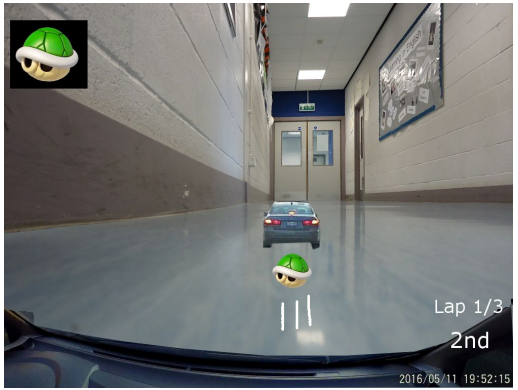
Team A9: ARioKart

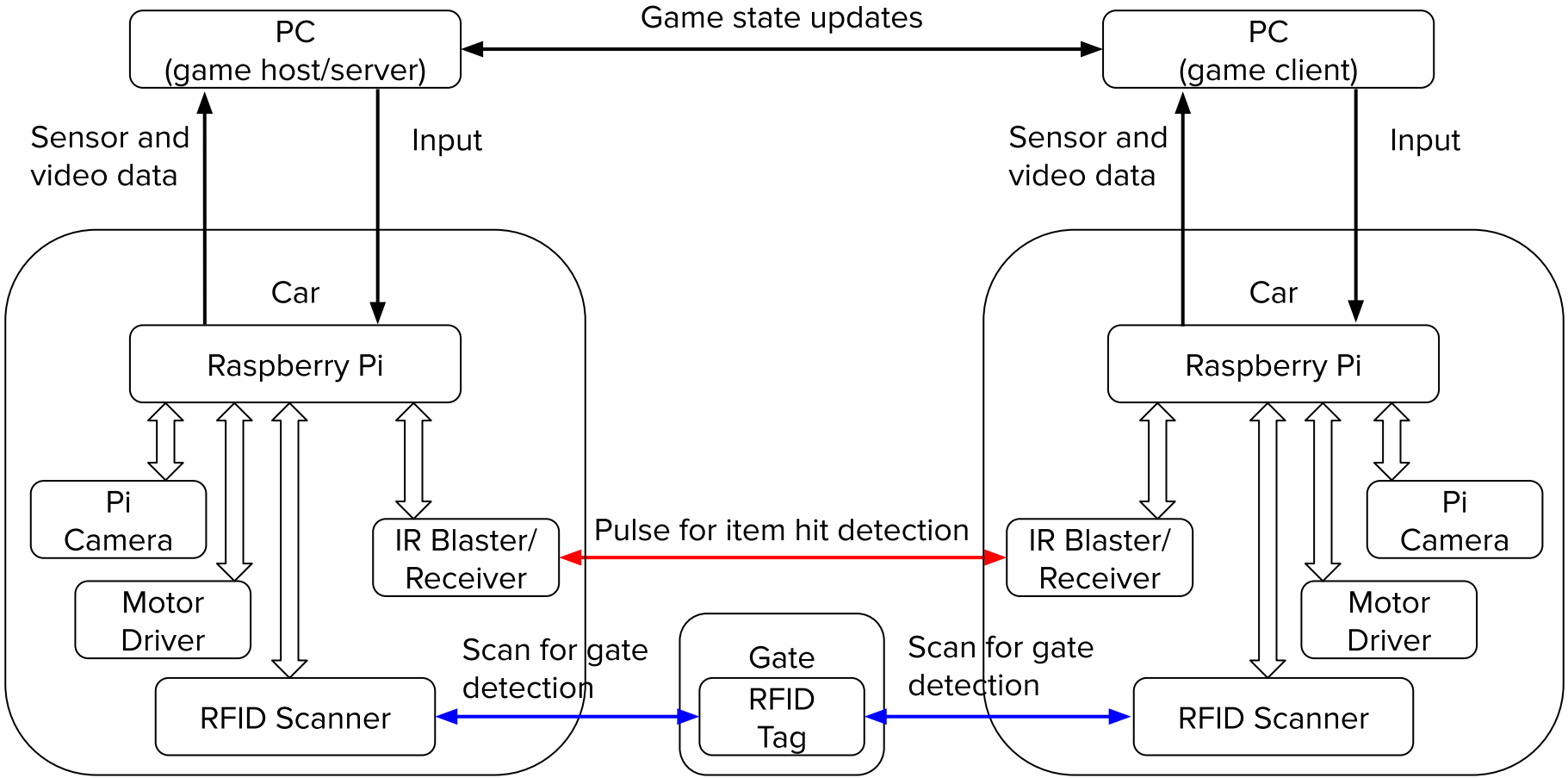
Sourav Panda
David Yang
Bujji Setty

ARioKart

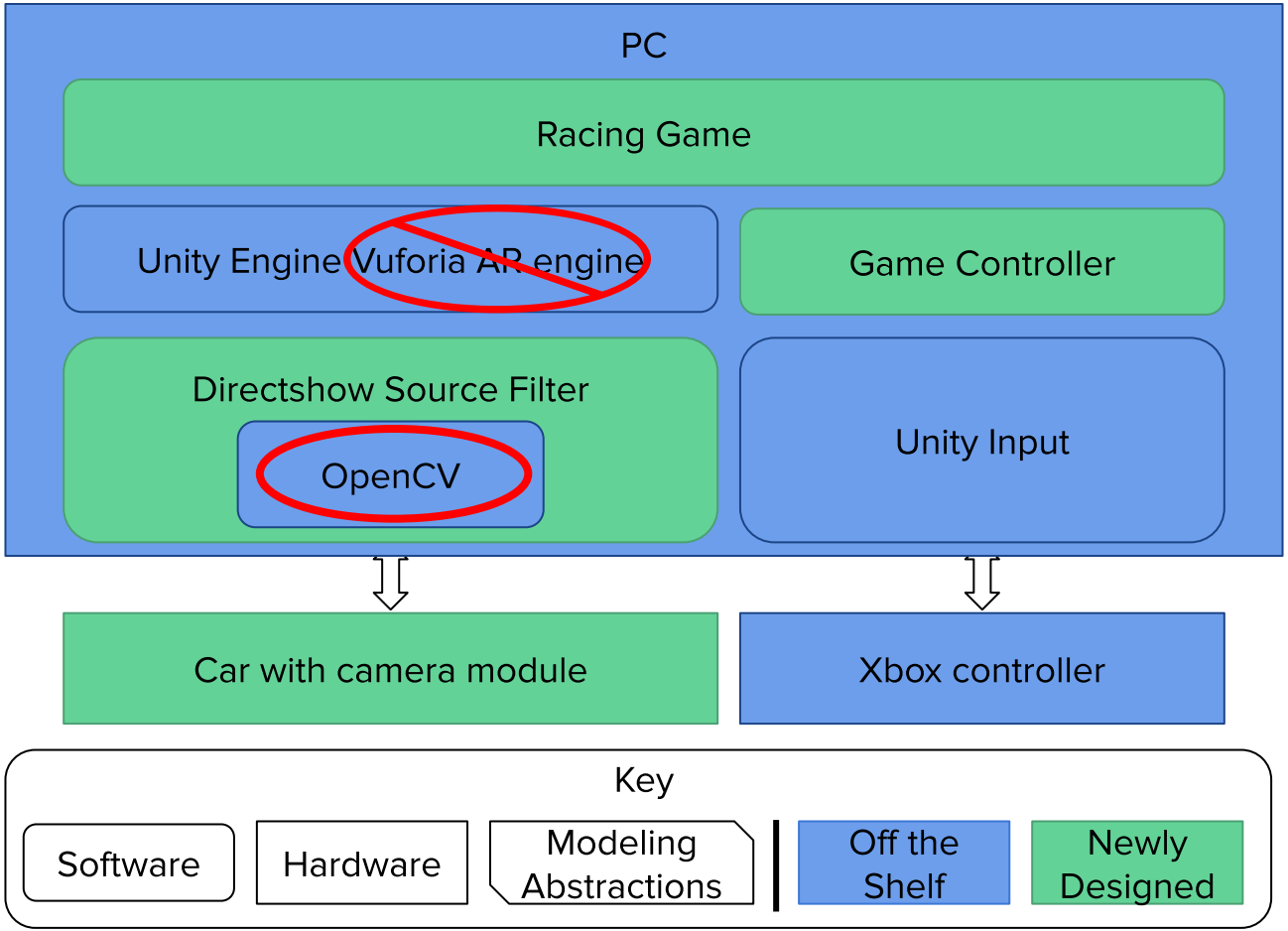
- A slalom-style racing game with physical cars and gates and virtual items
  - Low production cost
  - Extended battery life
  - Lively multiplayer gameplay
  - Dynamic AR



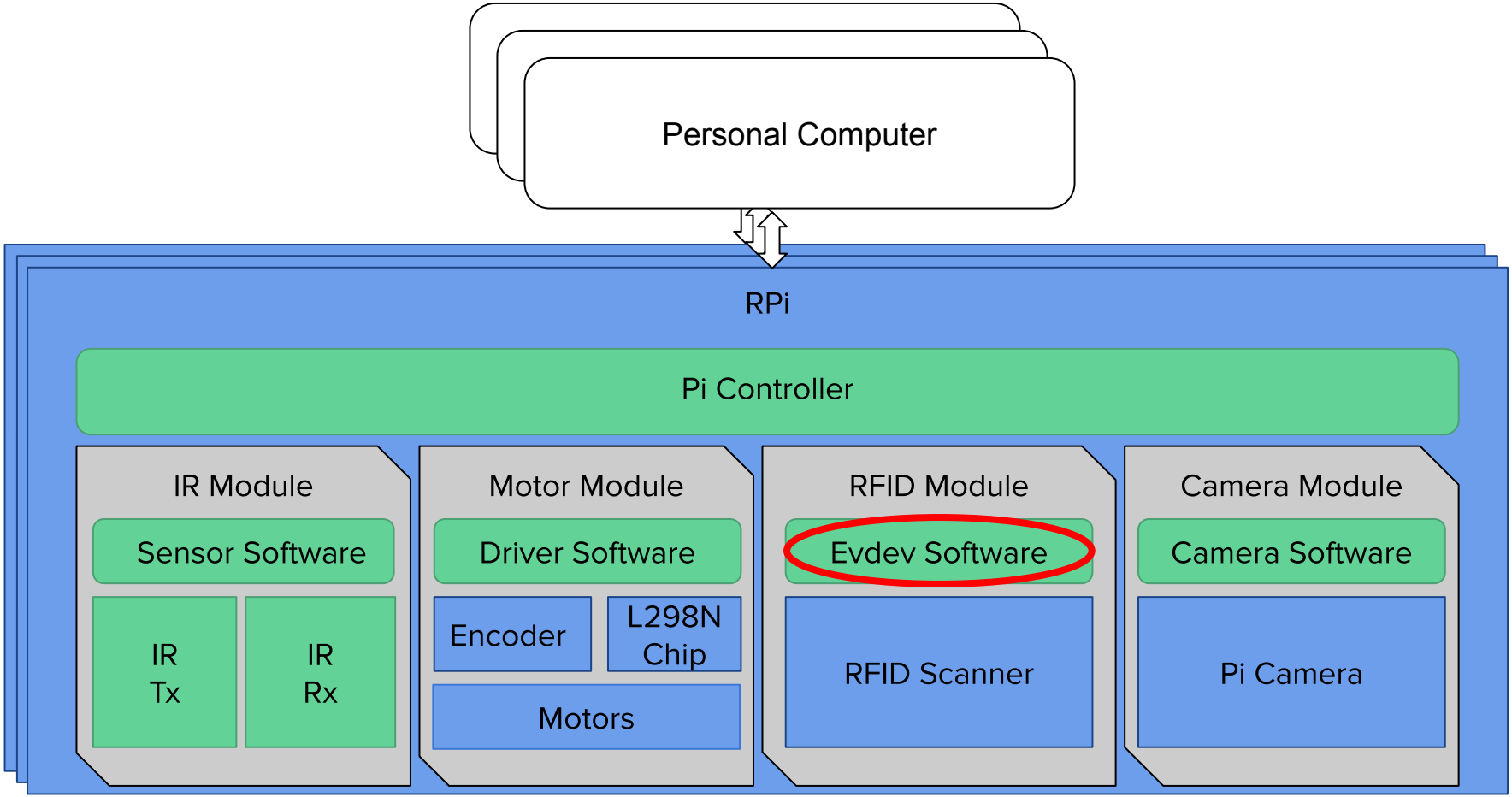
System Architecture



Game


PC
Racing Game
Unity Engine Vuforia AR engine
Game Controller
Directshow Source Filter
OpenCV
Unity Input
Car with camera module
Xbox controller
Key
Software
Hardware
Modeling Abstractions
Off the Shelf
Newly Designed

Pi

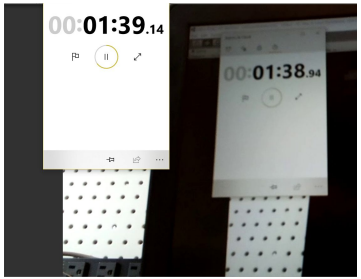

Personal Computer
RPi
Pi Controller
IR Module
Sensor Software
IR
Tx
IR
Rx
Motor Module
Driver Software
Encoder
L298N
Chip
Motors
RFID Module
Evdev Software
RFID Scanner
Camera Module
Camera Software
Pi Camera

Complete Solution

Metrics

Function	Requirement	Results
Video Stream Latency	< 100ms	170 + 30 ms = 200 ms
Control/Sensor Latency	< 100ms	< 16.5 ms
Battery Life	≥ 30 min	7 h 14 min
Top Speed	≥ 3 mph	3.81 mph
Motor Speed Control	< 1 car width deviance over 20 ft	5 in = 2/3rd car width
Turn Radius	< 5 ft @ base speed	5.5 ft
RFID Detection Speed	≥ base speed	0.76 mph = 1/4th base speed
IR Range	≥ 20 ft (demo size)	7 ft w/ width of ± 4.5 in

Latency

	Video Stream Latency	Control and Sensor Latency
Requirement	< 100ms	< 100 ms
Validation Method	Displaying and capturing a timestamp 	Measuring round-trip time for controller input to pi
Results	170 ms streaming + 30 ms rendering = 200 ms	< 16.5 ms

Motor Metrics

	Motor Speed Control	Top Speed	Turning Radius
Requirement	< 1 car width over 20ft	≥ 3 mph	< 5 ft @ base speed
Validation Method	Measured deviance after driving 20 ft without turn input	Calculated with top RPM and wheel radius	Drive car at base speed and turn
Result	5 in = 2/3rd car width	3.81 mph	5.5 ft

Power & Peripheral Metrics

	RFID Detection Speed	IR Range	Battery Life
Requirement	≥ base speed (3 mph)	≥ 20 ft (demo size)	≥ 30 min
Validation Method	Drove car repeatedly over the gate and varied the speed of the car	Varied the distance of the receiver while firing the blaster	Charge battery to full and run car until drained
Result	$\frac{1}{4}^{th}$ base speed (0.76 mph)	7 ft w/ width of ± 4.5 in	7 h 14 min

Management

Tasks	Start Date	End Date	Timeline
Project: ARioKart	02-24-2019	05-06-2019	
Spring Break	03-08-2019	03-16-2019	
Booth	04-06-2019	04-13-2019	
Race HUD and Menus	02-24-2019	03-02-2019	
PC to PC matchmaking	03-02-2019	03-06-2019	
PC to Pi matchmaking	03-06-2019	03-09-2019	
Video Streaming implementation	3-16-2019	03-23-2019	
Optimize video stream to meet latency req	03-23-2019	03-28-2019	
Xbox Controller integration	03-28-2019	03-29-2019	
Pi control integration	03-29-2019	03-30-2019	
PC to PC communication	03-30-2019	04-02-2019	
Race game logic	04-02-2019	04-06-2019	
Item use rendering and logic	04-06-2019	04-13-2019	
Pi Control	02-24-2019	03-02-2019	
Pi Server Input Handling	03-02-2019	03-09-2019	
Pi Motor Speed	03-17-2019	03-22-2019	
Pi Motor Turning	03-22-2019	03-26-2019	
Pi sensor data streaming	03-26-2019	03-31-2019	
Gameplay Motor Interactions	03-31-2019	04-03-2019	
Pi sensor data streaming	04-03-2019	04-06-2019	
Prepped for presentation on Monday	02-24-2019	02-27-2019	
Worked on physical design of car	02-27-2019	03-02-2019	
Worked on design report	03-02-2019	03-04-2019	
Finished first draft of the model of the car	03-04-2019	03-08-2019	
Set up RFID via SPI protocol	3-16-2019	03-18-2019	
Put together frames for two cars	03-18-2019	03-20-2019	
Built and tested the IR tx and rx circuits	03-20-2019	03-22-2019	
Designed physical layout for gates	03-22-2019	03-23-2019	
Improved IR cirfcuit perfomance	03-23-2019	03-25-2019	
Mounted components so that 1 car is done	03-25-2019	03-27-2019	
Redesigned car based on flaws found	03-27-2019	03-30-2019	
Prepare for demo on Wednesday	03-30-2019	04-02-2019	
Put together mountable IR circuits	04-02-2019	04-04-2019	
Fab third car	04-27-2019	05-02-2019	
System integration	04-13-2019	05-06-2019	

Lessons Learned

1. Choose a project within budget
2. Never believe the posted hardware specs
3. Plan for setbacks