

Remotely Piloted Vehicles

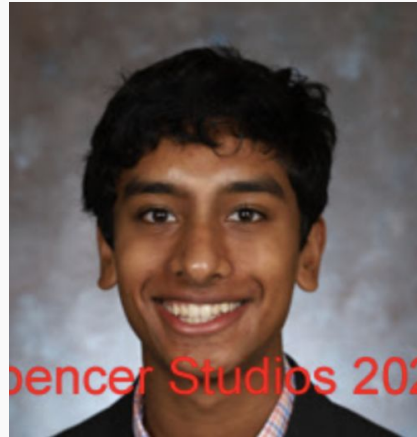
Team: Dhruv, Daniel, Nandini
Advisor: Dr. Richard Martin



Introducing our Group



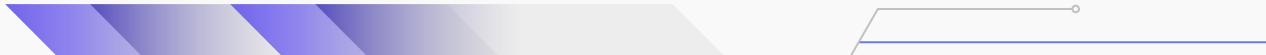
Daniel Mahany
(Hightstown High School,
Rising Junior)



Dhruv Ramaswamy
(The Pennington School,
Rising Senior)

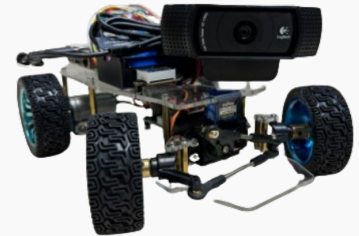


Nandini Venkatesh
(Edison Academy Magnet
School, Rising Senior)



Project Objectives

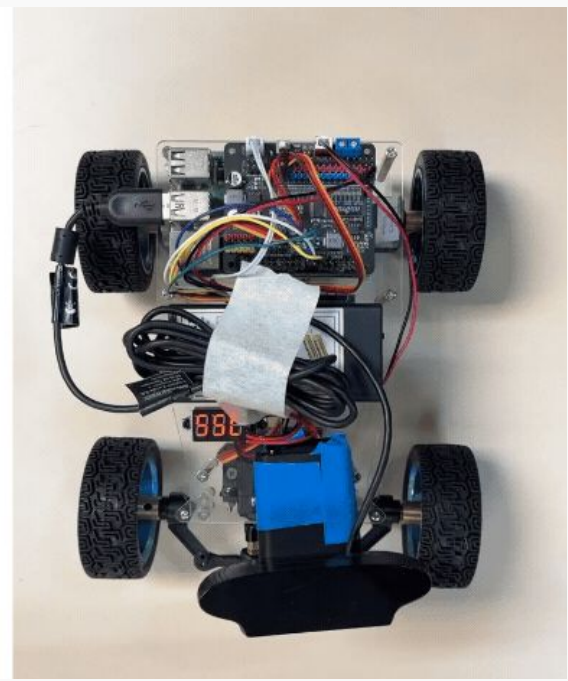
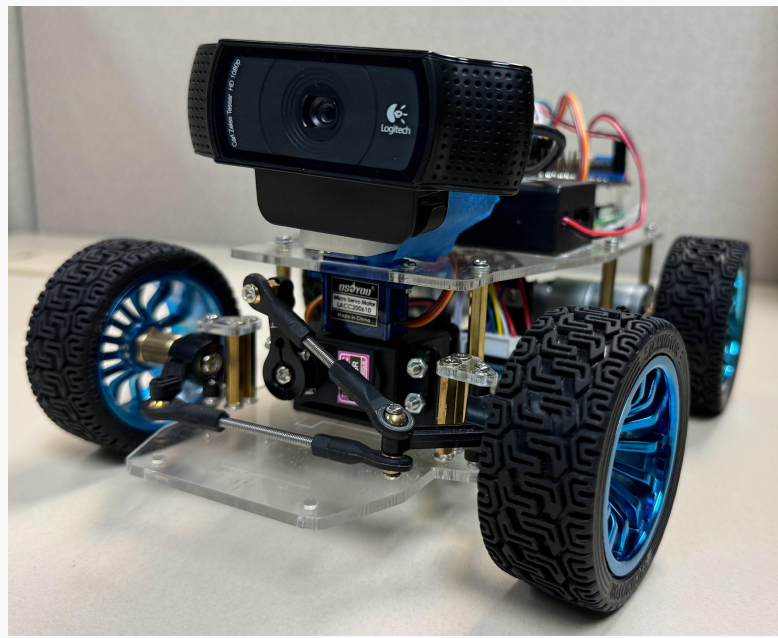
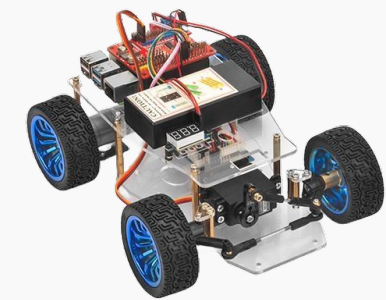
- Develop software for remote piloting vehicles
- Additional sensing will be added to aid the pilots
 - additional cameras
 - range sensors
- Evaluate the strengths and weaknesses of remote piloting interfaces for ground-based vehicles.



Hardware



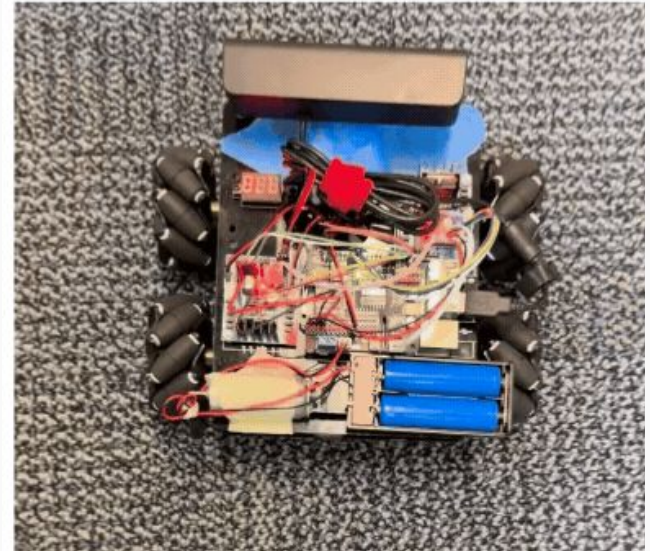
Ackermann Hardware



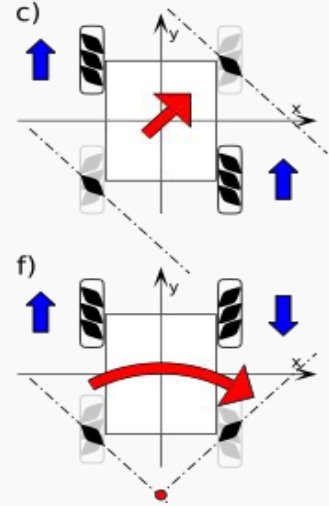
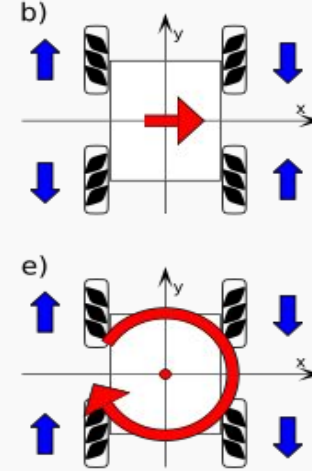
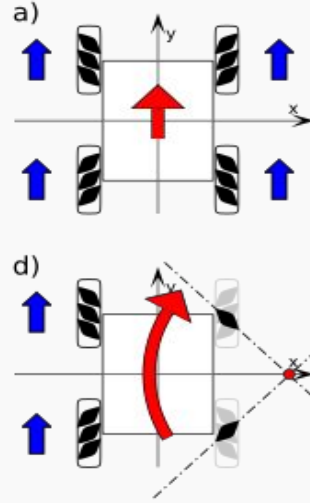
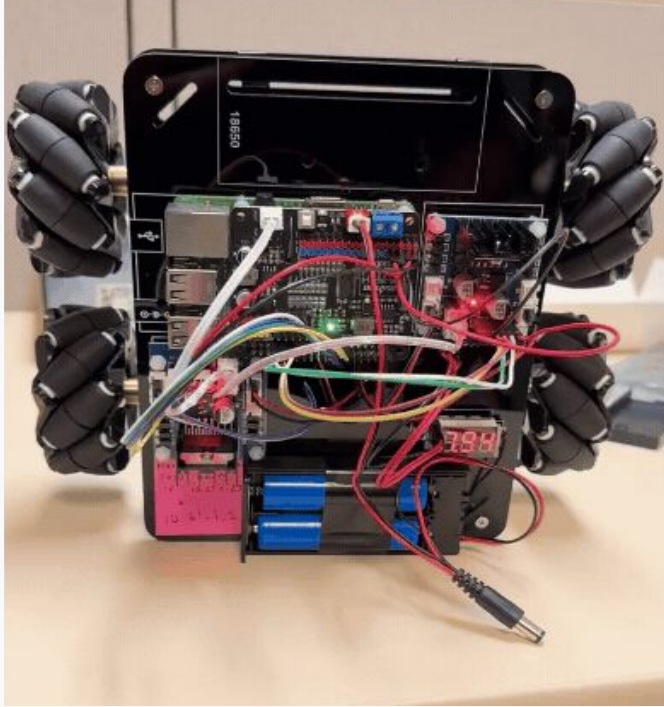
Mecanum Hardware



x2



Concept of Mecanum Drive



Motor Controller



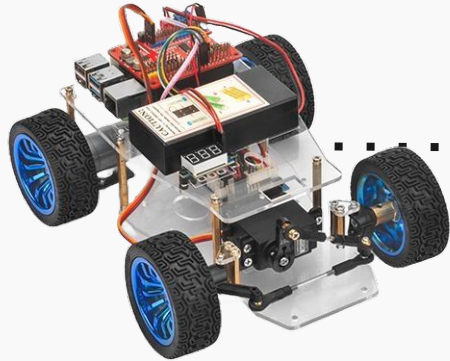
ENA↵	IN1↵	IN2↵	The State of DC Motor A↵
0↵	X↵	X↵	Stop↵
1↵	0↵	0↵	Brake↵
1↵	0↵	1↵	Rotate Clockwise↵
1↵	1↵	0↵	Rotate Counterclockwise↵
1↵	1↵	1↵	Brake↵

Networking



Network Architecture

“Server”



VPN
(ZeroTier)



Direct
Connection

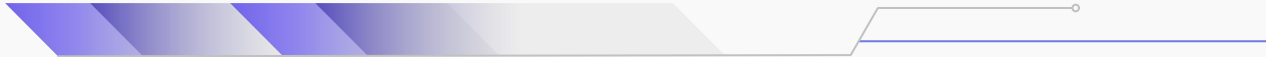
“Client”



Camera Data



Movement Commands



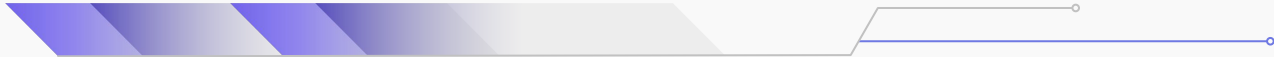
Zerotier



<input type="checkbox"/>	Edit	Auth	Address	Name/Desc	Managed IPs	Last Seen	Version	Physical IP
<input type="checkbox"/>		<input checked="" type="checkbox"/>	3FA36A0162 ee:ba:e2:87:8e:e7	pi	10.147.17.144	2 minutes	1.14.0	165.230.132.124
<input type="checkbox"/>		<input checked="" type="checkbox"/>	4B930BF7CF ee:ce:d2:e6:78:4a	comp2	10.147.17.210	2 minutes	1.14.0	165.230.132.124
<input type="checkbox"/>		<input checked="" type="checkbox"/>	A8914872CE ee:2d:d0:a5:fd:4b	comp	10.147.17.52	1 minute	1.14.0	165.230.132.124

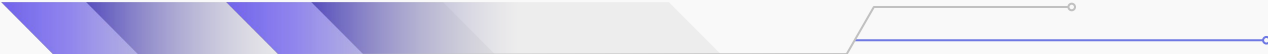
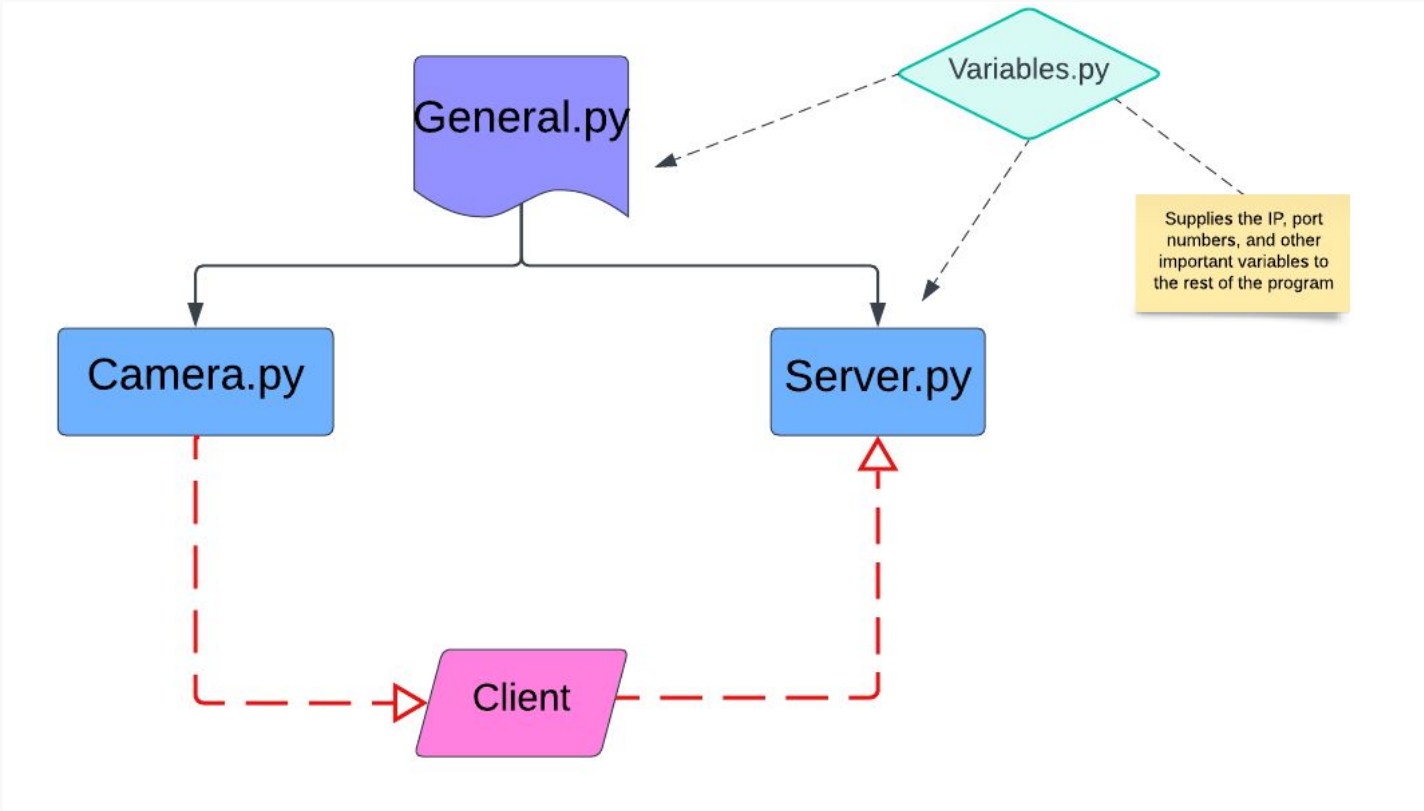
Managed Routes 2/128

- 10.147.17.0/24 (LAN)
- 192.173.1.0/24 via 10.147.17.144



Car Software

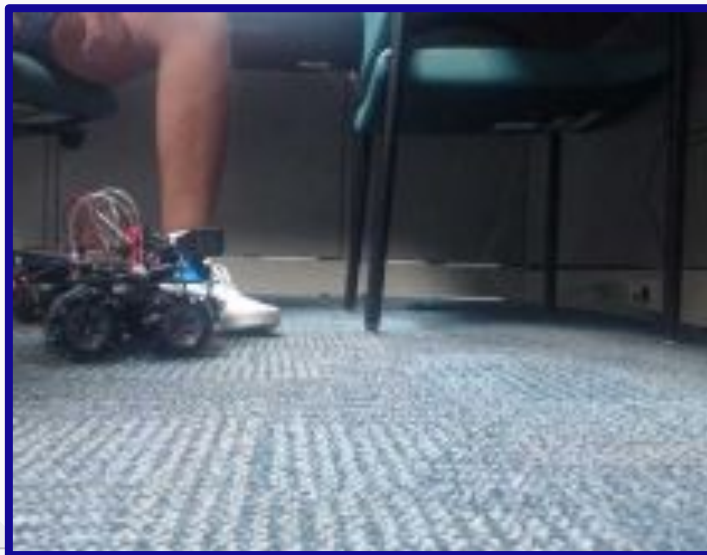
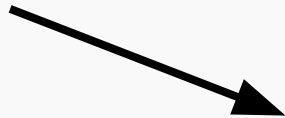




Camera Feed



MJPEG \longrightarrow RTMP?



Emergency Stop



Safety Mode



Client Software

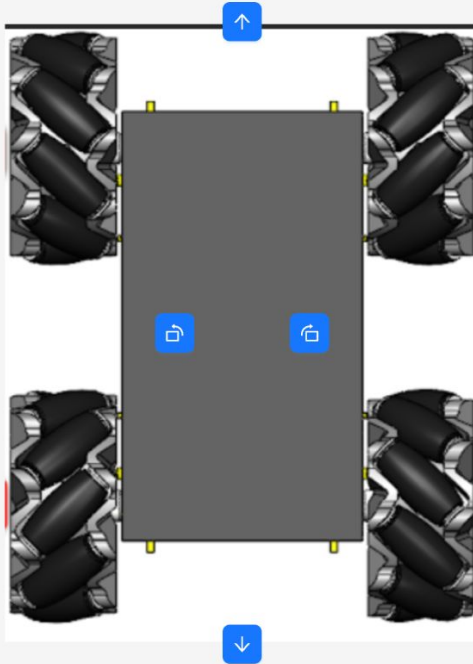


Connection Delay: 12.751ms

Diagonal

Diagonal

Mecanum UI



Retry

Controls

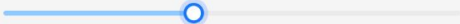
Camera

Diagonal

Diagonal

Ackermann Car UI

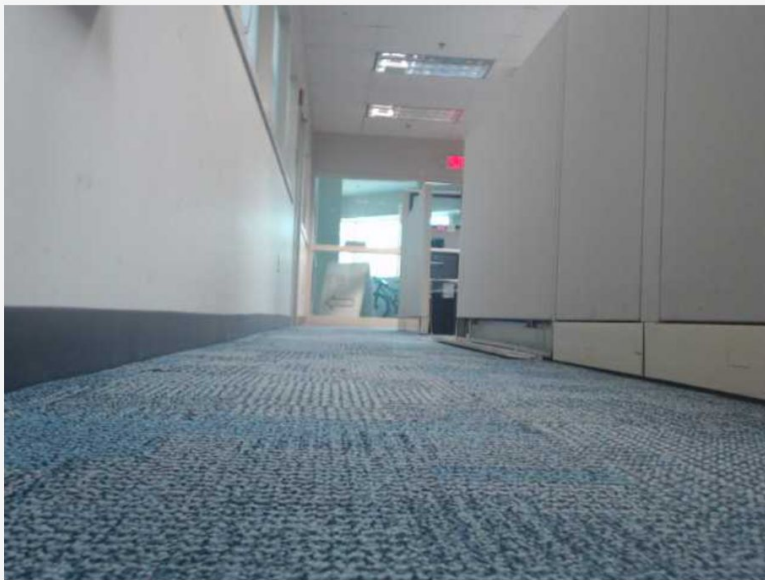
Steering / Camera Servo



Ping: 37.559

Forward

Backward



Retry

A screenshot of a network monitoring tool interface. The top bar shows 'top' and 'Default levels'. Below, it displays 'No Issues' and '2 hidden'. A list of network events follows, including ping times and stream connections. The last event is highlighted in blue and shows a ping time of 37.559 ms. The interface includes various icons for filtering and zooming.

Camera Feed



Retry



Error connecting to the stream.



Stream failed to load

Make sure stream is on and ip/port are correct.

Retry

Settings UI



Mecanum Four Wheel UI **Settings**

Mecanum Drive

Show Keyboard Shorcuts

Safety Mode

Four Wheel UI Settings

Mecanum Drive

Show Keyboard Shorcuts

Safety Mode

Shortcuts

Mecanum Shorcuts

- Key W: Forward
- Key A: Strafe Left
- Key S: Backward
- Key D: Strafe Right
- Key J: Rotate Counter-clockwise
- Key K: Rotate Clockwise
- Key Q: Diagonal Frontleft
- Key E: Diagonal Frontright
- Key Z: Diagonal Backleft
- Key X: Diagonal Backright

Ackerman Shorcuts

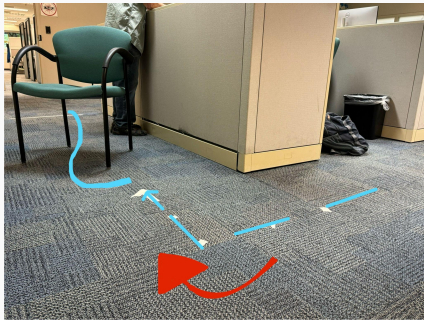
- Key W: Forward
- Key S: Backward

Cancel OK

Conclusions



Testing Course

The screenshot shows the RPV Client software interface. At the top, there are tabs for "Mecanum", "Four Wheel UI", and "Settings". The "Four Wheel UI" tab is active. Below the tabs, there is a "Steering / Camera Servo" slider. The current "Ping" is displayed as 4.273. There are two buttons: "Forward" and "Backward". A video feed on the right shows a room with a desk and a chair. A "Retry" button is located below the video feed. On the far right, there is a console window showing a list of ping and stream data.

RPV Client

Mecanum Four Wheel UI Settings

Steering / Camera Servo

Ping: 4.273

Forward Backward

Retry

Filter Default levels

No Issues | 2 hidden

16385	
ping...	Ping, Ixx:12
Ping: 15.384 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 6.569 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 16.432 ms	Ping, Ixx:15
18.147.18.228, Stream, Ixx:8	16385
ping...	Ping, Ixx:12
Ping: 17.786 ms	Ping, Ixx:15
18.147.18.228, Stream, Ixx:8	16385
ping...	Ping, Ixx:12
Ping: 8.182 ms	Ping, Ixx:15
18.147.18.228, Stream, Ixx:8	16385
ping...	Ping, Ixx:12
Ping: 6.342 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 28.251 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 13.318 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 38.088 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 24.19 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 9.683 ms	Ping, Ixx:15
ping...	Ping, Ixx:12
Ping: 4.273 ms	Ping, Ixx:15

Results

Average Number of Collisions while Driving:

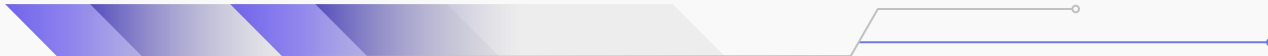
	Trial 1	Trial 2
Ackerman Vehicle	0.4	0.3
Mecanum Vehicle	0.5	0.4



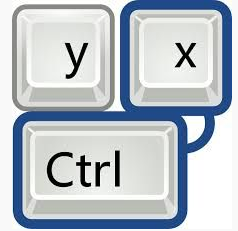
Results

Average Time to Complete the Course:

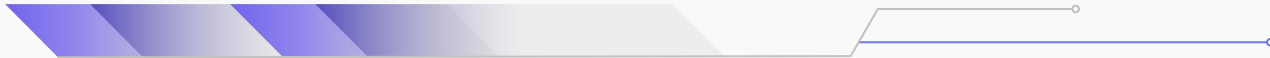
	Trial 1	Trial 2
Ackermann Vehicle	56.87 Seconds	42.43 Seconds
Mecanum Vehicle	55.01 Seconds	49.14 Seconds



Future Plans



- Improve mecanum movement and implement a joystick
- More sensor integration
- Better networking
- Use the driver feedback to make further improvements
 - Cellular connection



Any Questions?

Special thanks to Dr. Martin, Dr. Howard, Jenny, and
Ivan for making this project possible