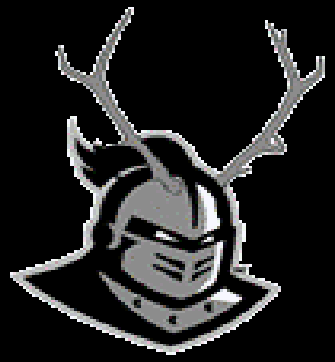
Autonomous Vehicle



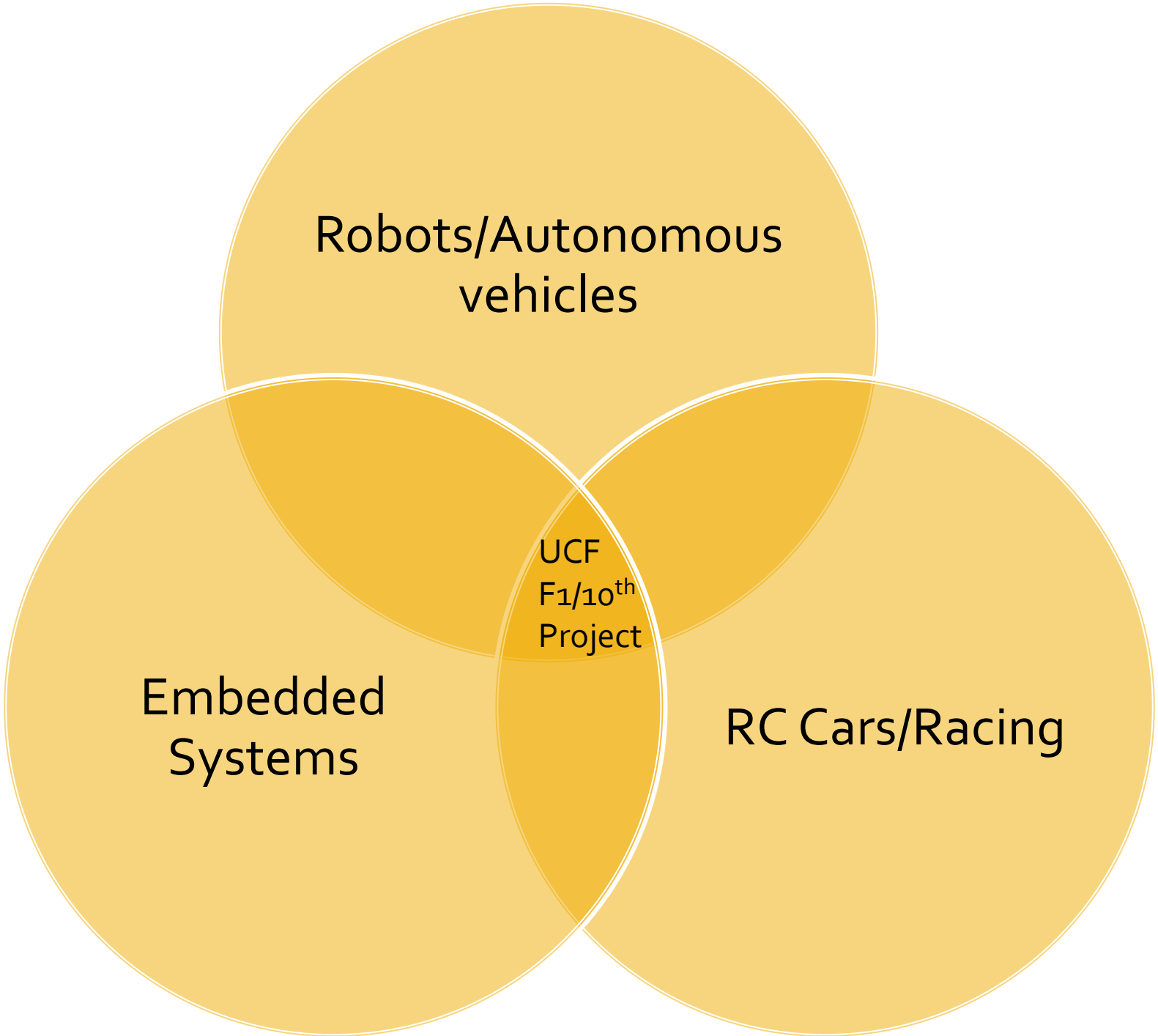
The Knights of Ni

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

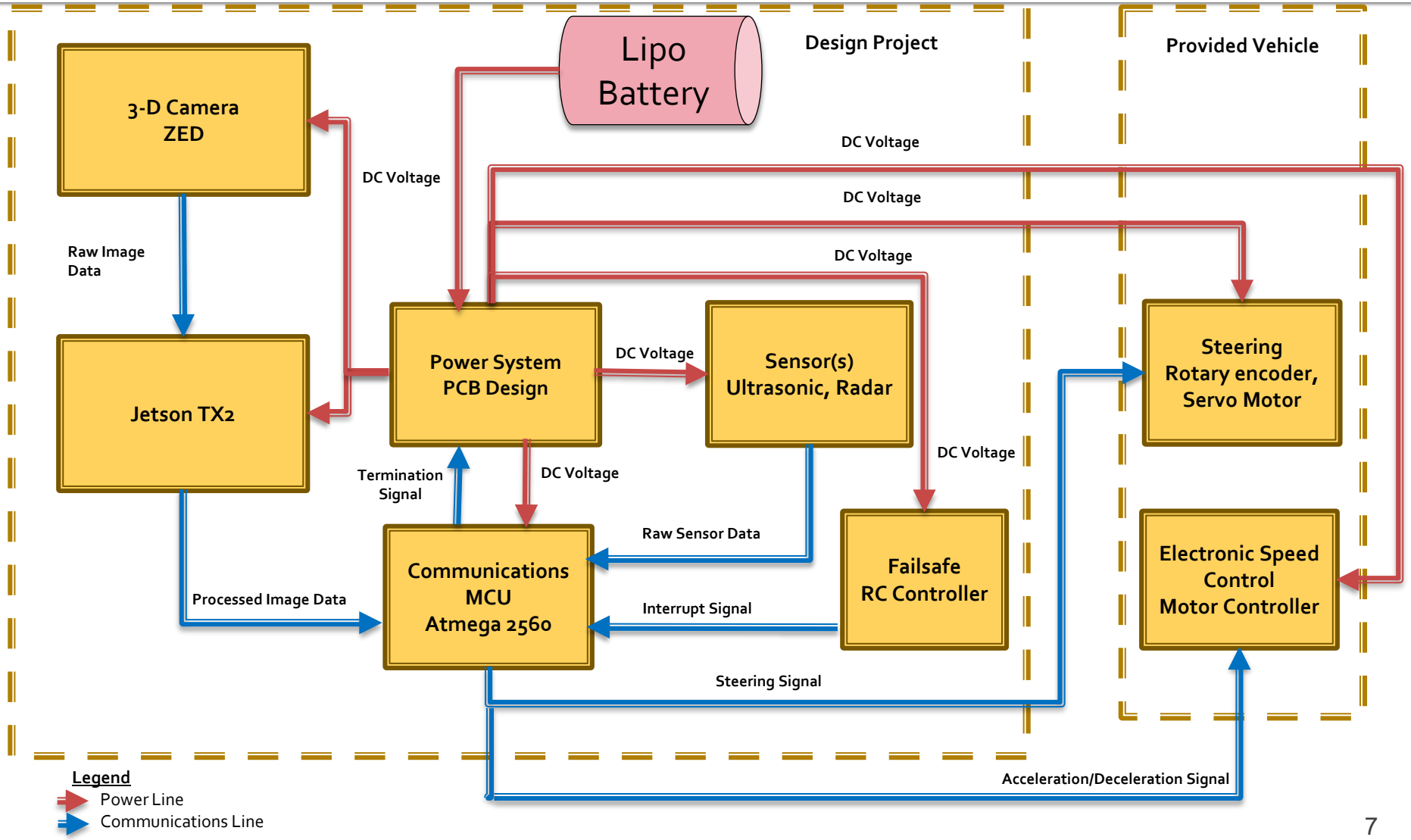
- Achieve a top speed of 5 mph
- Implement an emergency failsafe system to eliminate safety concerns associated with autonomous vehicles
- Achieve Level 4 automation

Level	0	1	2	3	4	5
Car	Nothing	Assist: Accelerate, brake or steer	Assist: Accelerate, brake and steer	Everything for short periods of time	Everything Restricted operating environment	Everything
Driver	Everything	Everything with some assistance	Everything with more assistance	Remain alert ready to resume control	Nothing restricted operating environment	Nothing

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

Design Choices

- Chassis Modifications
- Motors, Controllers & Safety
- Sensors/Communication Protocols
- Jetson/ZED
- MCU
- Power Supply/Battery Capacity

Chassis Modification

Physical Vehicle Modifications	
Plexiglass	Multilayered Payload Mounting Surfaces
Shocks	Shock Absorber Stiffening
Mounts	Sensor and Speaker
Wires	Harness construction

Motors, Controllers & Safety

Type	Model	Cost	Amps (A)	Specs	Status
Motor	Titan 12T 550	$0	3.5	19,300 RPM	Stock
	Velineon 3500	$169	4.5	50,000 RPM	Original
Speed	DRI0002	$11.18	2	6 ~ 12 V 2 A	Stock
	VXL-3S	$7.07	1	4.8 ~ 11.1 V 1 A	Original
Steering	Traxxas 2056 Servo	$0	2	6 V 60°	Stock
Safety	Audio FX Board	$16.95	1	3 ~ 5.5 V 16 MB	Changed

Distance Sensors

Type	Model	Range (cm)	Accuracy (cm)	Status	Communication Protocols
Ultrasonic	HC-SR04	2 ~ 400	0.3	Original	Analog
Radar	SEN0192	200 ~ 900	1	Changed	Analog
	XM-112	0 ~ 200	0.1	Original	UART
Camera	ZED Stereo 3D	20 ~ 2500		Provided	UART
Debug	FTDI	NA		Original	UART

Microcontroller

Model	Volts (V)	Memory (kB)	I/O Pins	Communications	Clock (MHz)	Core	UART Channels	Interrupt Pins
ATmega2560-16AU	4.5 ~ 5.5	256	86	2-Wire, SPI, UART	16	AVR	4	6

Note: Arduino libraries are more abundant and well-documented than other MCUs that we researched.

Battery Capacity

Original battery did not supply enough power. New 11.1V battery provides sufficient power:

- 11.1 V
- 5000 mAh
- 3S, 25C discharge rate

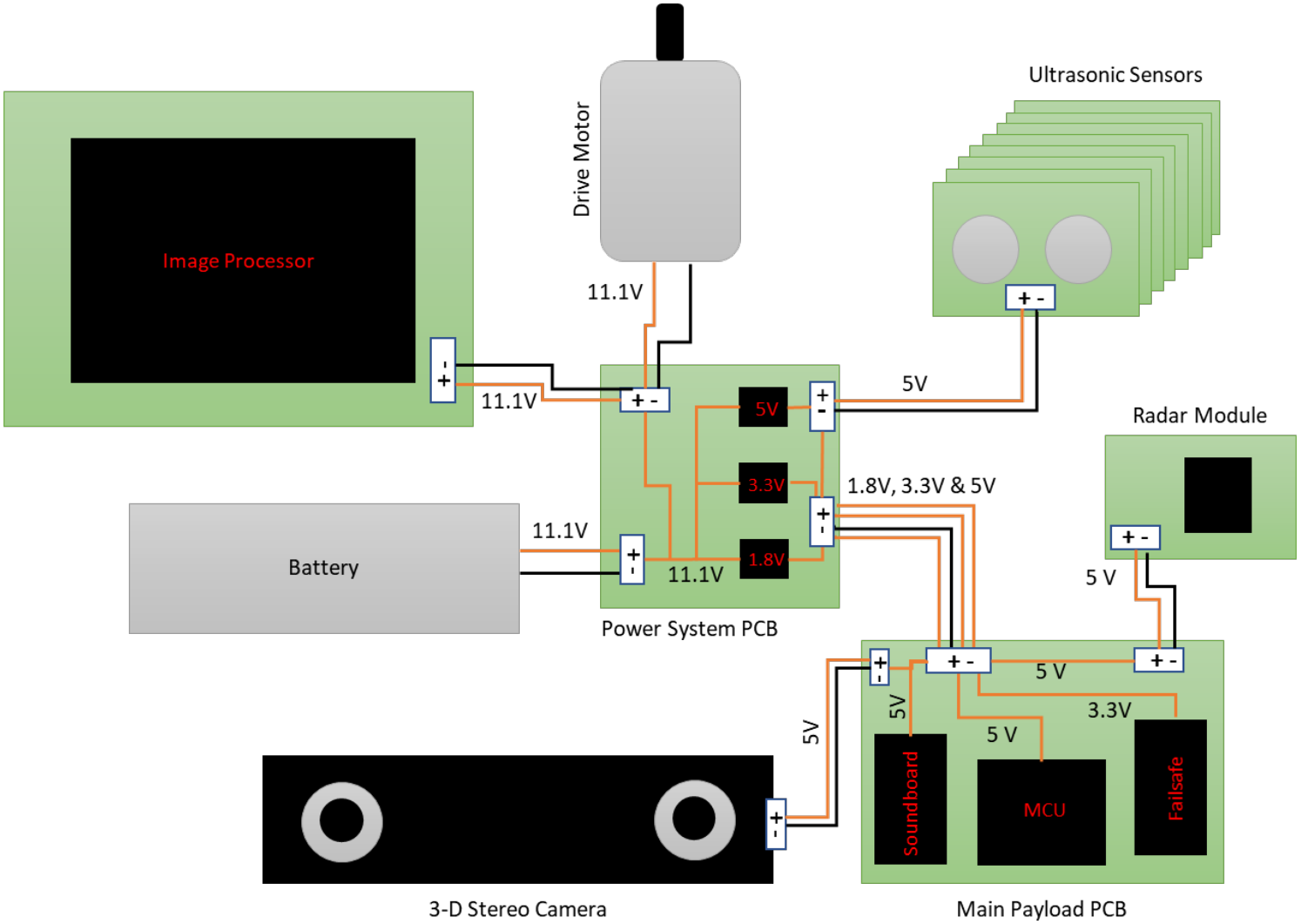
The regulators purchased to regulate the 7.4V battery will also regulate the 11.1V battery, and so our existing hardware is compatible with the new battery.

Power Supply

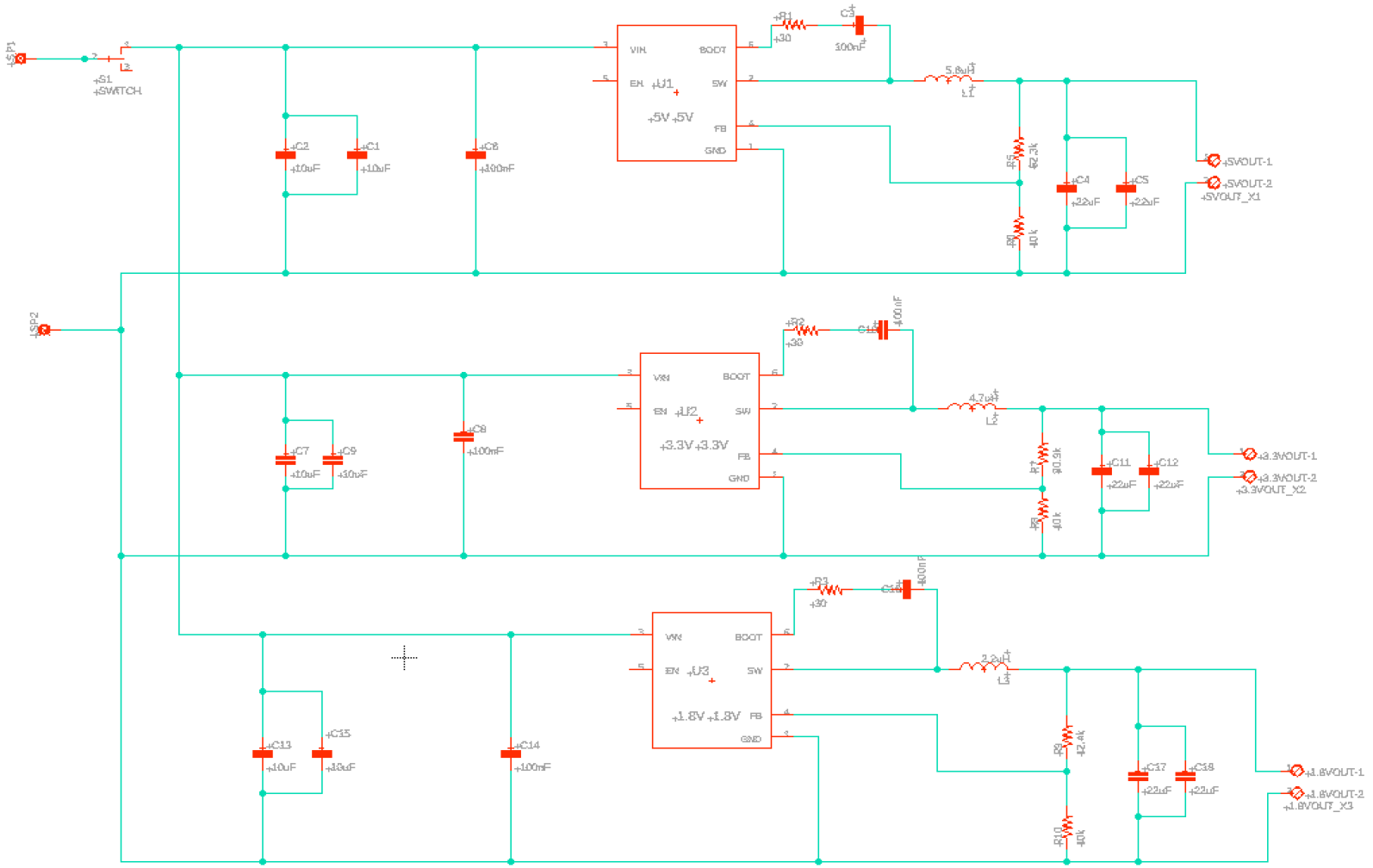
The power supply will regulate the 11.1VDC input voltage, provide by the LiPo battery pack, into three separate voltages for utilization by the autonomous vehicle.

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

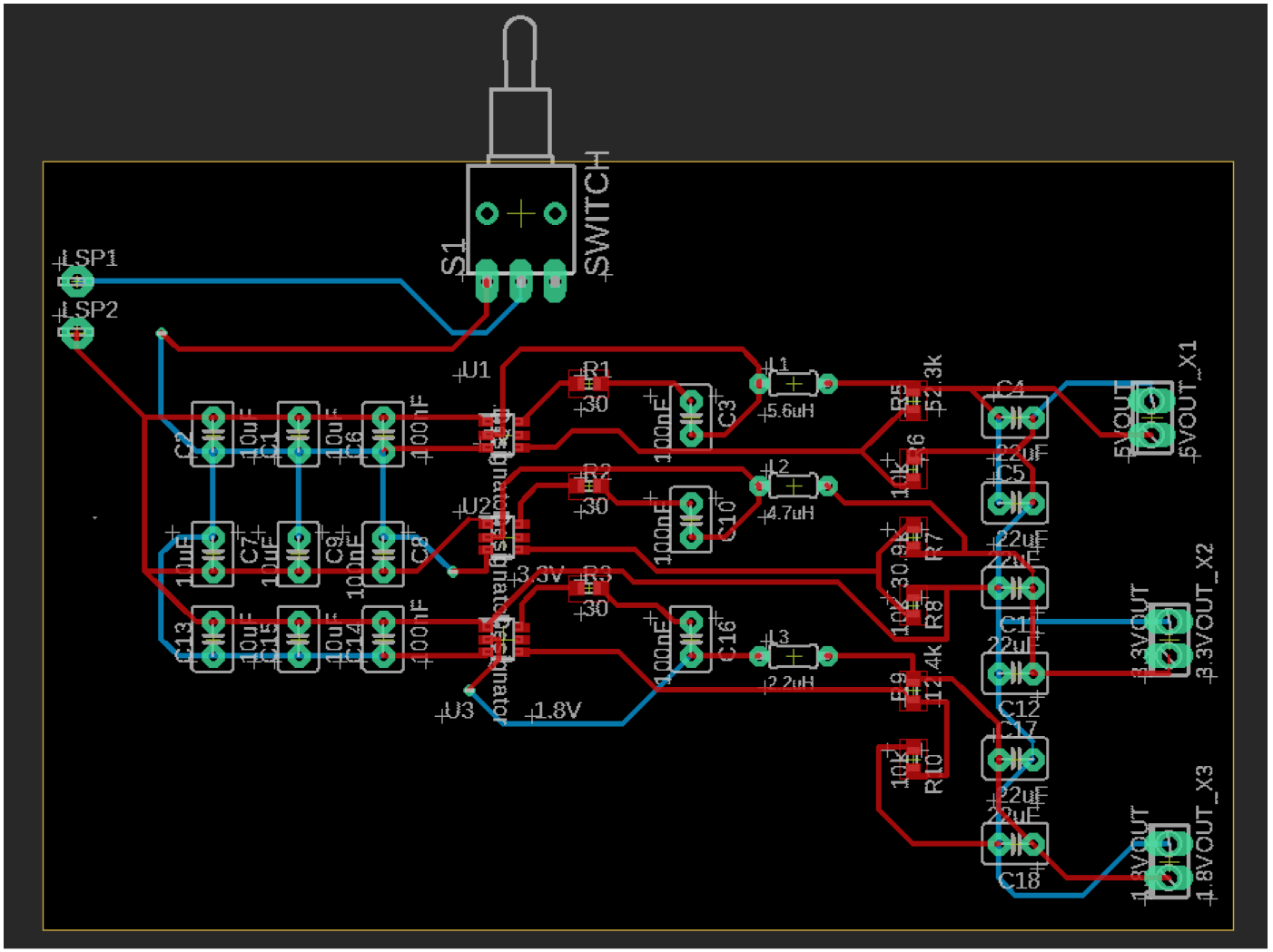
Voltage Flow Diagram



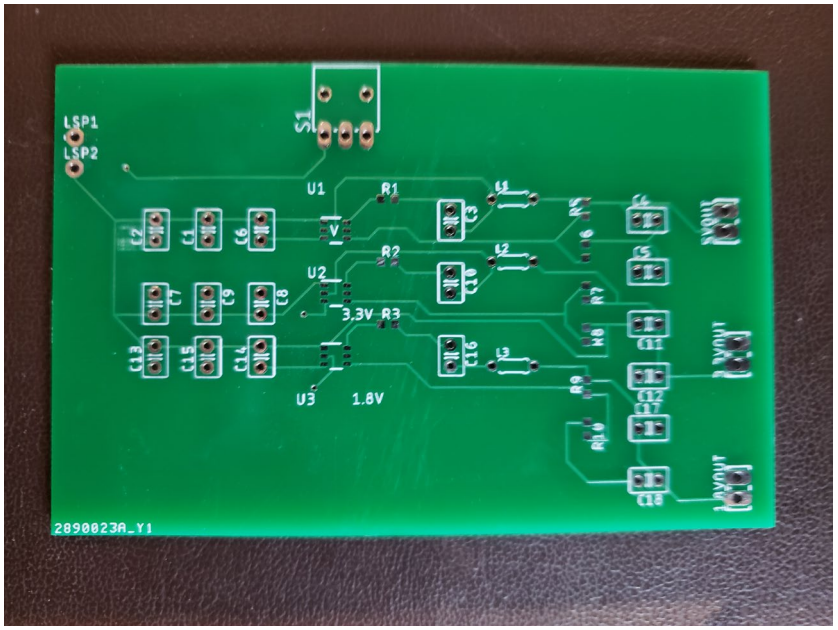
Power Supply Schematic



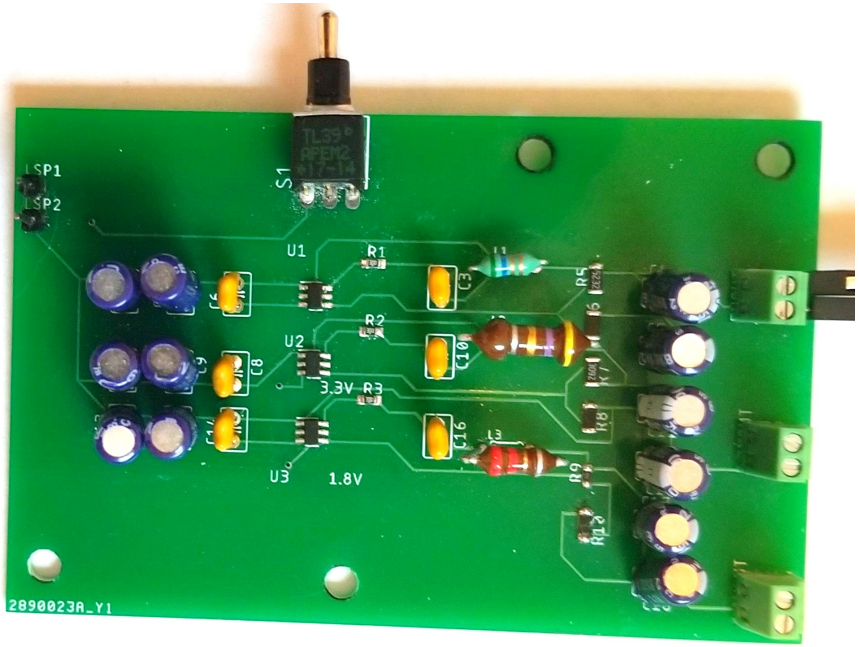
Power Supply PCB



Power Supply PCB (Production)

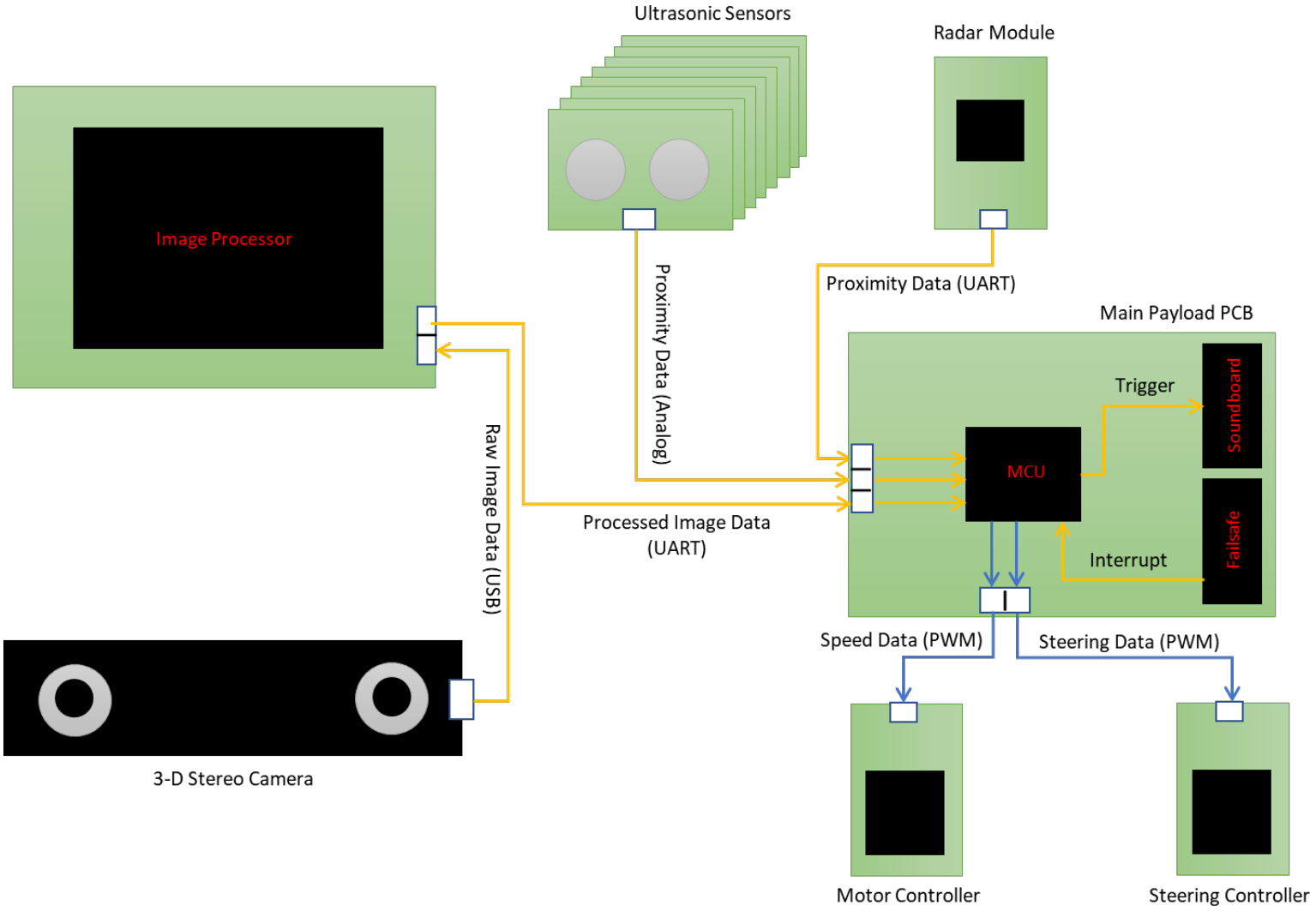


Bare Power PCB v1.0

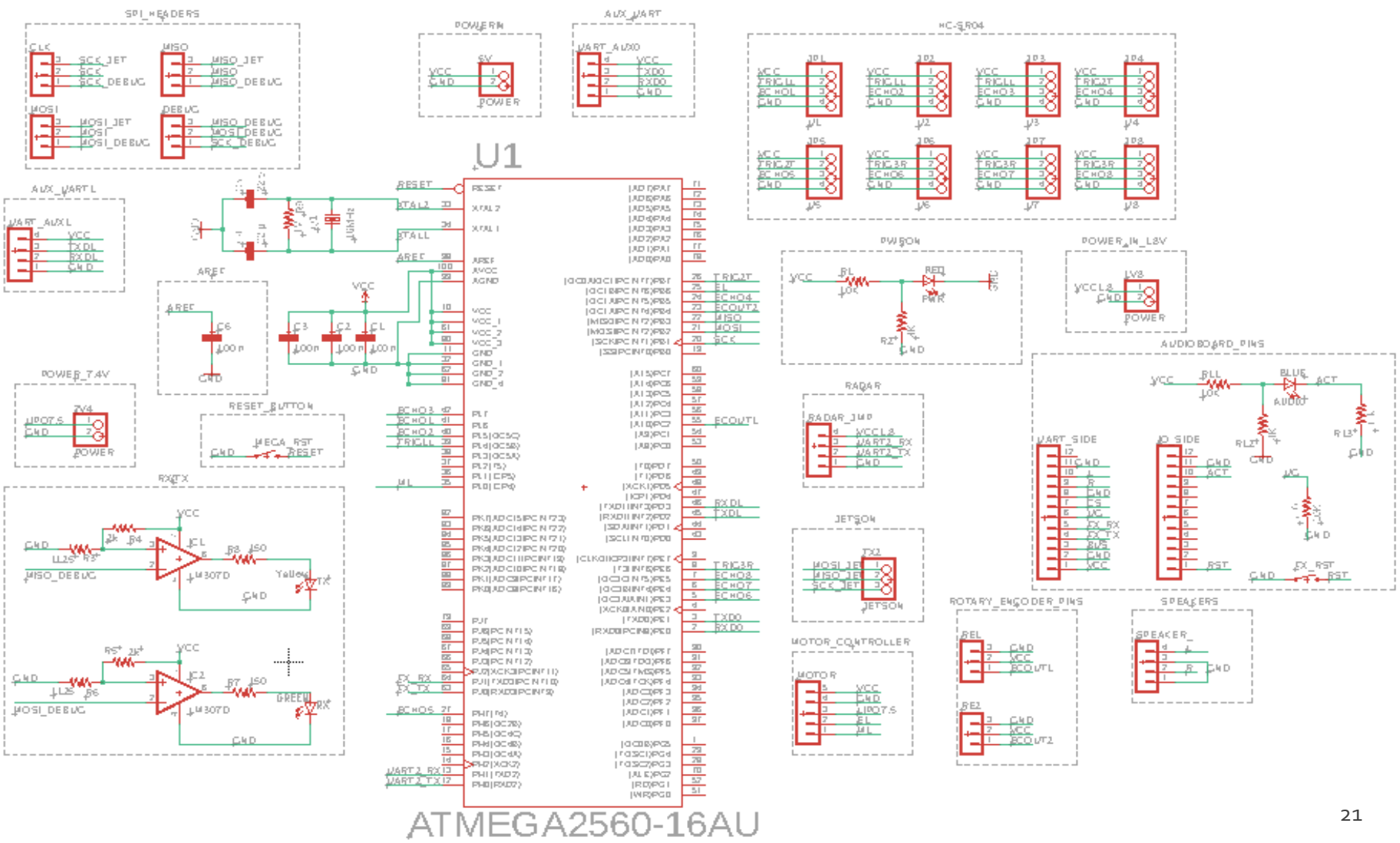


Power PCB v1.0

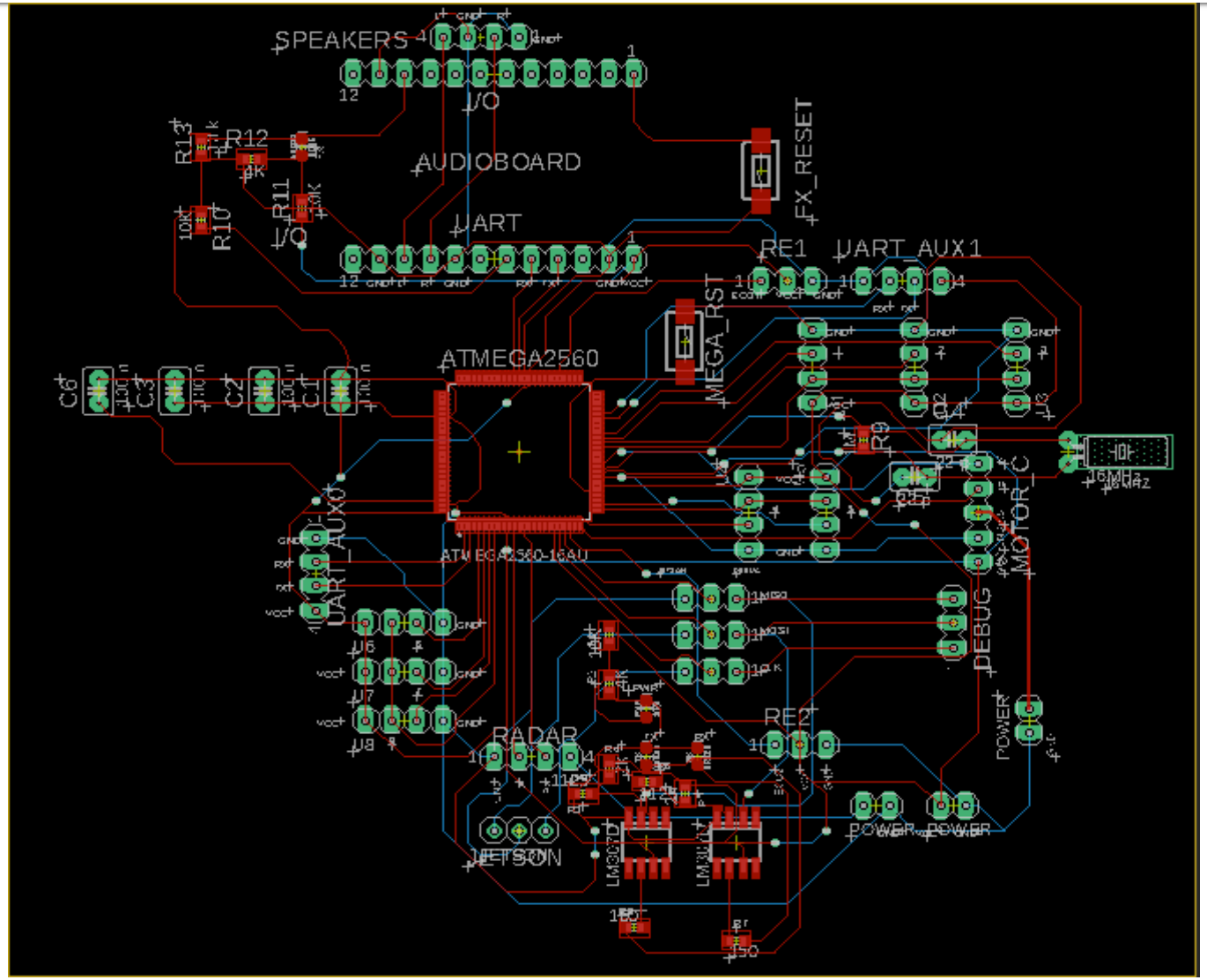
Signal Flow Diagram



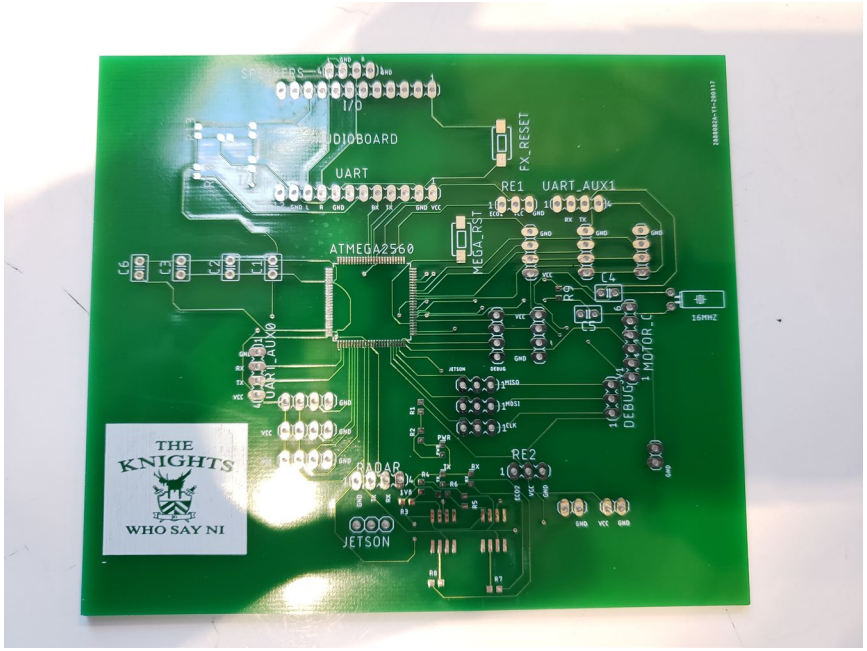
Sensor Board Schematic



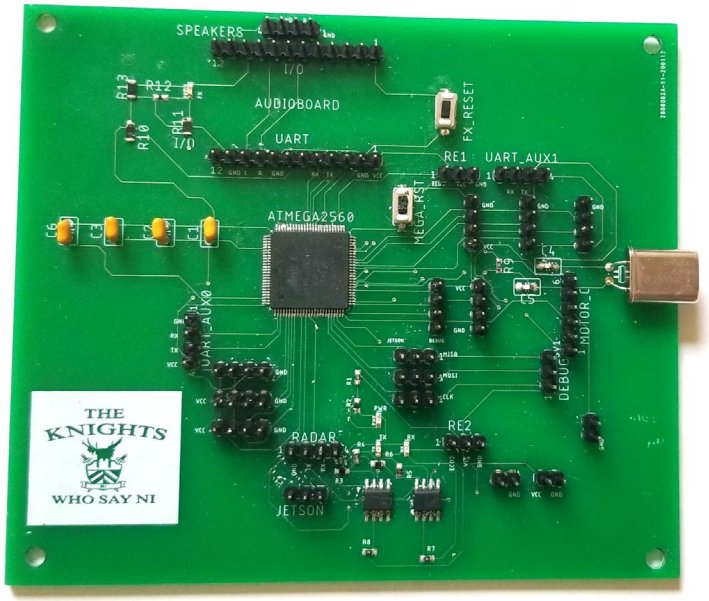
Sensor Board PCB



Sensor Board PCB (Production)

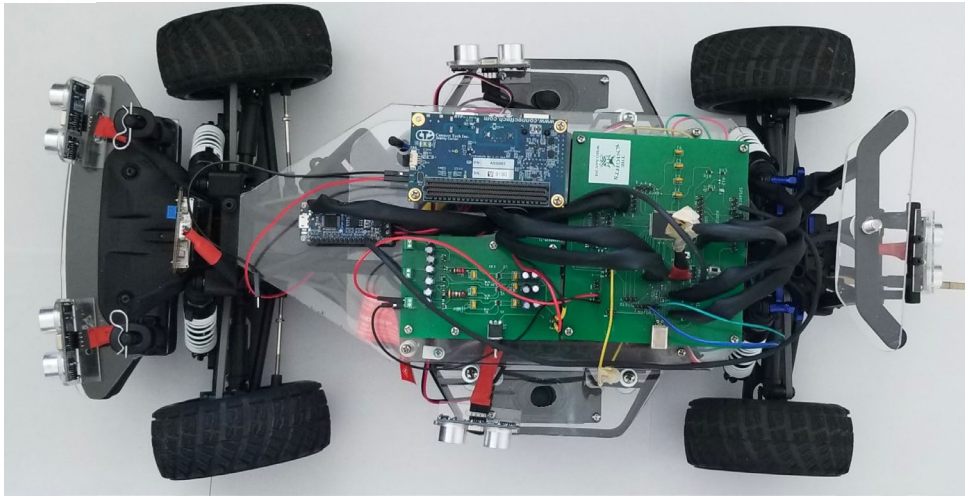


Bare MCU PCB v1.0

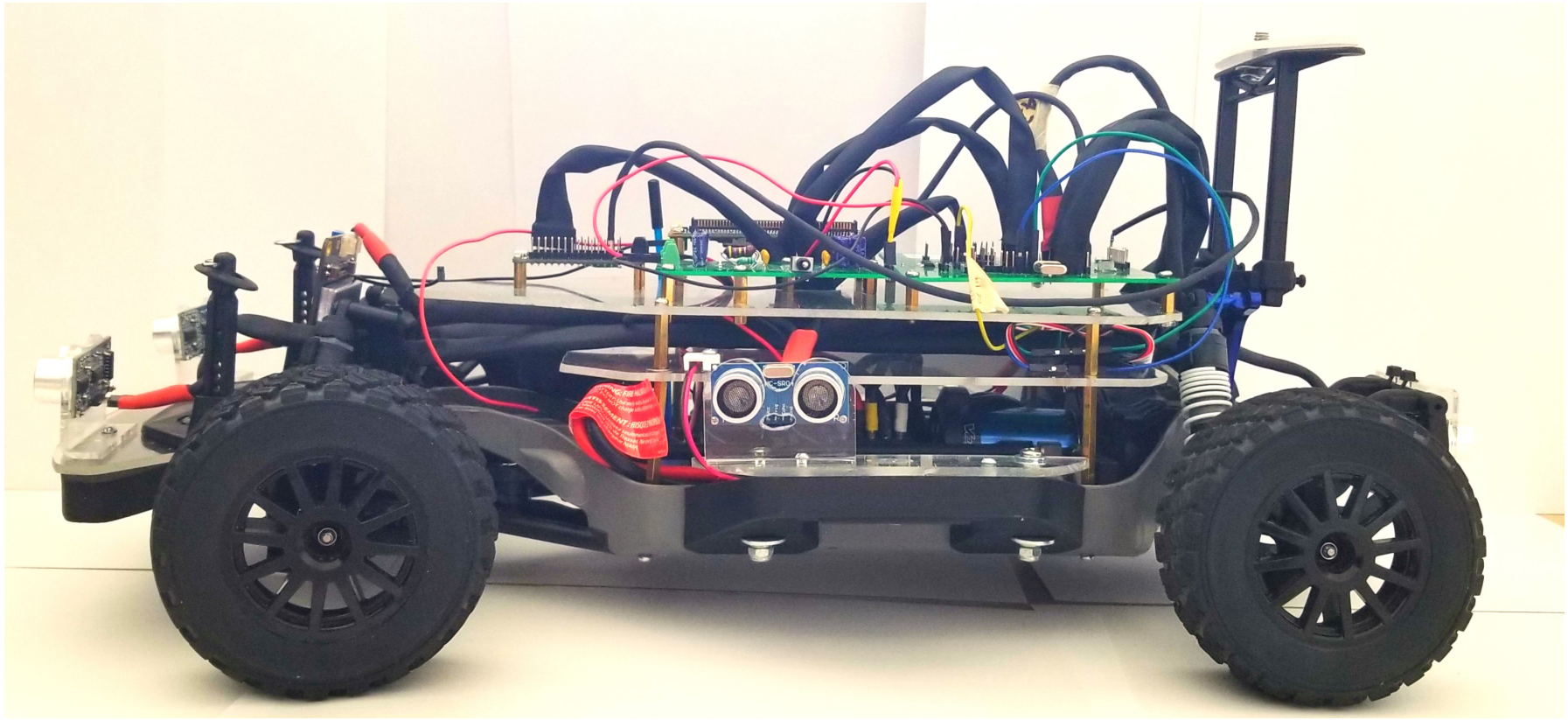


Populated MCU PCB v1.0

Vehicle Modifications



Vehicle Modifications



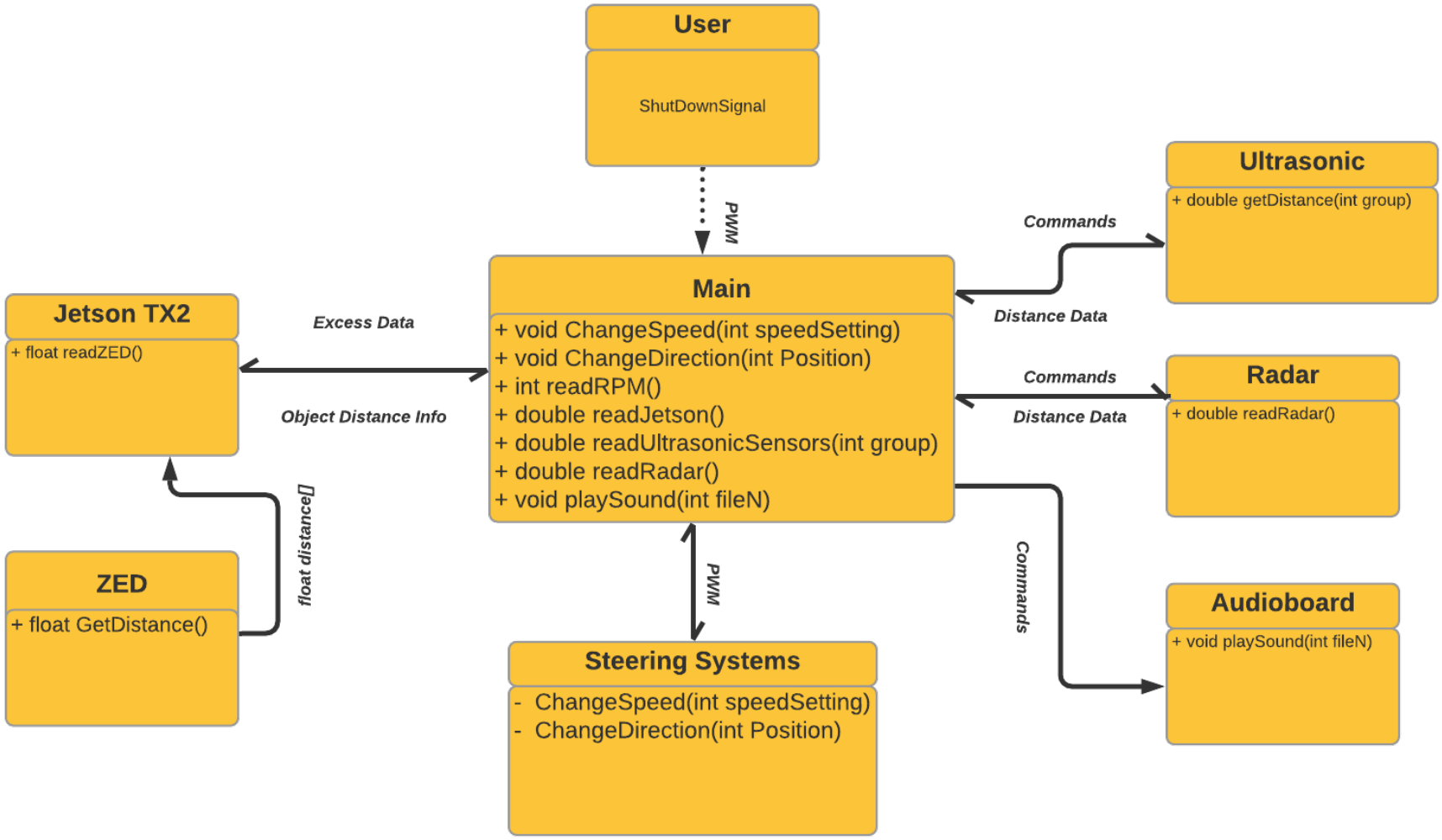
Software Development

- Arduino IDE – Atmega
  - Read sensors
  - Send navigation signals
- Ubuntu Environment – Jetson/ZED
  - Read camera data

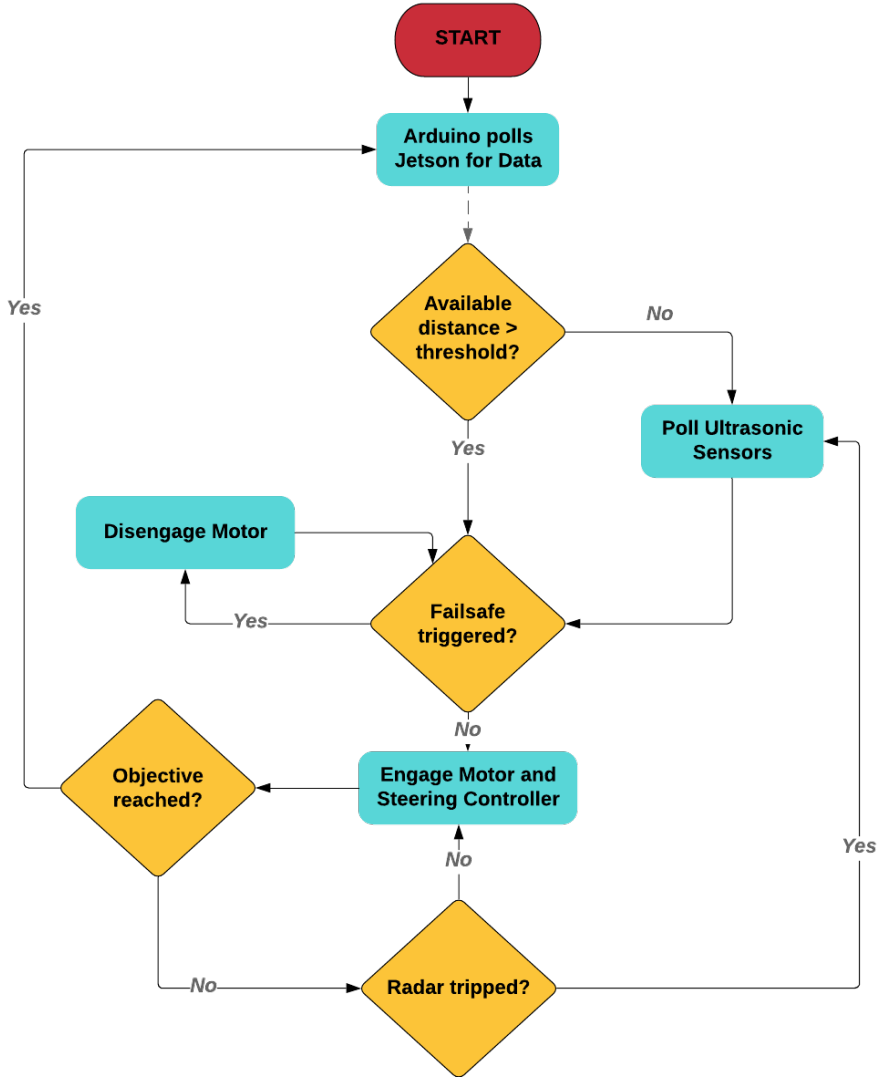
Software Description

- Arduino:
  - Velocity and Turning Radius predetermined
  - Makes decision based on camera data
- Jetson:
  - Takes average distances corresponding to turning angles
  - Sends payload over UART channel

Software Class Diagram



Software Flowchart



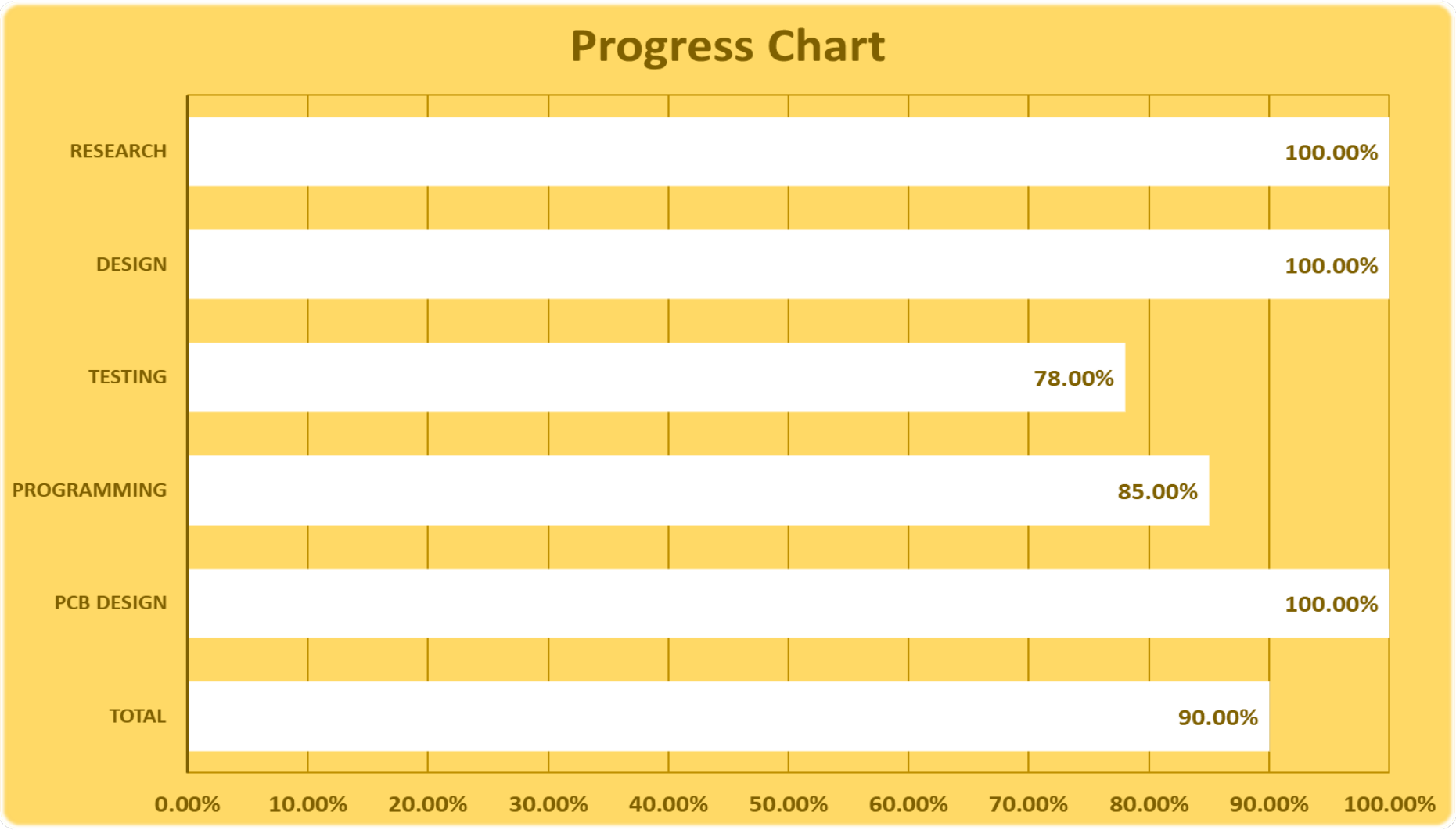
Economics

- 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
5000mAh Li-po	2832X	Traxxas	Traxxas	EA	$69.95	1
				Grand Total		$1,405.91
				Out of Pocket Expense Total		$198.54

Progress Chart



Challenges

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

Thank You

- The “Knights of NI” would like to extend our sincerest gratitude to the faculty during these trying times and we appreciate your patience, understanding and attention during our presentation.