VEHICLE INNOVATION TEAM

COLORADO STATE UNIVERSITY

CSU CAVs

Acknowledgements

- Sponsors
- Faculty Advisors:
  - Dr. Sudeep Pasricha
  - Dr. Thomas Bradley
  - Dr. Jason Quinn
  - Dr. Bret Windom
- Mentors:
  - Aaron Rabinowitz, Project Manager
  - Ben McKenney, Engineering Manager
  - Derek Adelman, Systems Safety Manager
  - Rachel Taylor, Communications Manager
  - Anthony Heap, General Motors
  - Scott Furry, Mathworks

Headline

U.S. DEPARTMENT OF ENERGY · GENERAL MOTORS · MathWorks

Visionary

NXP · NSF

Leadership

intel · AAM · BOSCH Invented for life · PACCAR · dSPACE

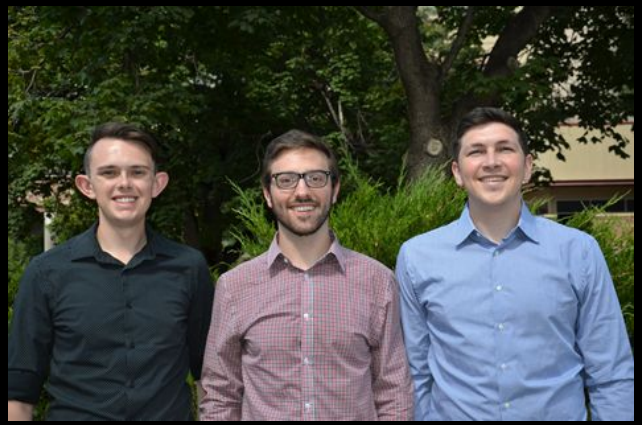
Sustaining

SIEMENS · DENSO · AVL · HORIBA

Contributor

Delphi Technologies · CALIFORNIA AIR RESOURCES BOARD · PROTERRA · tesa great to work with · VECTOR · EPRI ELECTRIC POWER RESEARCH INSTITUTE

Who are your presenters and their team?



Wes Taylor, JT Bovee, Mason Cheshier

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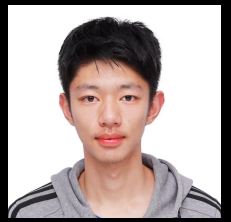
Undergraduate:

Kevin Alamo-Perez



Huanjia Liu

Drew Rackow

Graduate:

Joydeep Dey

Xinming Ye

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PRESENTATION OUTLINE

1

Lesson 1.

Importance of Project

2

Lesson 2.

Year-long goals

3

Lesson 3.

Fall 2019 Progress

4

Lesson 4.

Hardware and Software Architecture

5

Lesson 5.

Future Work

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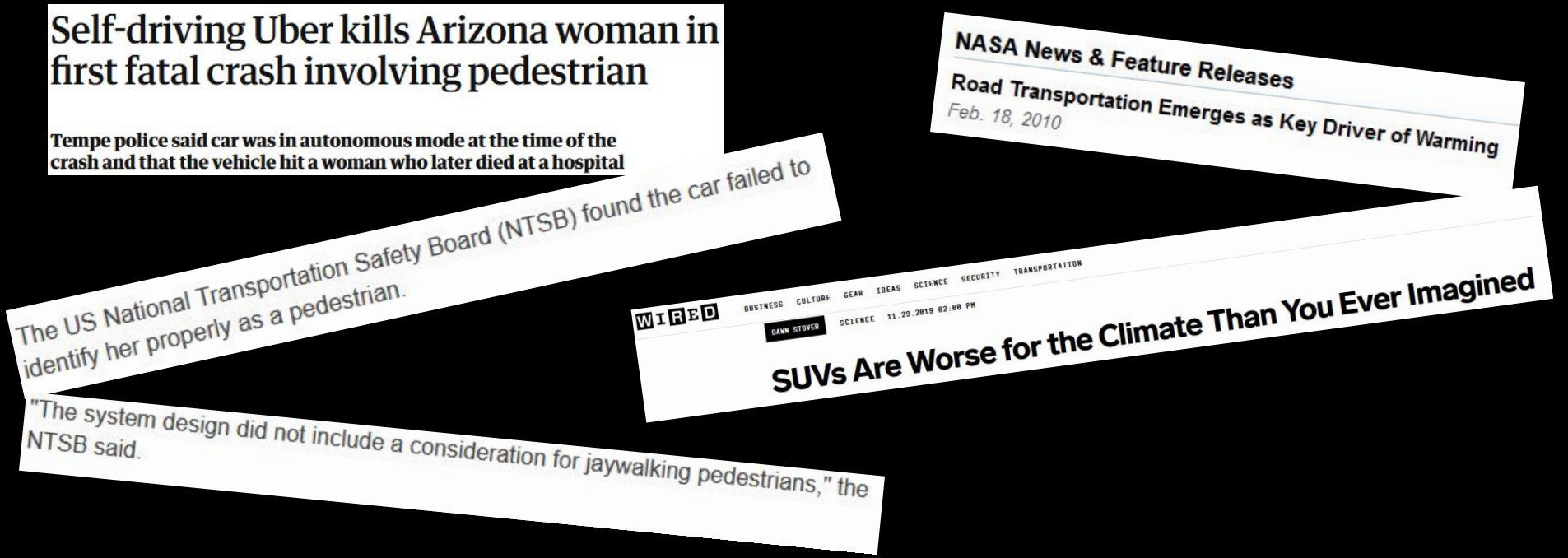
Importance of Project



Citations:
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https://www.bbc.com/news/business-50312340
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https://www.wired.com/story/suvs-are-worse-for-the-climate-than-you-ever-imagined/

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Year-Long Goals

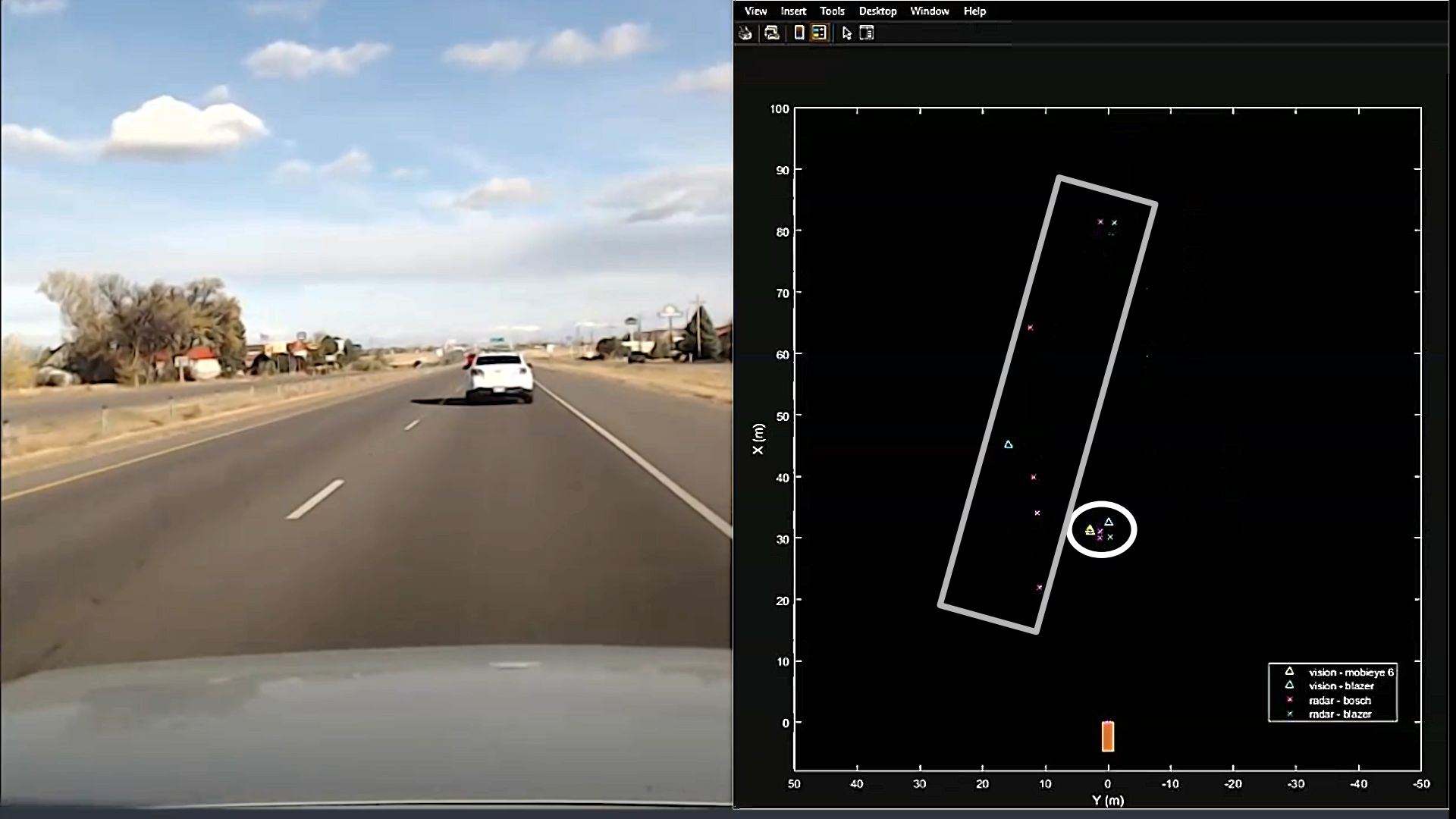
Prototype a CAV system that can perform:

1. Lane-Keep Assist
2. Automated Cruise Control (ACC)

Better than the stock Chevrolet system

Progress Fall 2019

- Characterized the Blazer CAVs system
- Gathered data with our Mobileye 6 and Bosch radar
- Developed our software architecture and sensor diagnostics
- Went over system safety for our CAVs system


View Insert Tools Desktop Window Help
X (m)
Y (m)
vision - mobileye 6
vision - blazer
radar - bosch
radar - blazer

CAVs Sensor Mounting on Blazer

Sensors

Mobileye 630

FLIR BlackFly

Leddar M16 LiDAR

Bosch MRR

U-Blox GNSS Receiver

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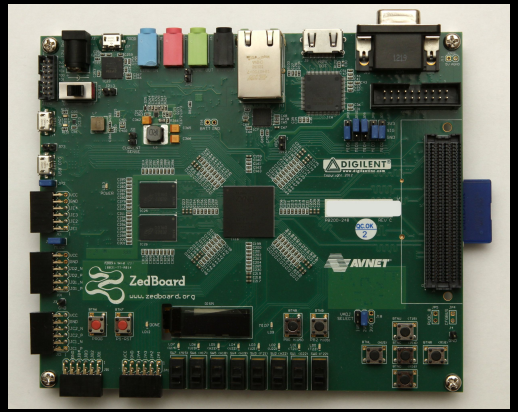
Development Boards

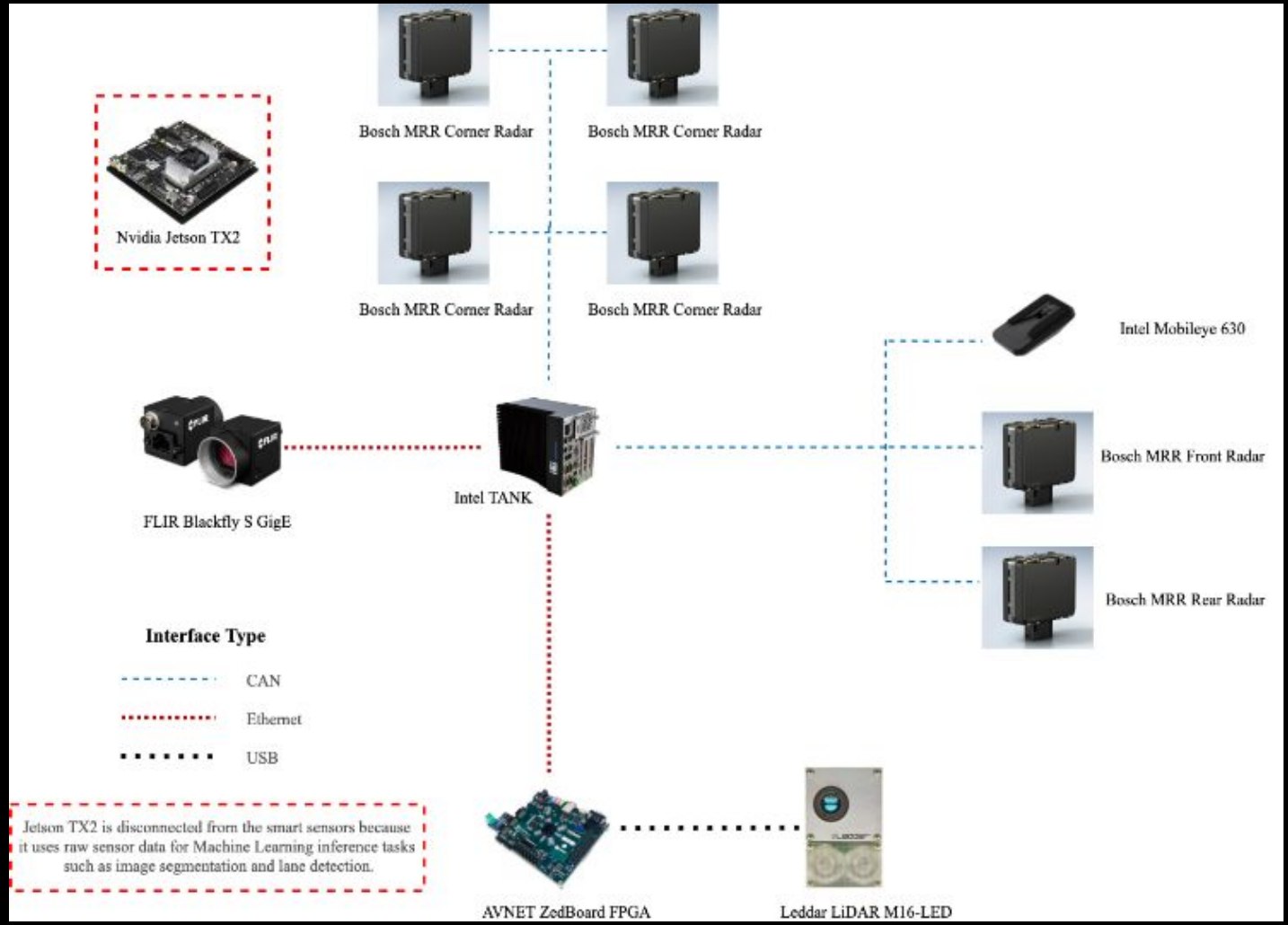
Jetson TX2



Zedboard Zynq-7000

IEI TANK

Hardware Architecture



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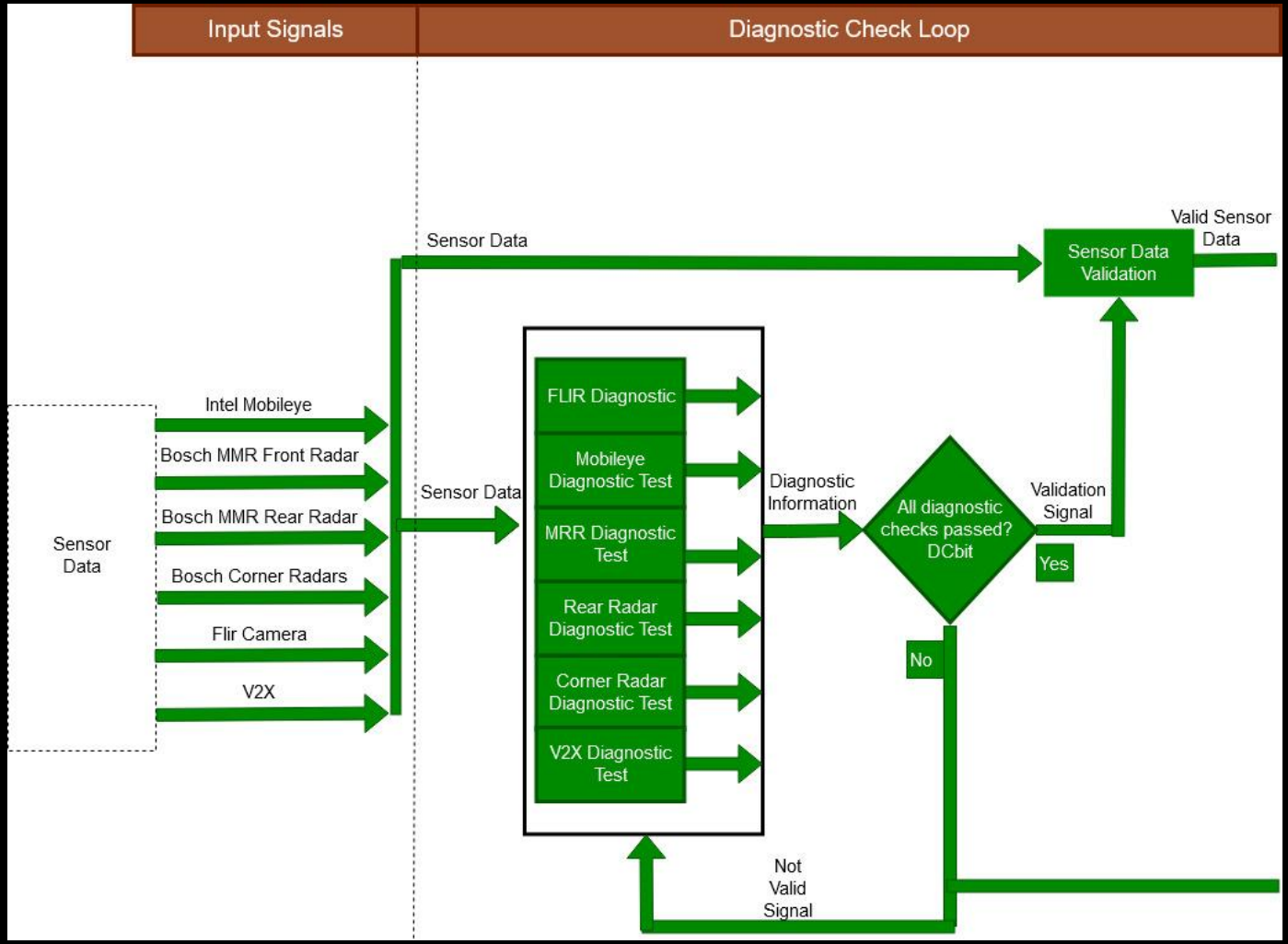
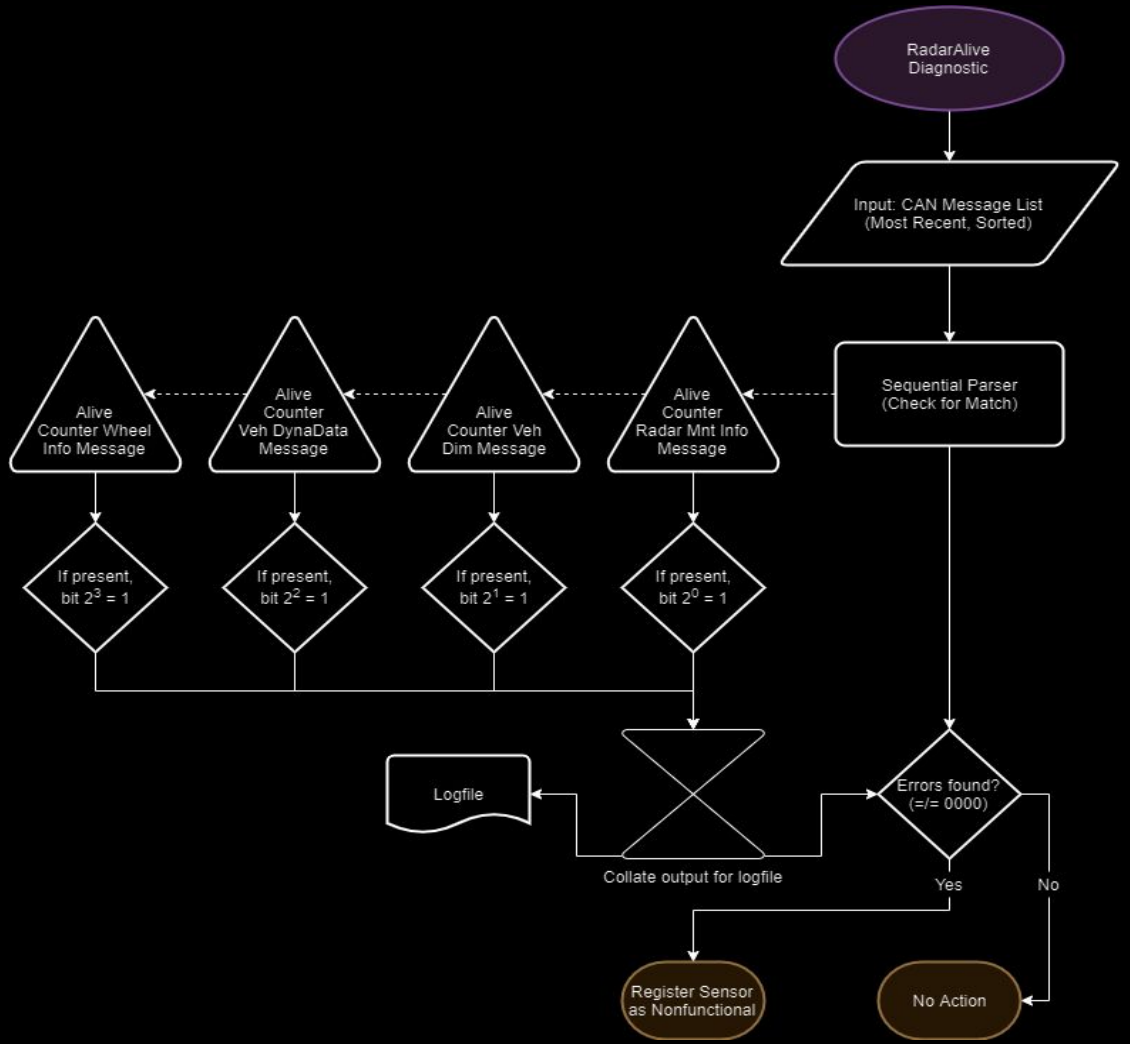
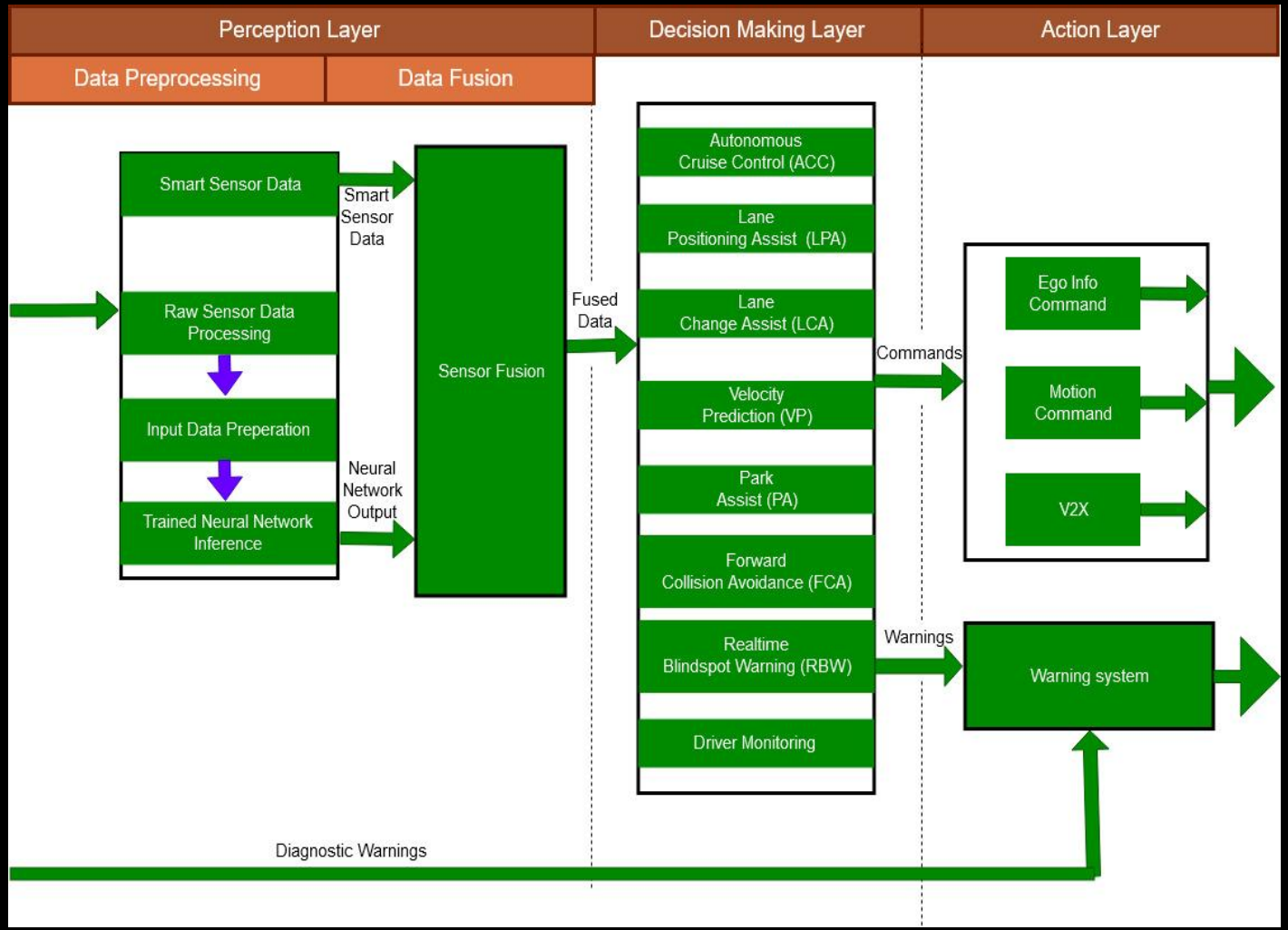
Software Architecture



Diagnostic Check



Software Architecture cont.



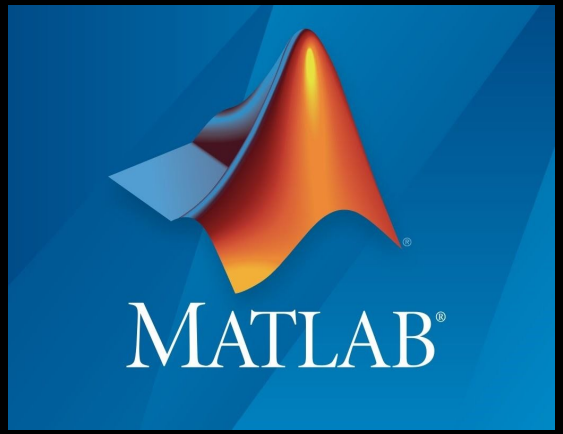
SEFA Safety Testing

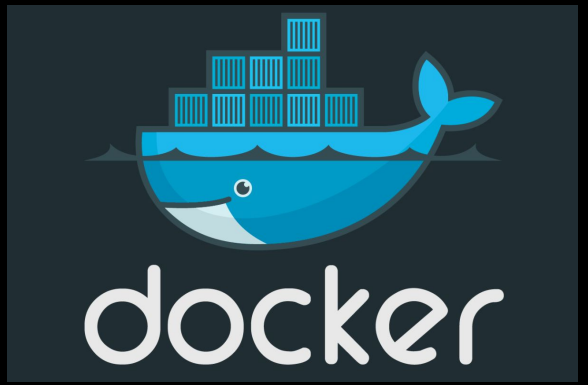
			PRIMARY Fault / RESULTING Fault																
			Element Operating States																
Item Number	**Normal Operation in Perception**	**Function(s)** (Responsibilities)	Element name 1	Element name 2	Element name 3	Element name 4	Element name 5	Element name 6	Element name 7	Element name 8	Element name 9	Element name 10	Element name 11	Element name 12	**Impact of Element Fault** (Impact prior to any remedial or mitigation actions)	**Immediate Resulting State** (State of the system prior to any remedial or mitigation actions)	**Potential Safety Hazard(s)**	**Diagnostic Method(s)**	**Mitigation Action(s)**	**System State After Mitigation**	**SAFETY Requirements**	**Safety Comments / Questions**
	Normal Operation	*System Functions to be Delivered*	1	1	1	1	1	1	1	1	1	1	1	1	NORMAL OPERATION		NONE	NONE	NONE	NONE	NONE	NONE
1	Intel TANK	Data Processing for sensors, Motion Requests for ACC, LPA, LCA, VP, PA, FCW, RBW	0	0	0	0	0	0	0	0	0	0	0	0	CAVs System Offline	CAVs Fault Light Illuminated, CAVs features disabled	Possibility of vehicle accident without adequate driver intervention	MABx II determines that CAVs controller is broken. Inspection of CAVs controller will determine fault	attempt reinitialization or automated system diagnostic and repair of CAVs controller or replace CAVs controller	All or portion of CAVs features re-enabled	Ensure CAVs system is securely mounted to prevent inadvertent tampering (etc. accidental coffee spill, more than 10 pounds of force applied to TANK) and ensure TANK software stack is robust enough to tolerate automated on-the-fly diagnosis and re-initialization	NONE
2	Nvidia Jetson TX2	Data Processing for either FLIR or Leddar LiDAR	1	0	1	0	1	1	1	1	1	1	1	0	CAVs System no longer recieveing FLIR or Leddar data	LPA, VP Disabled. PA, FCA, Performance Diminished	Sudden loss of CAVs features could lead to vehicle accident without adequate driver intervention	CAVs controller diagnostics will determine loss of Jetson	attempt reinitialization or automated system diagnostic and repair of Jetson or replace Jetson	Disabled CAVs features re-enabled, Diminished CAVs features at full performance	Ensure CAVs system is securely mounted to prevent inadvertent tampering (etc. accidental coffee spill, no force applied to Jetson) and ensure Jetson software stack is robust enough to tolerate automated on-the-fly diagnosis and re-initialization	NONE
3	AVNET ZedBoard FPGA	Data Processing for either FLIR or Leddar LiDAR	1	1	0	0	1	1	1	1	1	1	1	0	CAVs System no longer recieveing FLIR or Leddar data	LPA, VP Disabled. PA, FCA, Performance Diminished	Sudden loss of CAVs features could lead to vehicle accident without adequate driver intervention	CAVs controller diagnostics will determine loss of ZedBoard	attempt reinitialization or automated system diagnostic and repair of ZedBoard or replace ZedBoard	Disabled CAVs features re-enabled, Diminished CAVs features at full performance	Ensure CAVs system is securely mounted to prevent inadvertent tampering (etc. accidental coffee spill, no force applied to ZedBoard) and ensure ZedBoard software stack is robust enough to tolerate automated on-the-fly diagnosis and re-initialization	NONE

Future Work

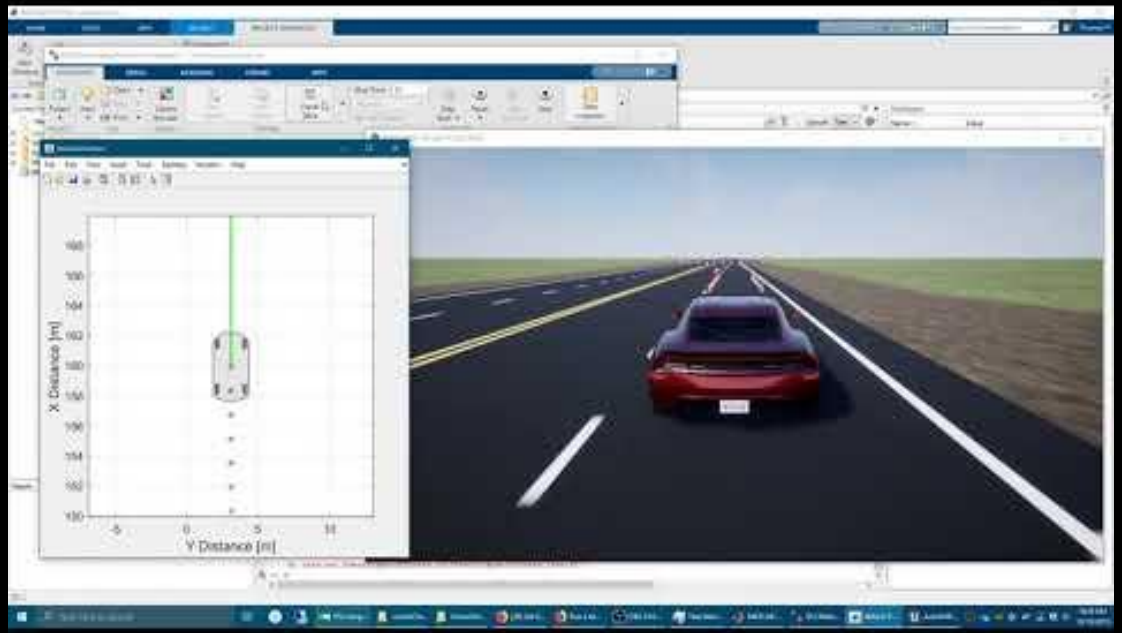
- Use collected sensor data and matlab simulations to develop ACC and LKA
- Develop communications between the controls system and CAVs system

Software Stack





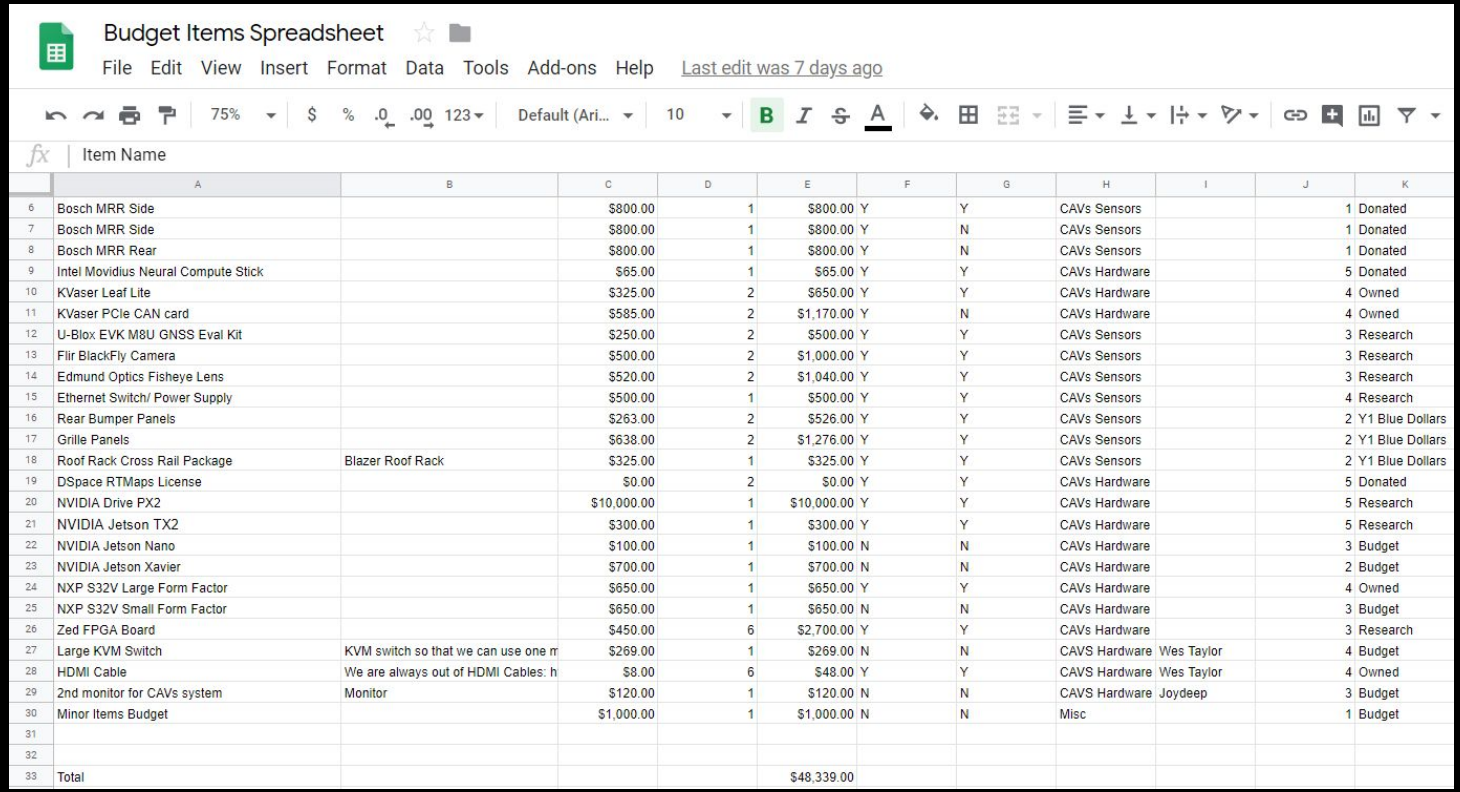
Software Demo



Algorithms

- Sensor Fusion
- Lane Detection
- Lane Keeping
- Object Detection
- Distance Estimation
- Intel RSS Compliance

Budget



Budget Items Spreadsheet

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fx Item Name

	A	B	C	D	E	F	G	H	I	J	K
6	Bosch MRR Side		$800.00	1	$800.00	Y	Y	CAVs Sensors		1	Donated
7	Bosch MRR Side		$800.00	1	$800.00	Y	N	CAVs Sensors		1	Donated
8	Bosch MRR Rear		$800.00	1	$800.00	Y	N	CAVs Sensors		1	Donated
9	Intel Movidius Neural Compute Stick		$65.00	1	$65.00	Y	Y	CAVs Hardware		5	Donated
10	KVaser Leaf Lite		$325.00	2	$650.00	Y	Y	CAVs Hardware		4	Owned
11	KVaser PCIe CAN card		$585.00	2	$1,170.00	Y	N	CAVs Hardware		4	Owned
12	U-Blox EVK M8U GNSS Eval Kit		$250.00	2	$500.00	Y	Y	CAVs Sensors		3	Research
13	Flir BlackFly Camera		$500.00	2	$1,000.00	Y	Y	CAVs Sensors		3	Research
14	Edmund Optics Fisheye Lens		$520.00	2	$1,040.00	Y	Y	CAVs Sensors		3	Research
15	Ethernet Switch/ Power Supply		$500.00	1	$500.00	Y	Y	CAVs Sensors		4	Research
16	Rear Bumper Panels		$263.00	2	$526.00	Y	Y	CAVs Sensors		2	Y1 Blue Dollars
17	Grille Panels		$638.00	2	$1,276.00	Y	Y	CAVs Sensors		2	Y1 Blue Dollars
18	Roof Rack Cross Rail Package	Blazer Roof Rack	$325.00	1	$325.00	Y	Y	CAVs Sensors		2	Y1 Blue Dollars
19	DSpace RTMaps License		$0.00	2	$0.00	Y	Y	CAVs Hardware		5	Donated
20	NVIDIA Drive PX2		$10,000.00	1	$10,000.00	Y	Y	CAVs Hardware		5	Research
21	NVIDIA Jetson TX2		$300.00	1	$300.00	Y	Y	CAVs Hardware		5	Research
22	NVIDIA Jetson Nano		$100.00	1	$100.00	N	N	CAVs Hardware		3	Budget
23	NVIDIA Jetson Xavier		$700.00	1	$700.00	N	N	CAVs Hardware		2	Budget
24	NXP S32V Large Form Factor		$650.00	1	$650.00	Y	Y	CAVs Hardware		4	Owned
25	NXP S32V Small Form Factor		$650.00	1	$650.00	N	N	CAVs Hardware		3	Budget
26	Zed FPGA Board		$450.00	6	$2,700.00	Y	Y	CAVs Hardware		3	Research
27	Large KVM Switch	KVM switch so that we can use one m	$269.00	1	$269.00	N	N	CAVS Hardware	Wes Taylor	4	Budget
28	HDMI Cable	We are always out of HDMI Cables: h	$8.00	6	$48.00	Y	Y	CAVS Hardware	Wes Taylor	4	Owned
29	2nd monitor for CAVs system	Monitor	$120.00	1	$120.00	N	N	CAVS Hardware	Joydeep	3	Budget
30	Minor Items Budget		$1,000.00	1	$1,000.00	N	N	Misc		1	Budget
31											
32											
33	Total				$48,339.00						

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Conclusion

- By the end of this year, we will have a baseline CAVs system which can track a lead vehicle
- We are building a system that can perform ACC/LKA *safely*
- Opening the door for vehicle autonomy research here at CSU