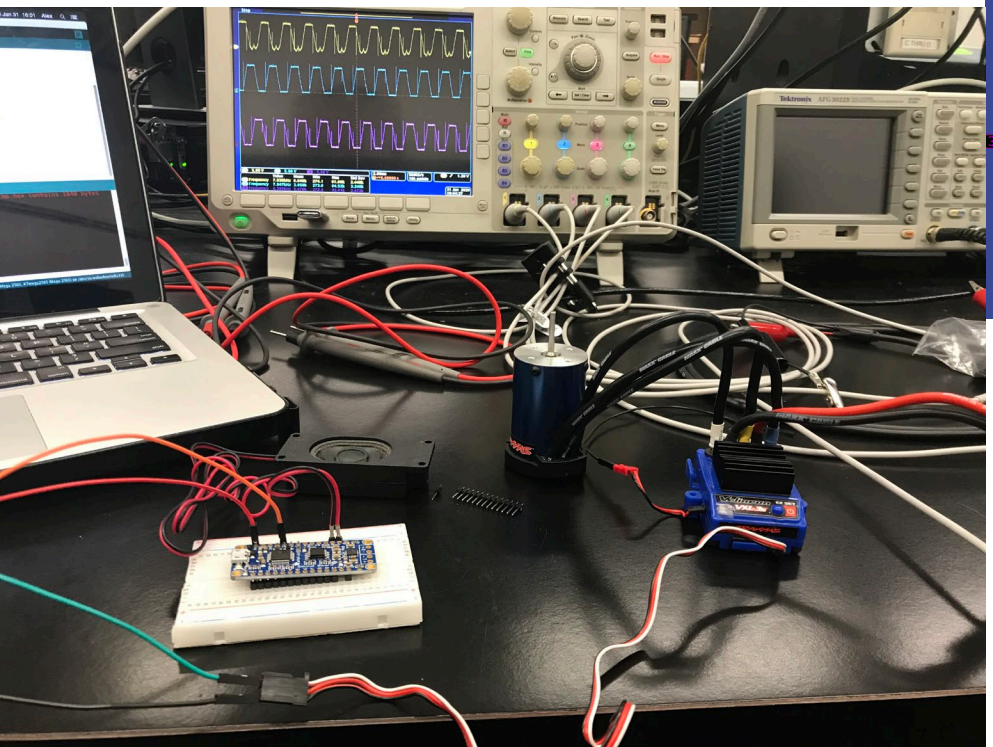
```
Distance (cm): 10.58
Distance (cm): 10.48
Distance (cm): 10.03
Distance (cm): 10.44
Distance (cm): 10.03
Distance (cm): 10.03
Distance (cm): 10.03
Distance (cm): 10.03
Distance (cm): 10.02
Distance (cm): 10.03
Distance (cm): 10.03
Distance (cm): 10.14
Distance (cm): 10.14
Distance (cm): 10.14
Distance (cm): 10.14
Distance (cm): 10.14
```

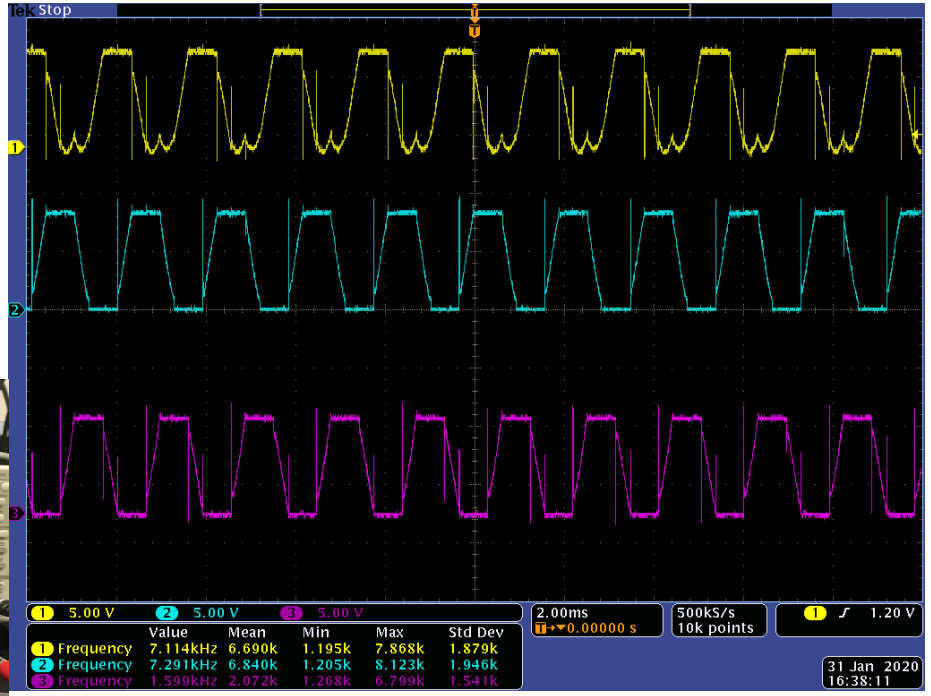
n	Diff
1348	0.27

Motor, Controllers & Safety

Type	Model	Cost	Amps (A)	Specs	Pros and Cons
Motor	Titan 12T 550	$0	3.5	19,300 RPM	+ Cheap/ - Slow
	Velineon 3500	$169	4.5	50,000 RPM	+ Fast/ - $$$
Speed	DRI0002	$11.18	2	6 ~ 12 V 2 A	+ Multiple/ - No protection
	VXL-3S	$7.07	1	4.8 ~ 11.1 V 1 A	+ Protection/ - Limited
Steering	Traxxas 2056 Servo	$0	2	6 V 60°	+ Stock
Sensor	DAGU Wheel Encoder	$12.95	4 m	3 ~ 24 V 25 mA	+ Provided
Safety	Audio FX Board	$16.95	1	3 ~ 5.5 V 16 MB	+ Cheap

Motor Controller & Safety Testing





Microcontrollers

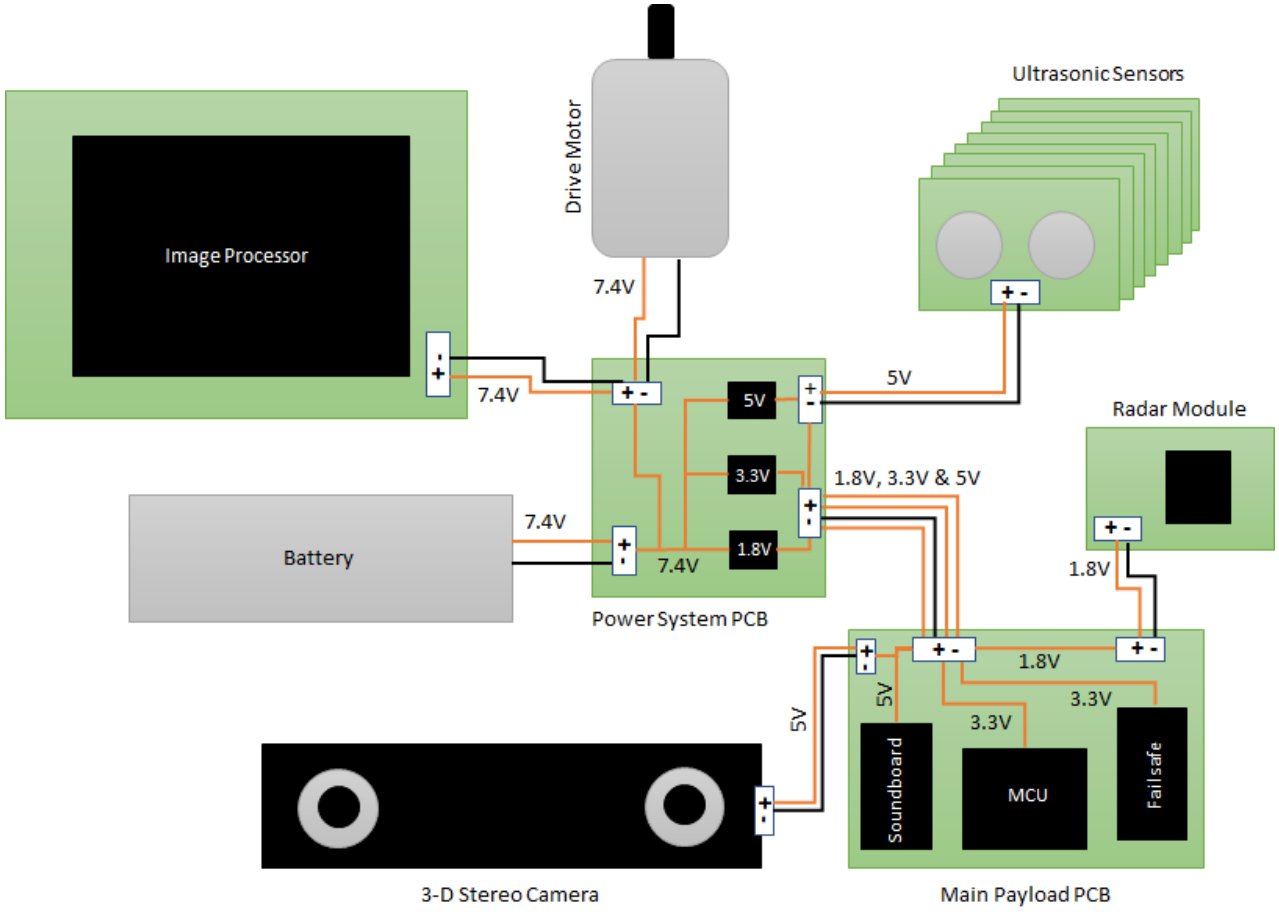
Model	Cost	Volts (V)	Memory (kB)	I/O Pins	Communications	Clock (MHz)	Core	Pros and Cons
MK20DX128 VFM5	$6.14	1.71 ~ 3.6	128	86	2-Wire, SPI, UART, I2C, I2s	32	ARM	+ Processor - Smaller form factor
PIC18F47K42 -I/P	$2.49	2.3 ~ 5.5	128	86	I2C, SPI, RS-232, RS-485, UART	64	PIC18	+ Faster - Expensive IDE
ATmega2560 -16AU	$11.85	4.5 ~ 5.5	256	54/86	2-Wire, SPI, UART	16	AVR	+ Memory - Slower Clock

Power Supply

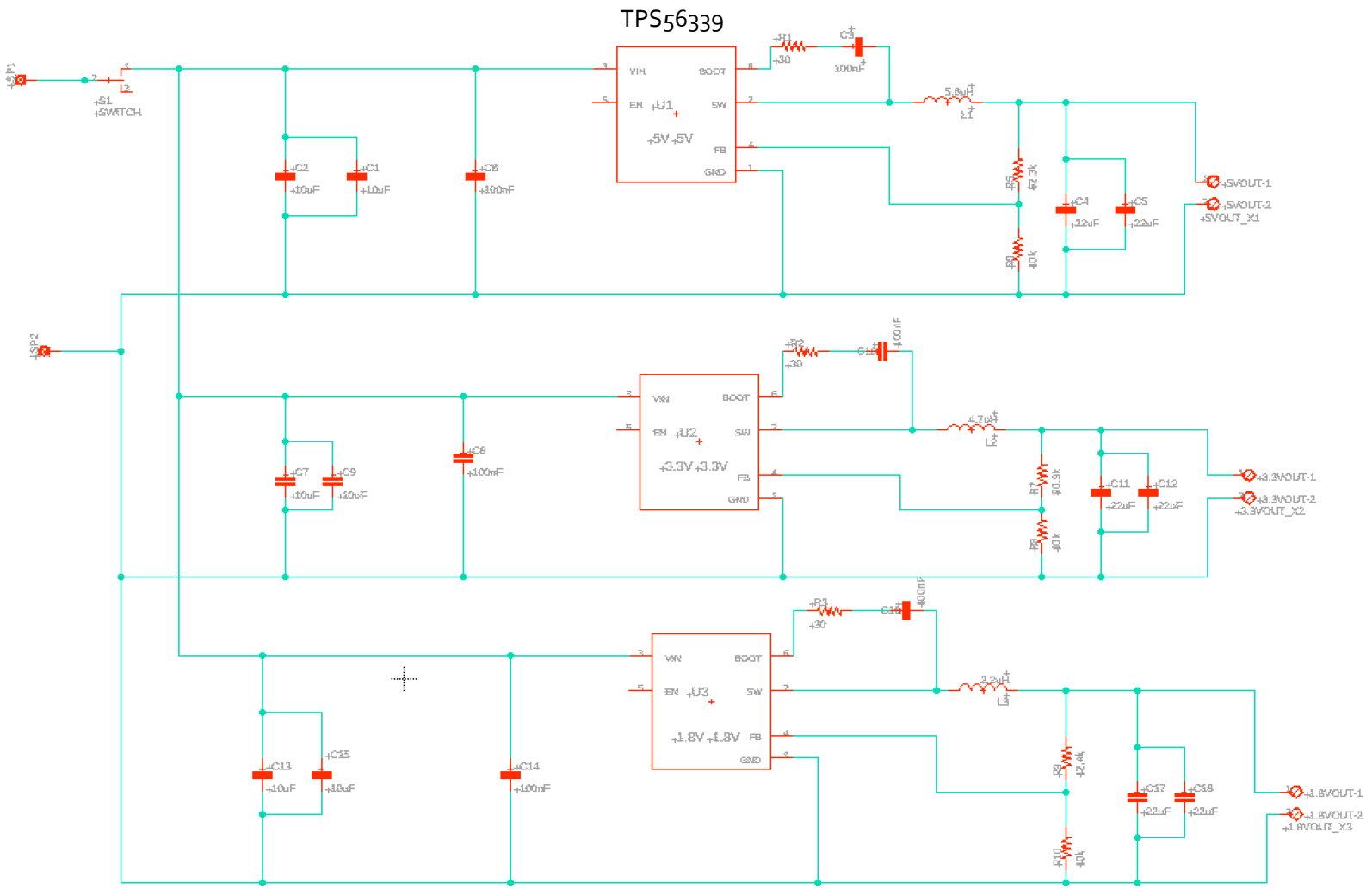
The power supply will regulate the 7.4VDC input voltage, provided by the LiPo battery pack, into three separate voltages for utilization by the autonomous vehicle.

- 1.8 VDC @ 1.5A max
- 3.3 VDC @ 1.5A max
- 5.0 VDC @ 1.5A max

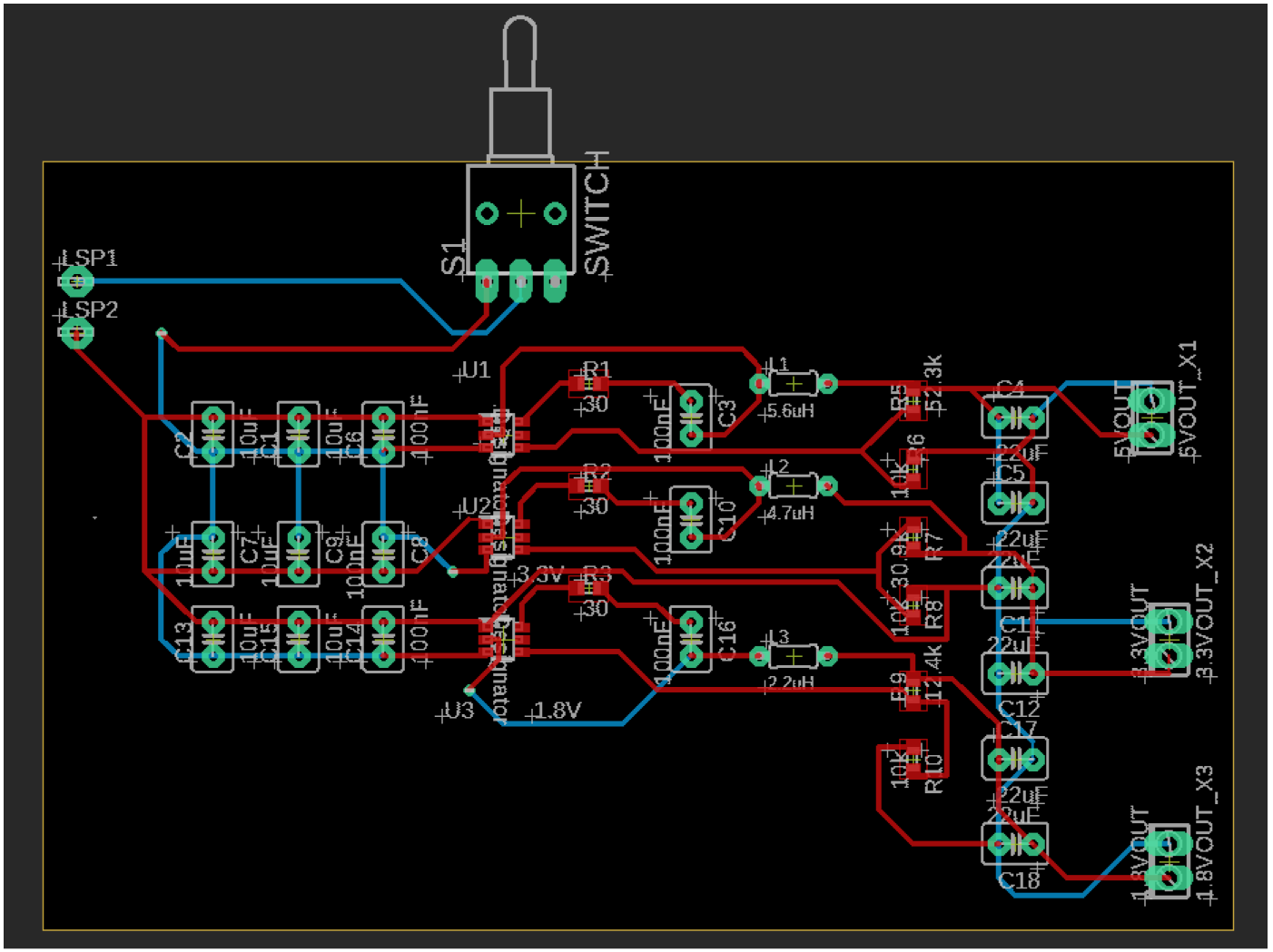
Voltage Flow Diagram



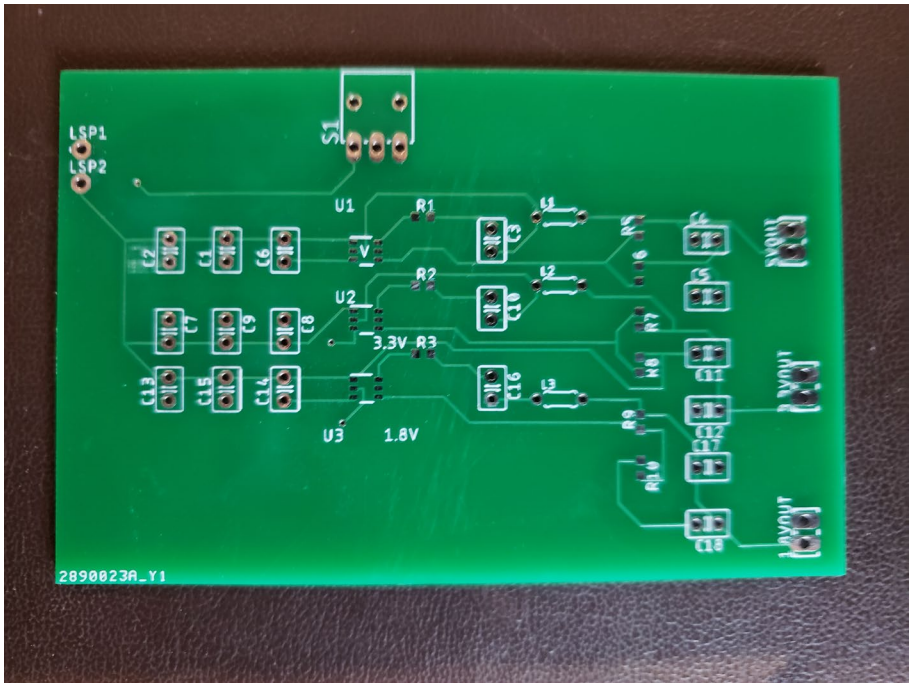
Power Supply Schematic



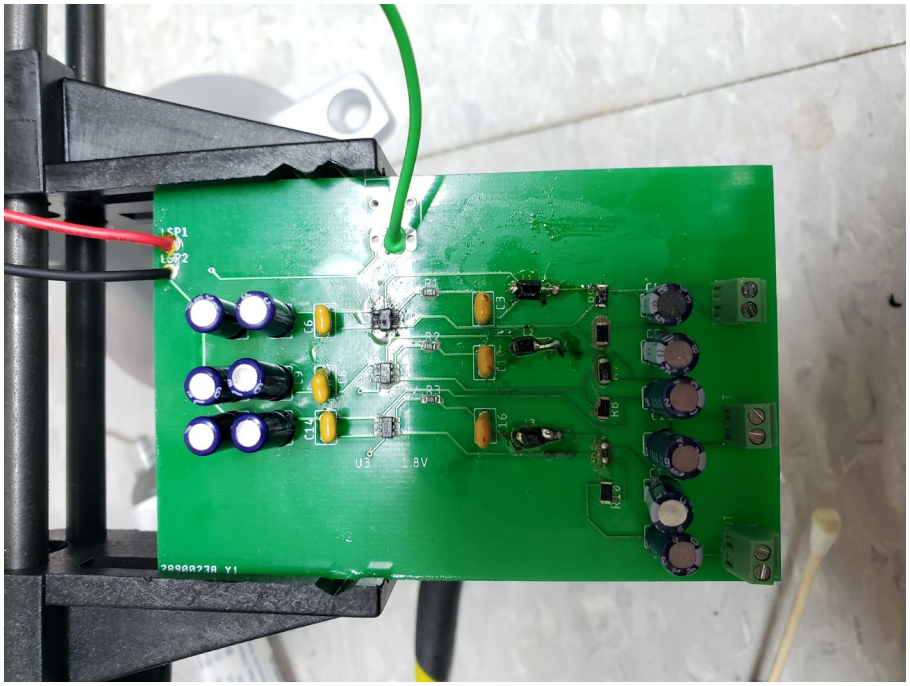
Power Supply PCB



Power Supply PCB (Production)

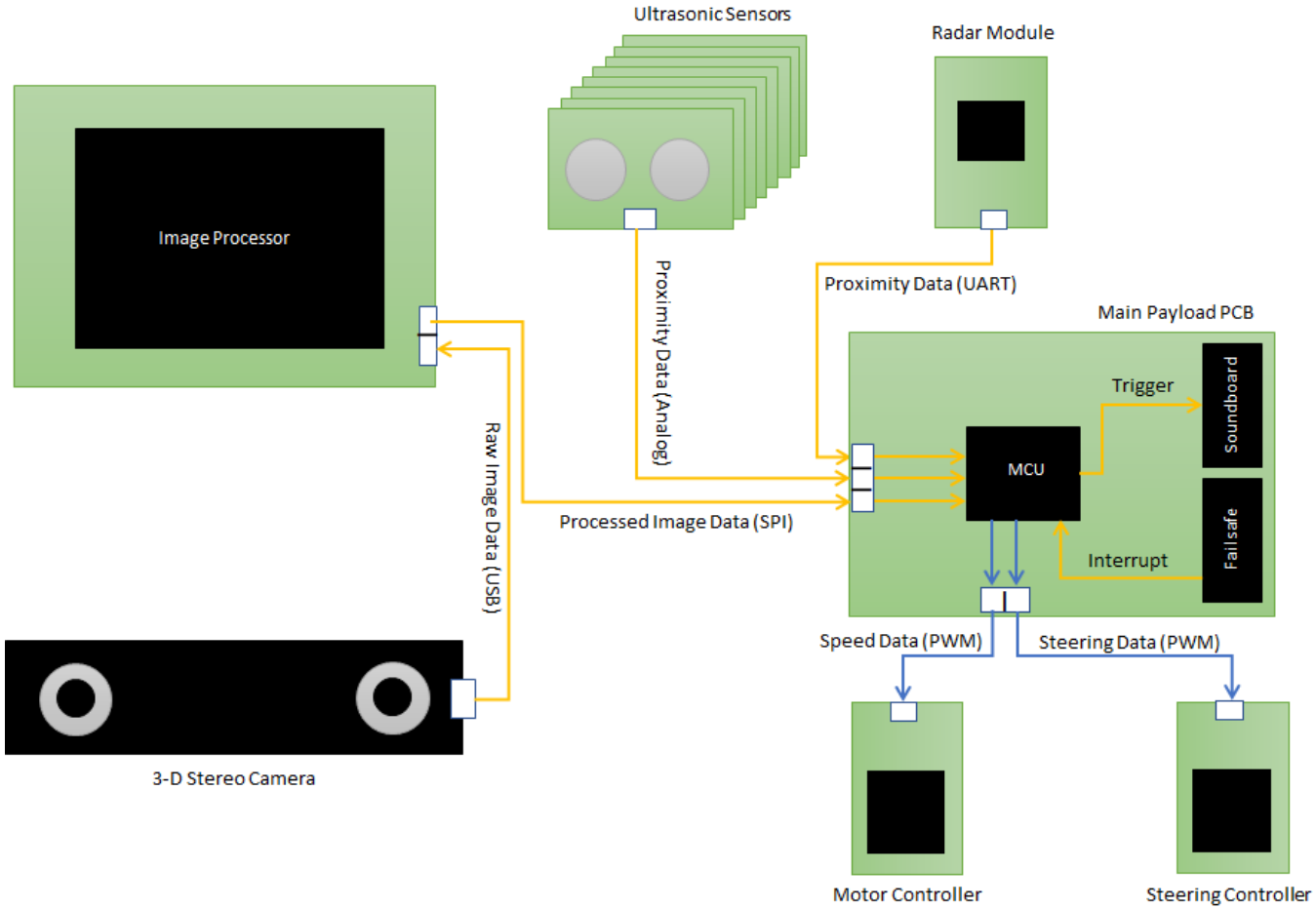


Bare Power PCB v1.0

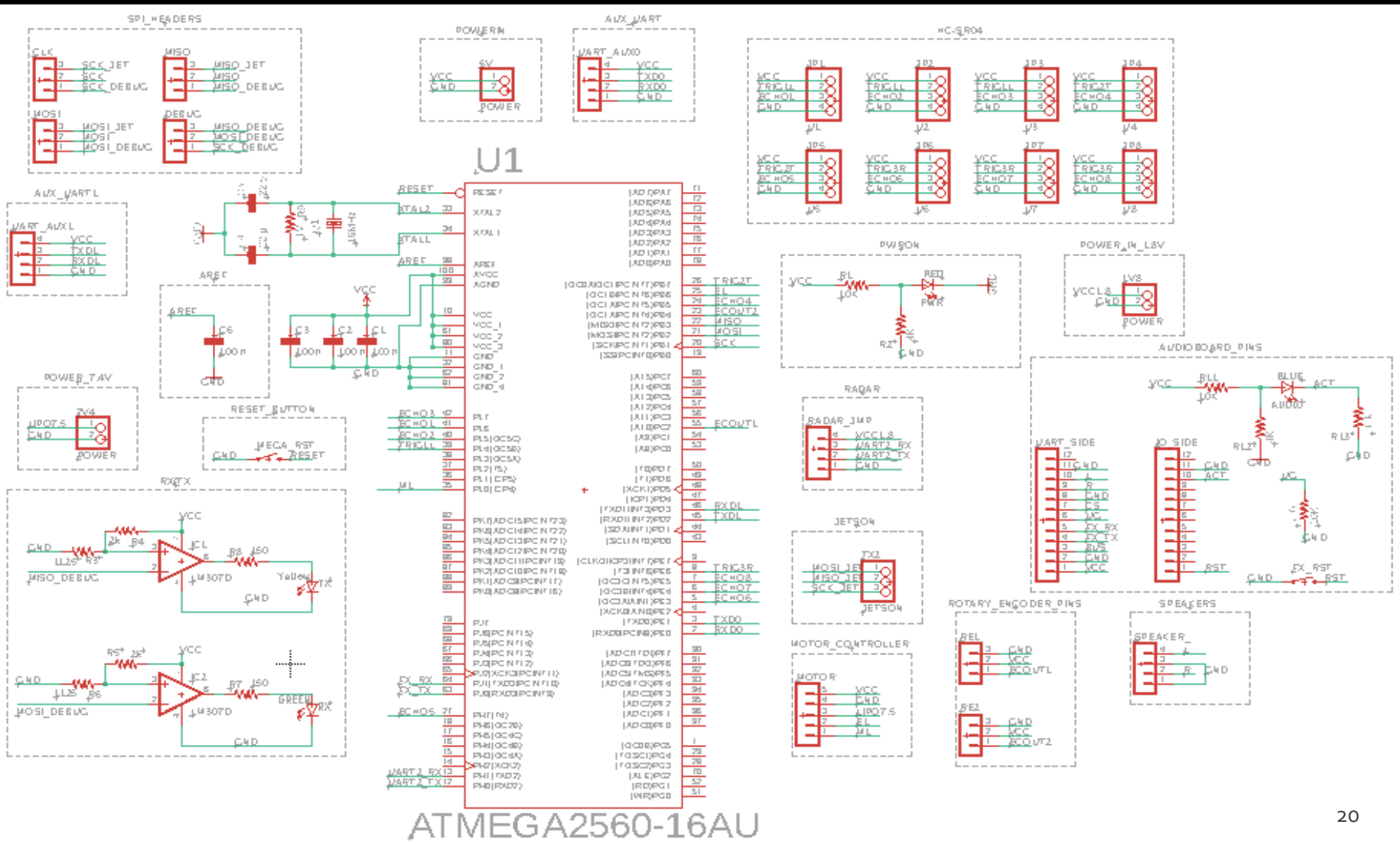


Populated Power PCB v1.0

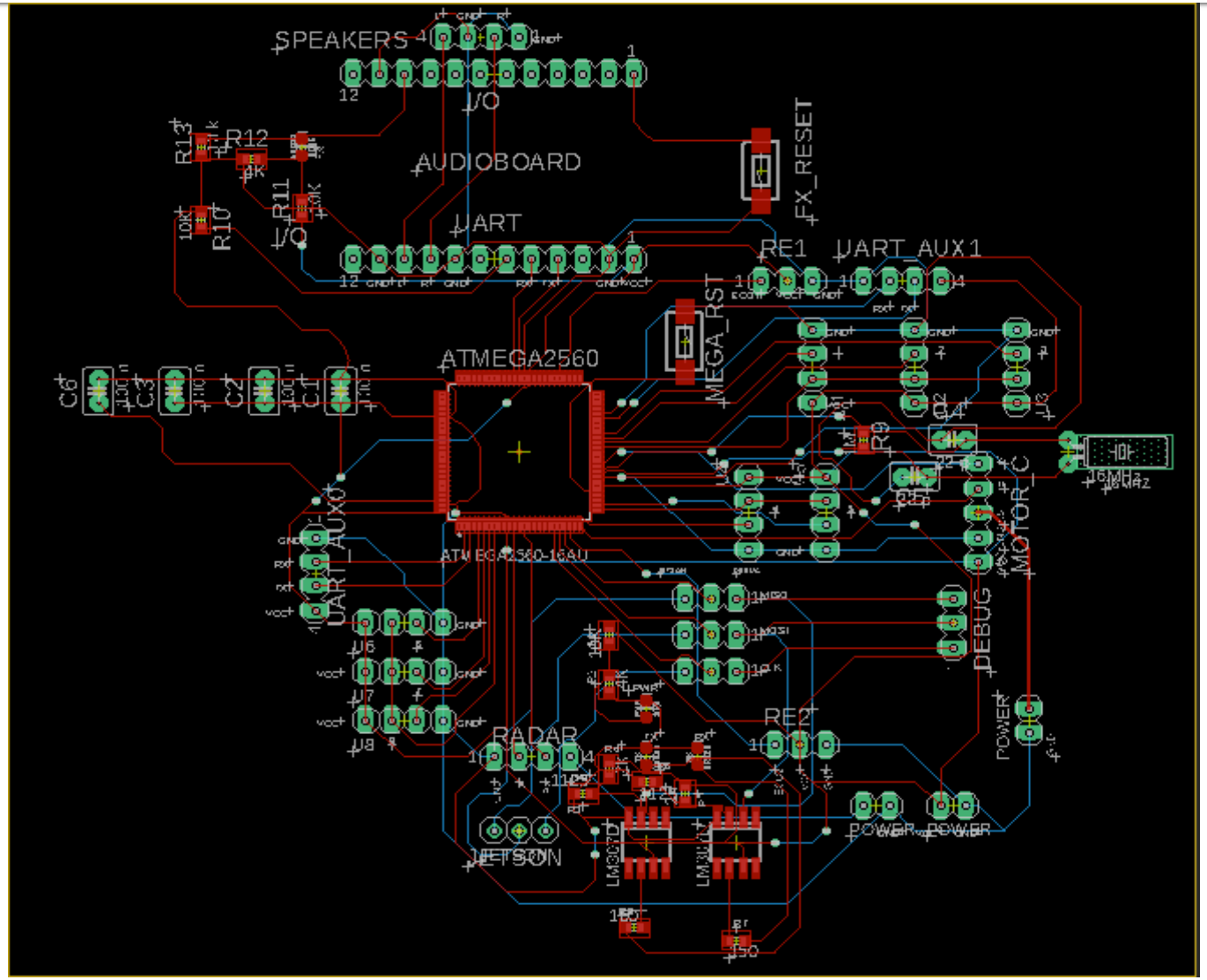
Signal Flow Diagram



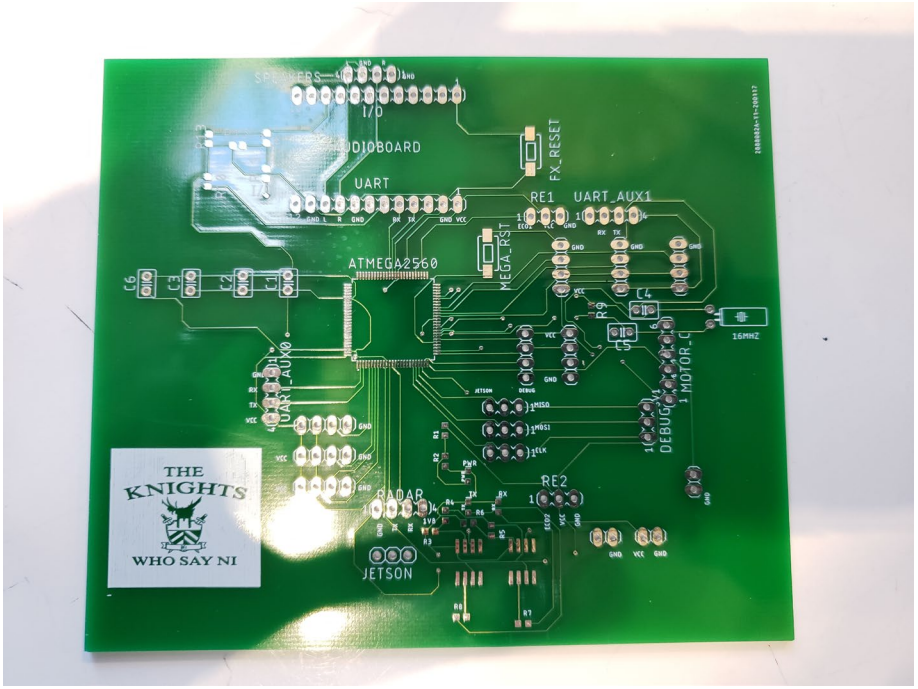
MCU Board Schematic



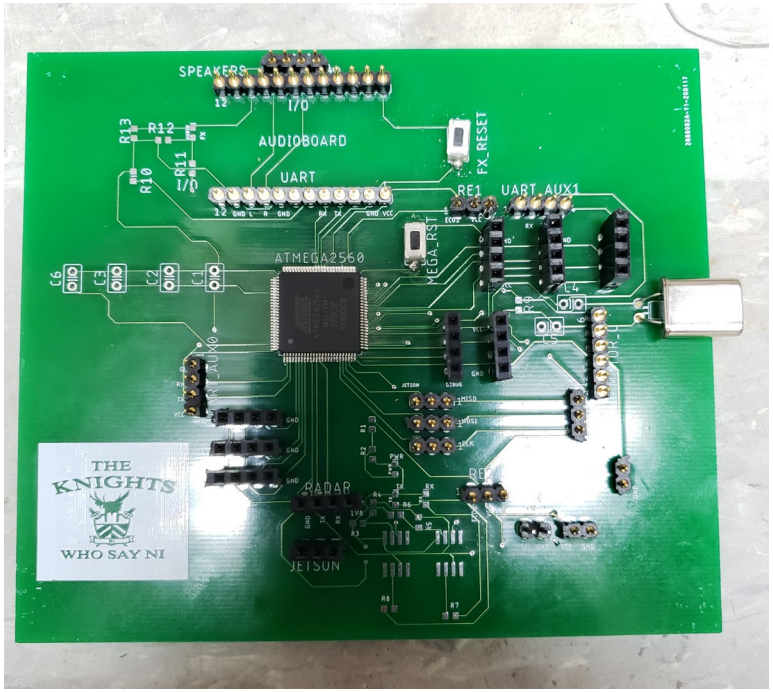
MCU Board PCB



MCU Board PCB (Production)



Bare MCU PCB v1.0

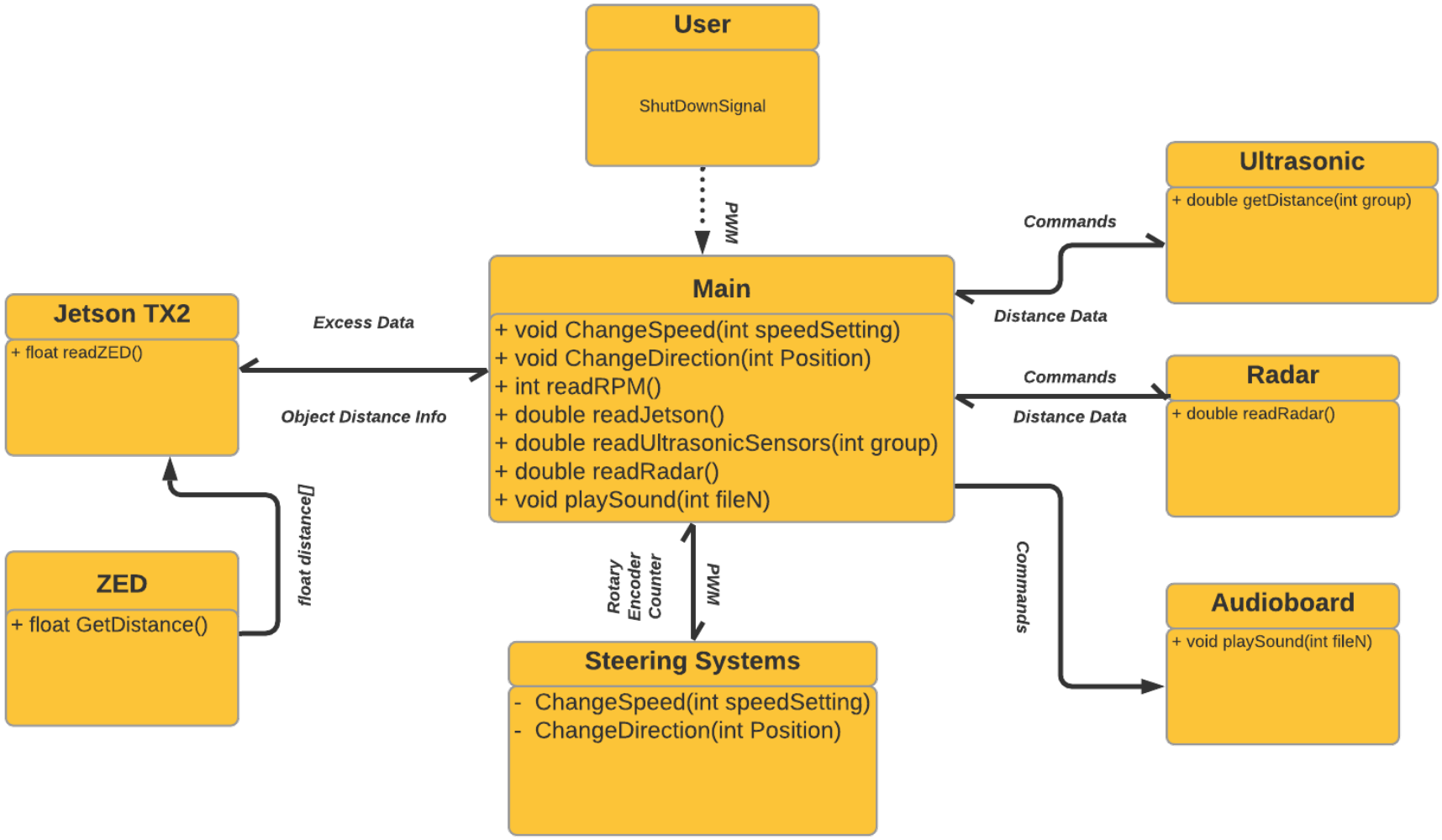


Partially Populated MCU PCB v1.0

Software Development

- Arduino IDE – Atmega
  - Read sensors
  - Send navigation signals
- Ubuntu Environment – Jetson
  - Read camera data
- ZED SDK – ZED Stereo Camera
  - Gathers distance data

Class Diagram



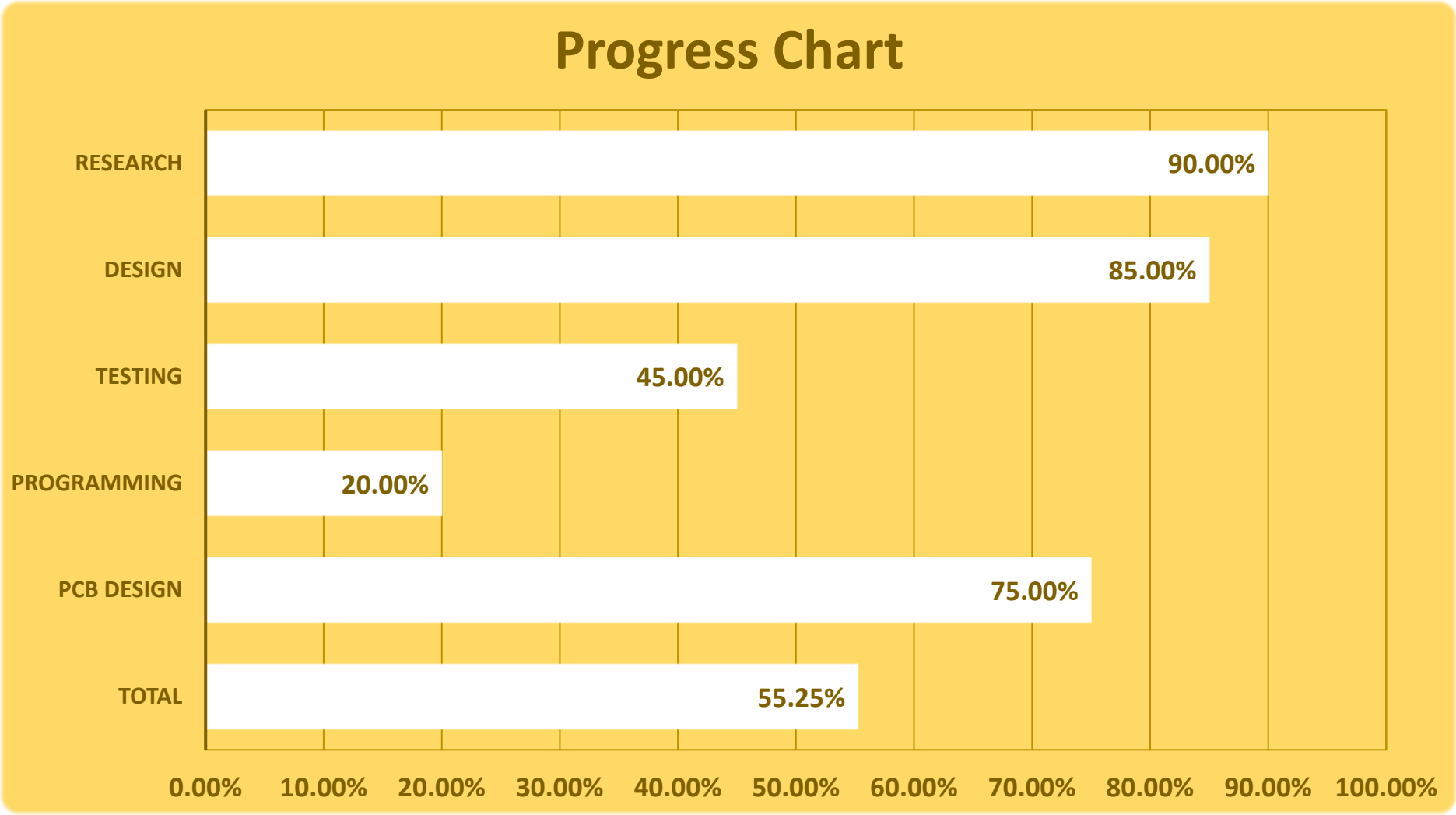
Economics

- Major components provided by our sponsor, Dr. Guo
- Secondary components purchased by "The Knights of NI"

Economics

Part Name	Part Number	MFR	Vendor	Unit	Price	Qty
* Carrier Board	ASG003	CTI	WDL Systems	EA	$174	1
* Jetson TX2	TX2	NVIDIA	NVIDIA	EA	$299	1
* Rotary	RS030	Sparkfun	Sparkfun	EA	$12.95	1
* Vehicle	74054-4	Traxxas	Traxxas	EA	$289	1
* 3D Camera	ZED	Stereolabs	Stereolabs	EA	$449	1
Microcontroller	Atmega2560-16AU	Arduino	Mouser	EA	$11.85	1
Radar	XM112	Acconeer	Mouser	EA	$74.95	1
Sound Board	2342	Adafruit	Adafruit	EA	$16.95	1
Ultrasonic	HC-SR04	WYPH	Amazon	10 pc	$12.99	1
				Grand Total		$1,335.96
				Out of Pocket Expense Total		$128.59

Progress Chart



Hurdles

- Motor control capability
- Integration of “Kill Switch”
- Lack of technical documents due to proprietary components

Q and A

- Suggestions?
- Tips?
- Feedback?
- Upgrades?