ROSE-HULMAN INSTITUTE OF TECHNOLOGY

2012 IGVC Design Entry: **Moxom's Master**

Team Members:

Allison Crump, Rain Dart, Kyle Green, Ben Griffith, Derek Heeger, Alex Memering, Michael Pauly, Ander Solorzano, Trent Tabor, Dmitry Votintsev, Elias White, Ruffin White

Team Advisor:

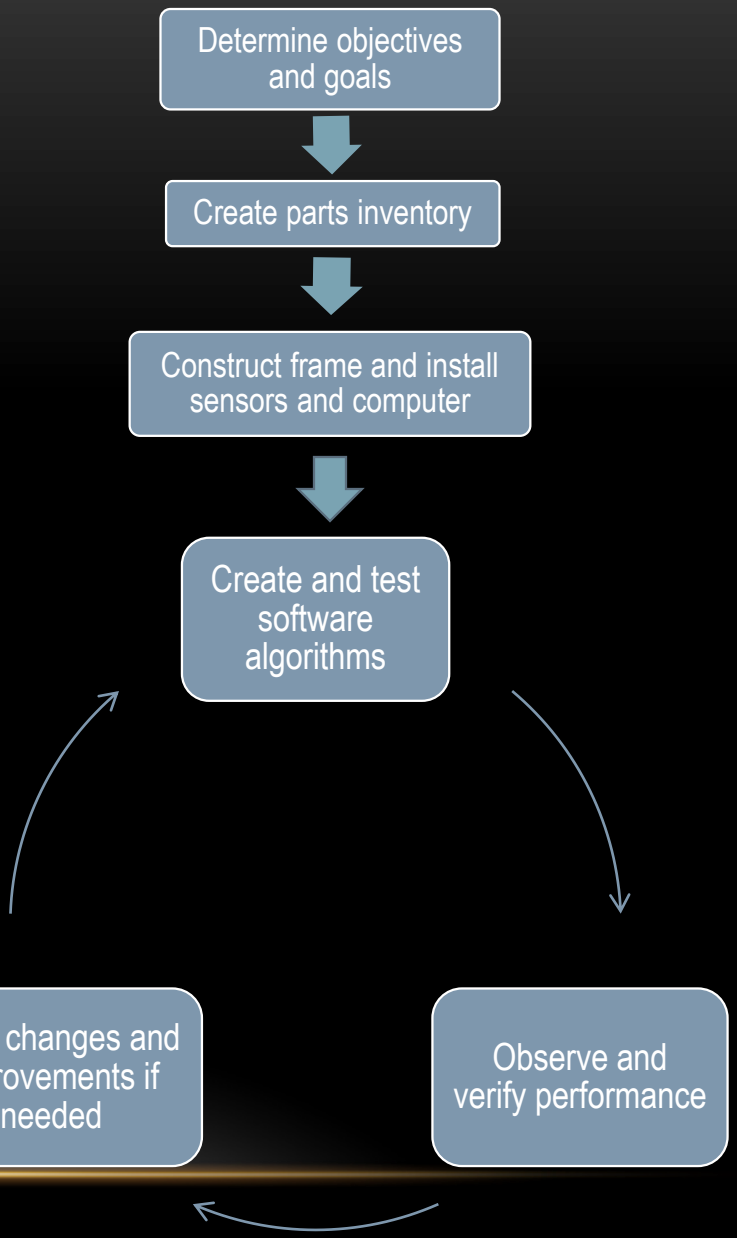
Dr. David Mutchler (Ph.D. Computer Science)

PRESENTATION OVERVIEW

- Overall Design Plan
- Hardware Features and Improvements
- Overall Software Design Concept
- Software Features and Innovations
- Concluding Remarks and Future Plans

OVERALL DESIGN PLAN

- Durable and reliable
- Modular and easy to change
- Intelligent
- Low Power Consumption
- Safe



MAJOR COMPONENTS AND COSTS

Component	List	Cost to Team
Hardware		
Cases	$255	$85
Drivetrain	$400	$400
Acrylic Panels	$119	$119
Lubrication	$50	$50
80 / 20	$400	$200
Frame Hardware	$200	$200
Electronics		
RoboteQ Motor Controllers	$385	$385
Optical Encoders	$228	$228
Wire and Connectors	$380	$330
Breakers, fuses	$170	$170
Batteries	$330	$330
Tools	$56	$56
Battery Charger	$200	$200
Power Supply	$80	$80
MicroStrain 3 DM -G IMU	$1,300	$0
Hokuyo LIDAR	$7,000	$7,000
Logitech Webcam	$80	$0
NAVCOM GPS	$1,500	$0
Miscellaneous	$100	$100
Computer		
CPU	$360	$360
Motherboard	$150	$150
Video Card	$50	$50
RAM	$120	$120
60 GB SSD	$85	$85
TOTAL	**$15,747**	**$10,698**

HOKUYO LIDAR

MicroStrain IMU

NAVCOM GPS

Logitech Webcam

RoboteQ Motor Controller

Intel i5 Core

MECHANICAL FEATURES AND IMPROVEMENTS

Shortened case and lightened mast to decrease weight

Improved encoder to motor shaft connection

Added shocks to dampen bounce and add durability

Modified wheel base to improve mobility

Observed changes in performance

Adds stability and durability to sensors

Increased turning speed

Heavier on the back wheels

Meets physical constraints

ELECTRICAL FEATURES AND IMPROVEMENTS

Replaced old emergency shut off switch for increased safety

Replaced SICK LIDAR with Hokuyo model for increased angular scan

Replaced Black Jaguar motor controllers with RoboteQ motor controller

Moved the battery charger off of the robot to decrease weight

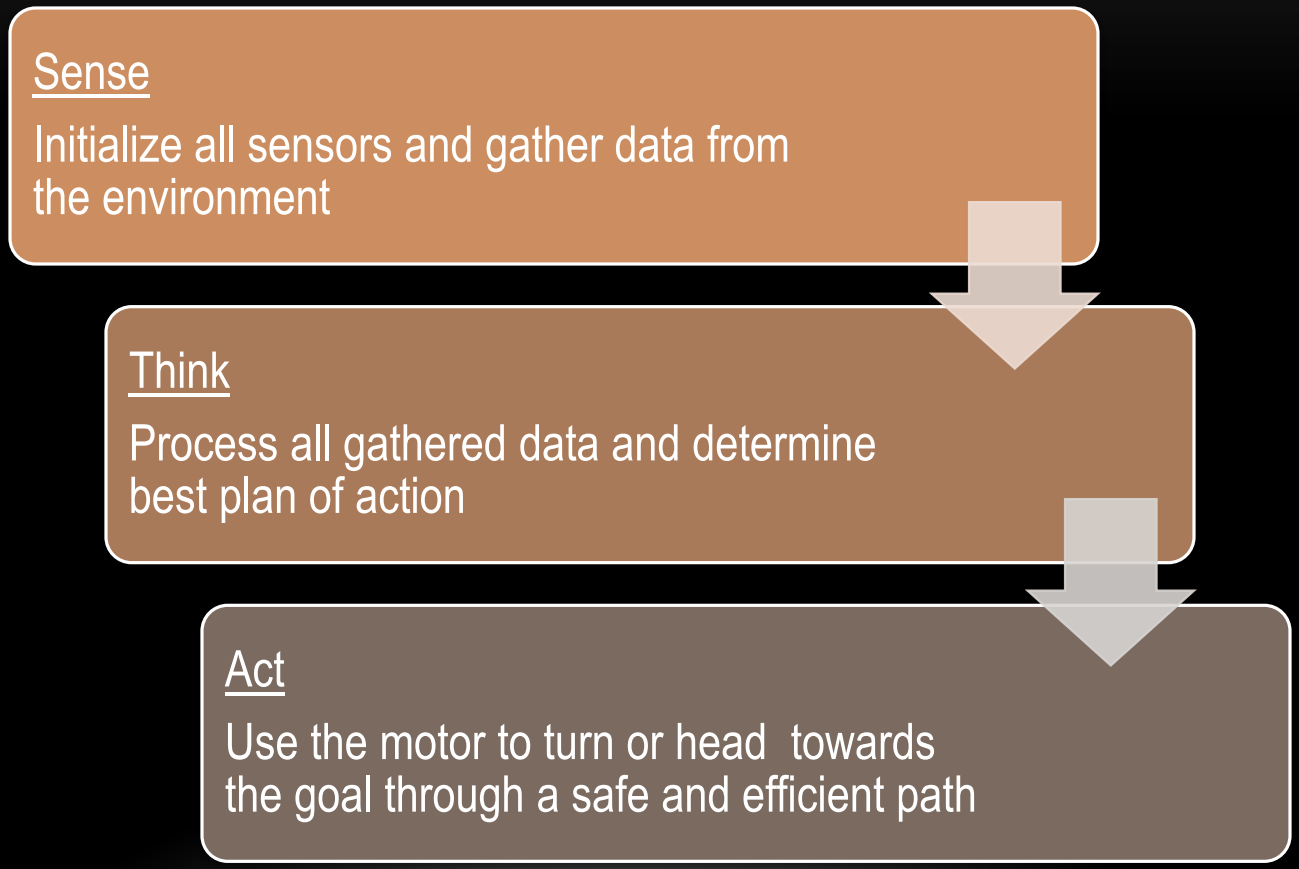
Replaced the Elphel camera with a Logitech webcam for easier communication

Incorporated the WAAS features of the GPS for increased accuracy

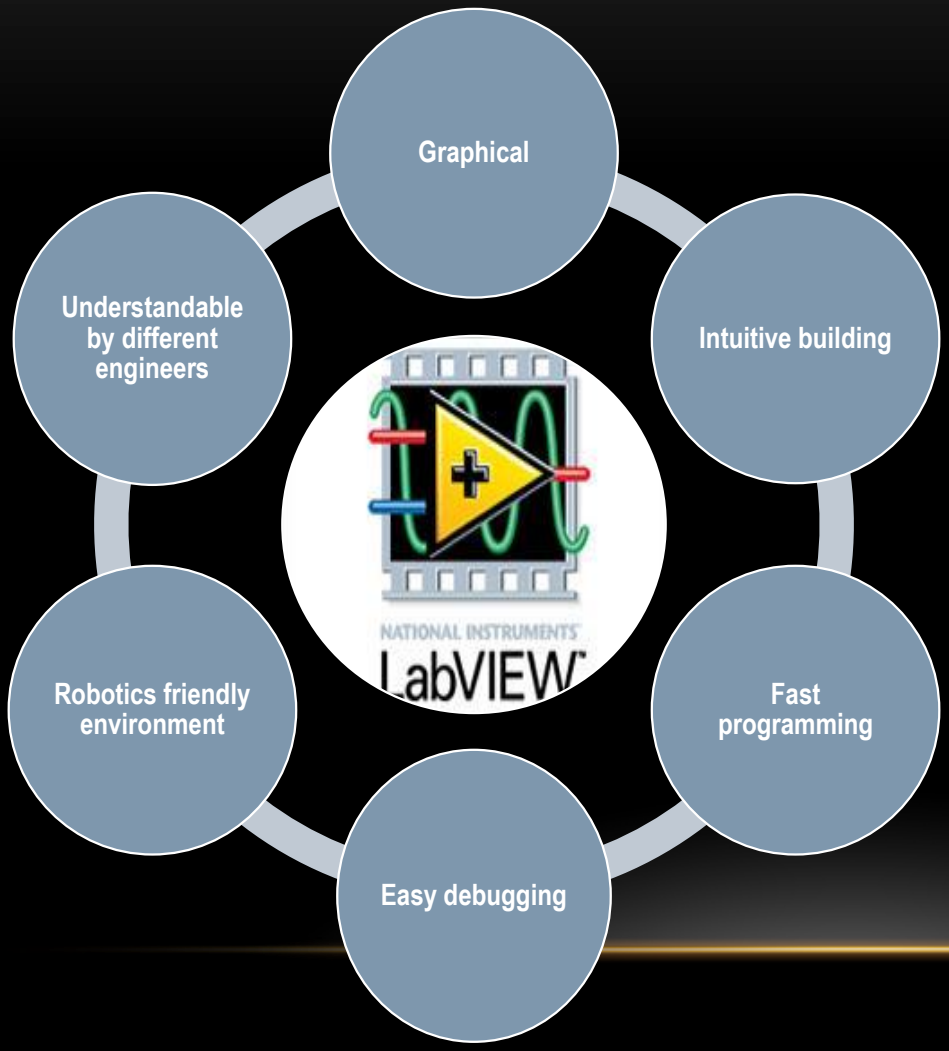
Observed changes in performance

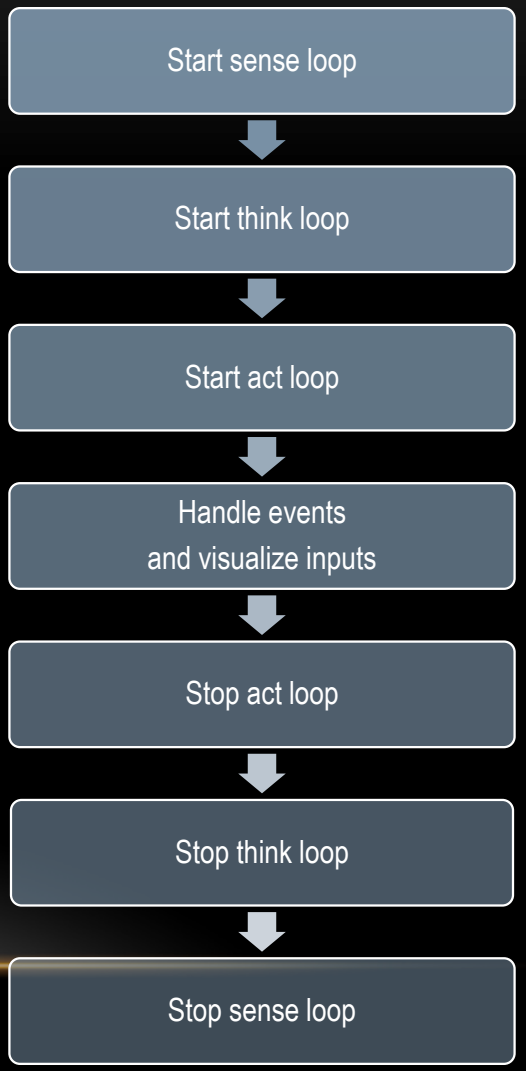
Increased obstacle detection view	Increased agility
Faster and sufficient line detection	Reduced power consumption
Faster and reliable response in case of emergency	Reliable waypoint navigation

OVERALL SOFTWARE DESIGN CONCEPT

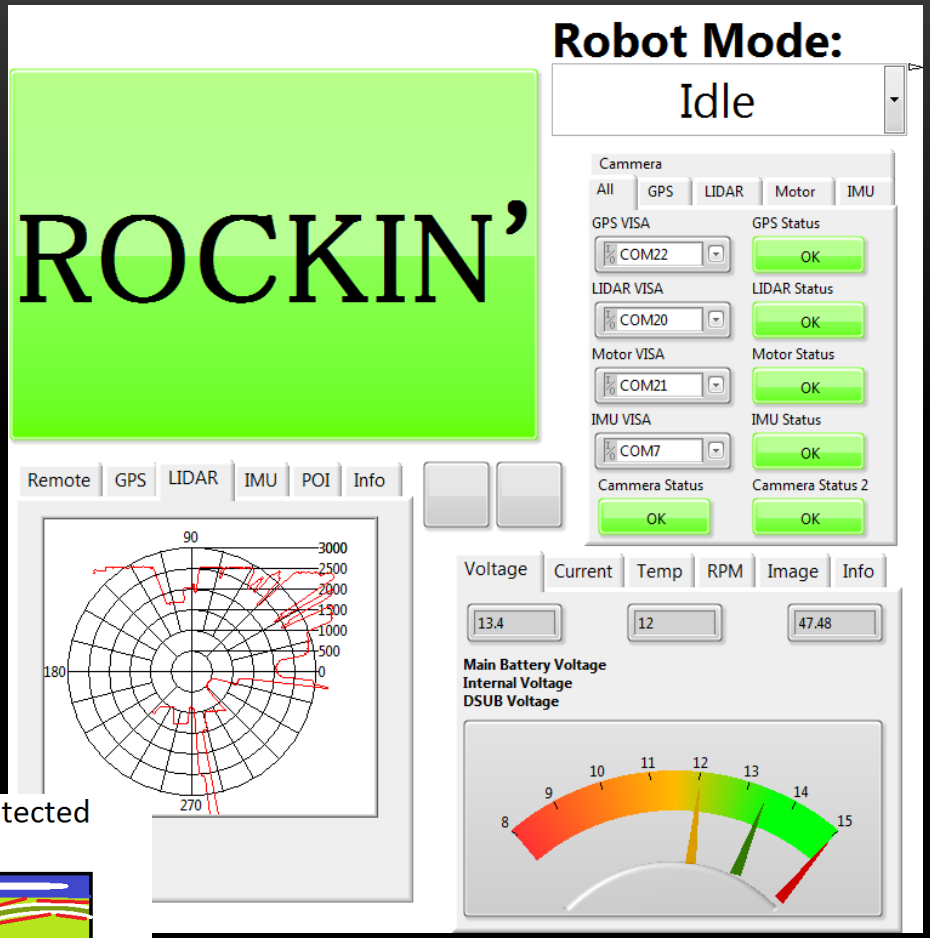


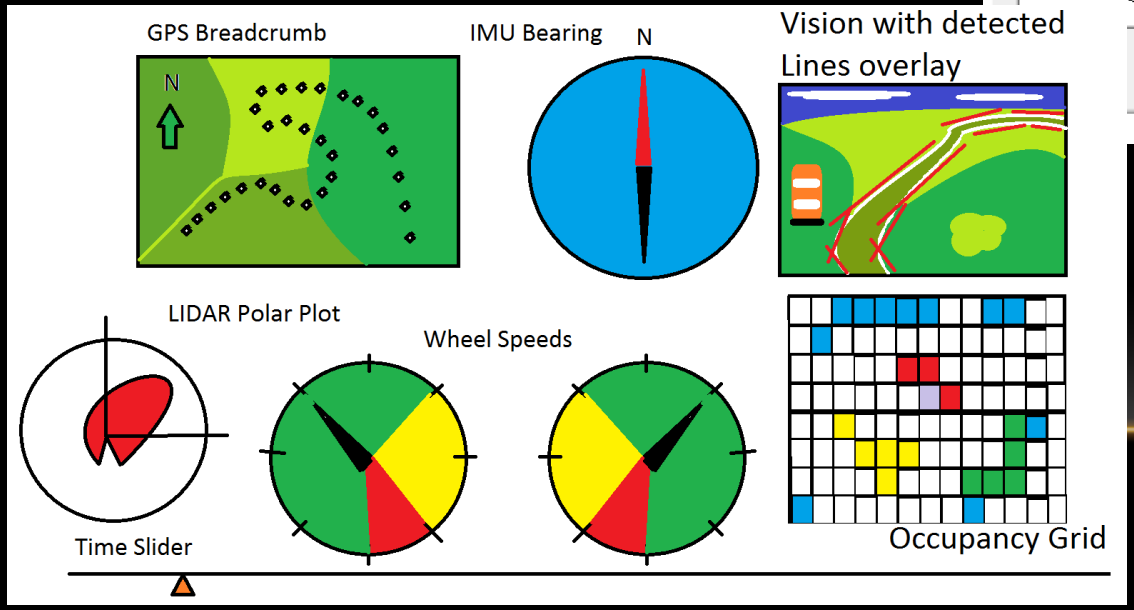
SOFTWARE IMPLEMENTATION





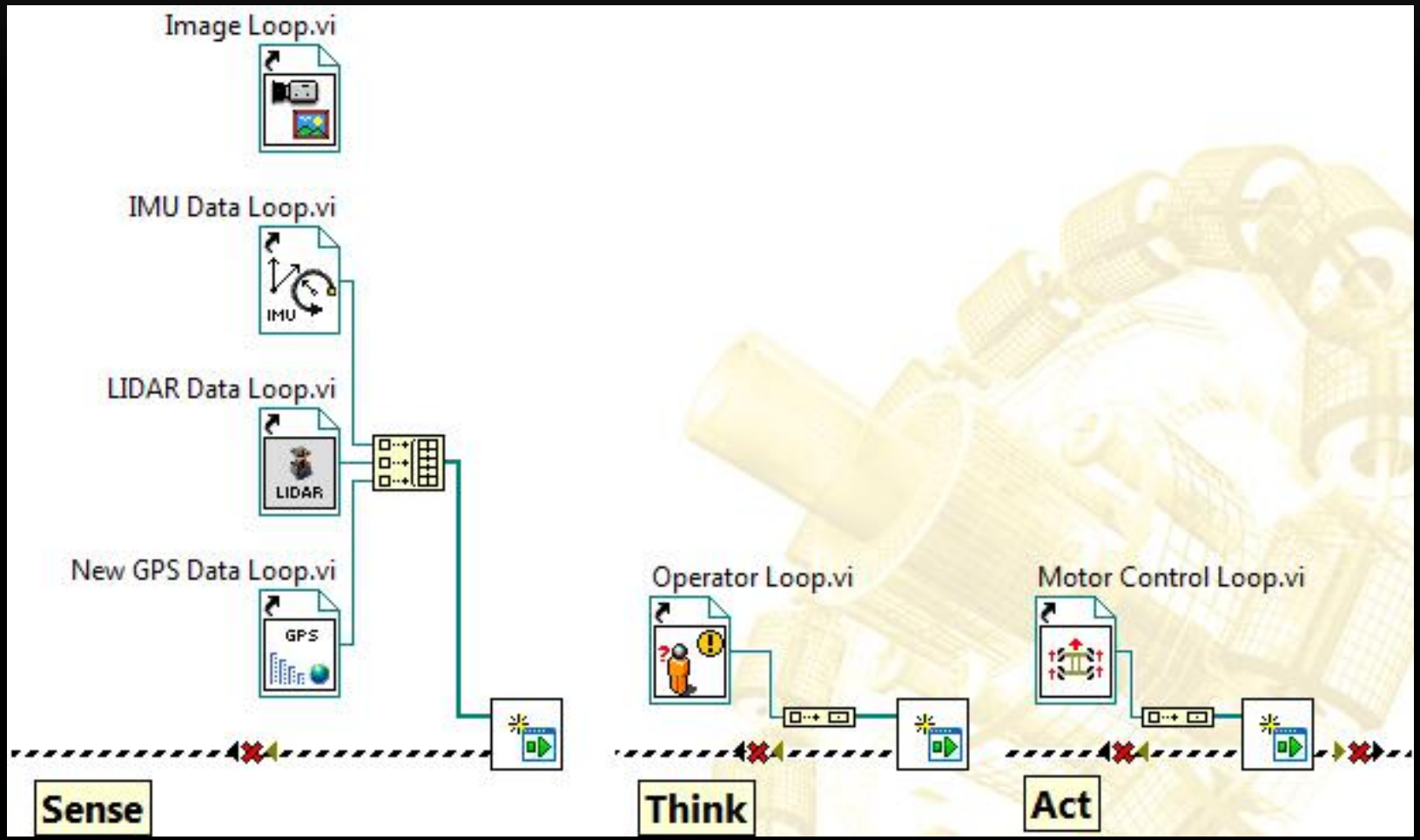
OVER VIEW


Robot Mode:
Idle
ROCKIN'
Cammera
All
GPS
LIDAR
Motor
IMU
GPS VISA
COM22
GPS Status
OK
LIDAR VISA
COM20
LIDAR Status
OK
Motor VISA
COM21
Motor Status
OK
IMU VISA
COM7
IMU Status
OK
Cammera Status
OK
Cammera Status 2
OK
Remote
GPS
LIDAR
IMU
POI
Info
90
180
270
3000
2500
2000
1500
1000
500
0
Voltage
Current
Temp
RPM
Image
Info
13.4
12
47.48
Main Battery Voltage
Internal Voltage
DSUB Voltage
8
9
10
11
12
13
14
15

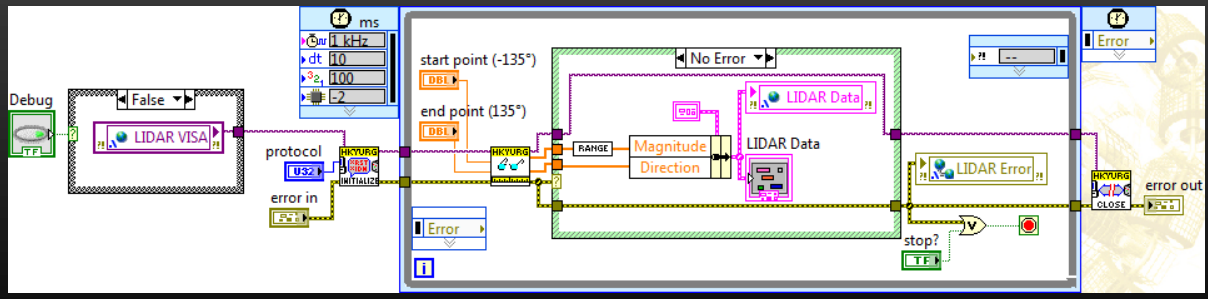

GPS Breadcrumb
N
IMU Bearing
N
Vision with detected
Lines overlay
LIDAR Polar Plot
Wheel Speeds
Time Slider
Occupancy Grid

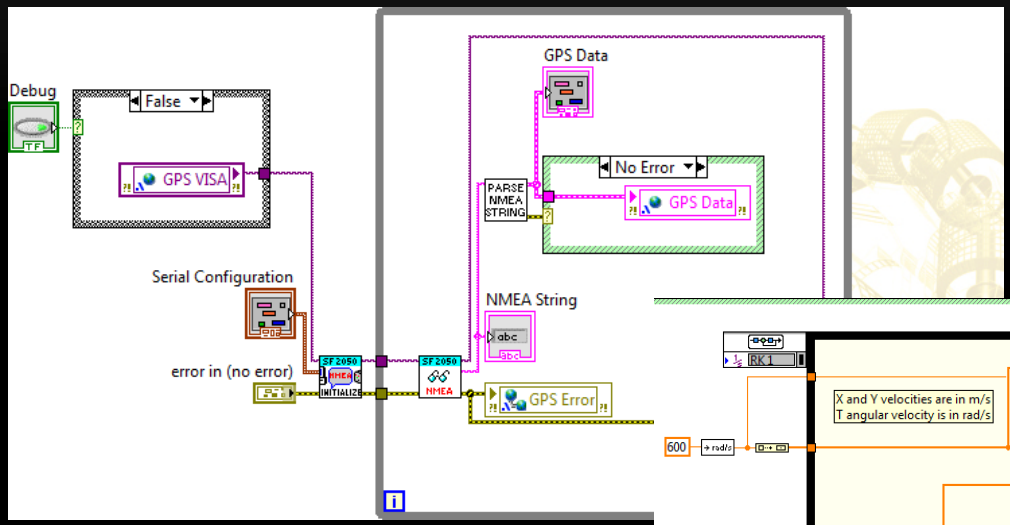
FRAMEWORK

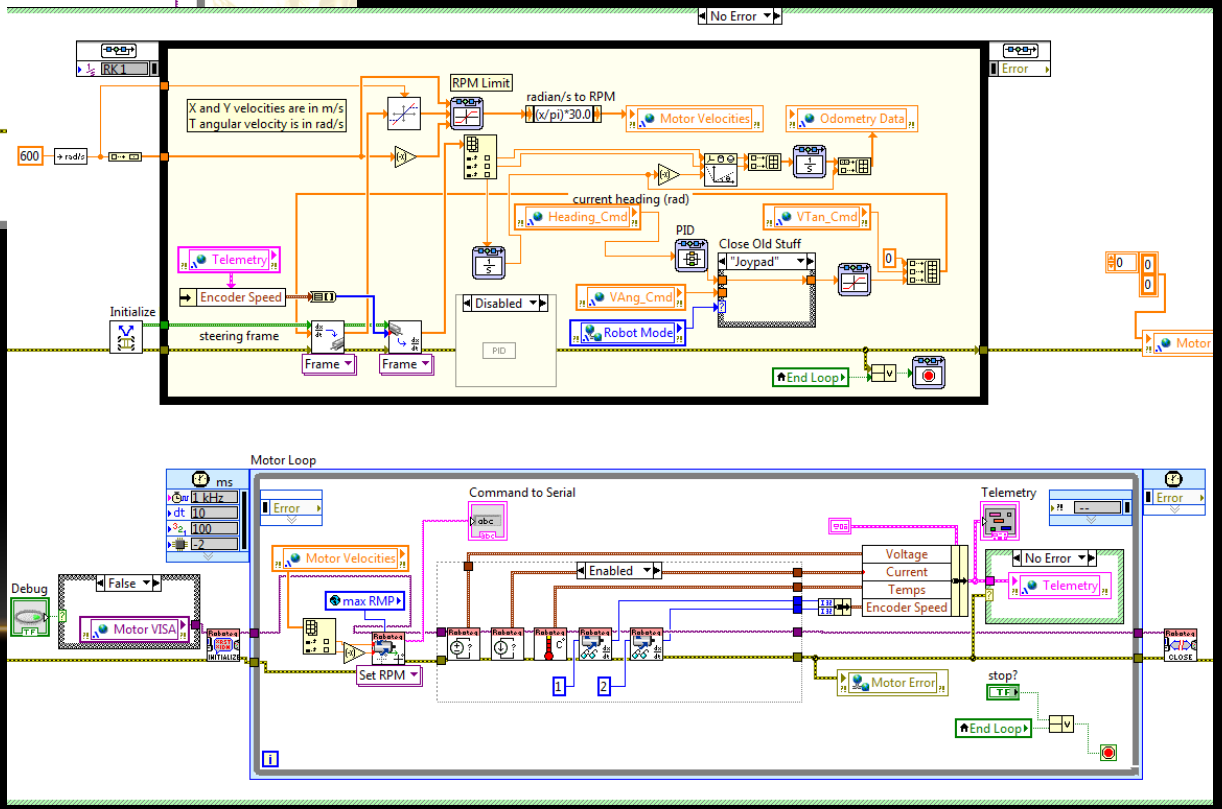
Sense → Think → Act



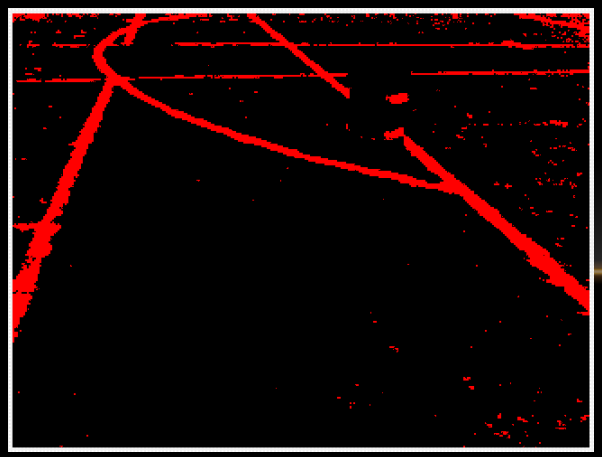
SENSOR LOOPS

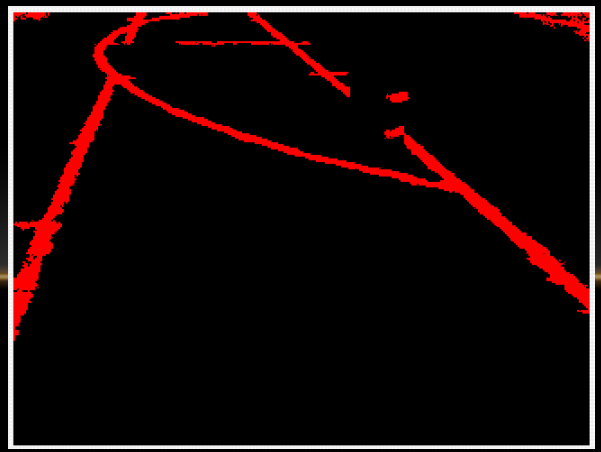


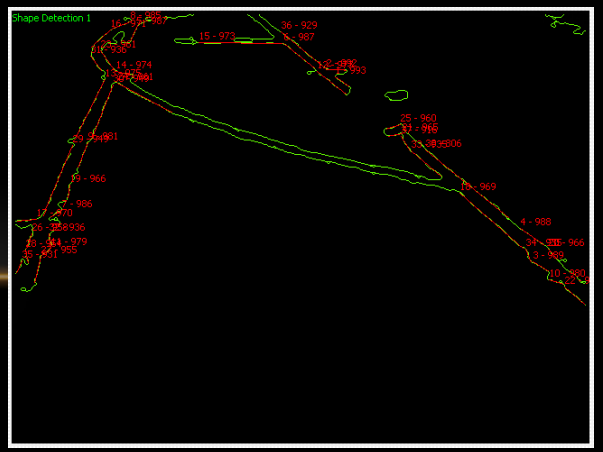




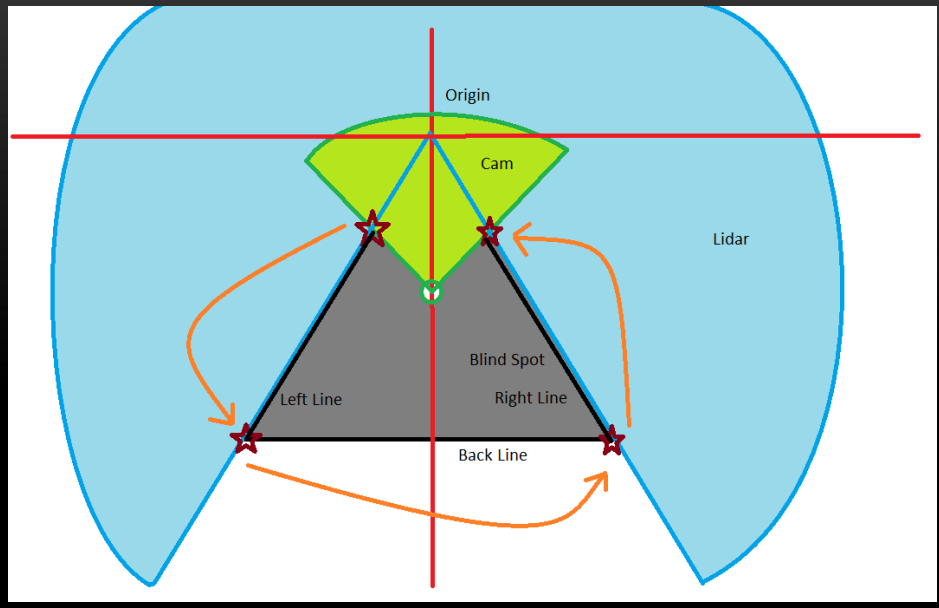
VISION ACQUISITION

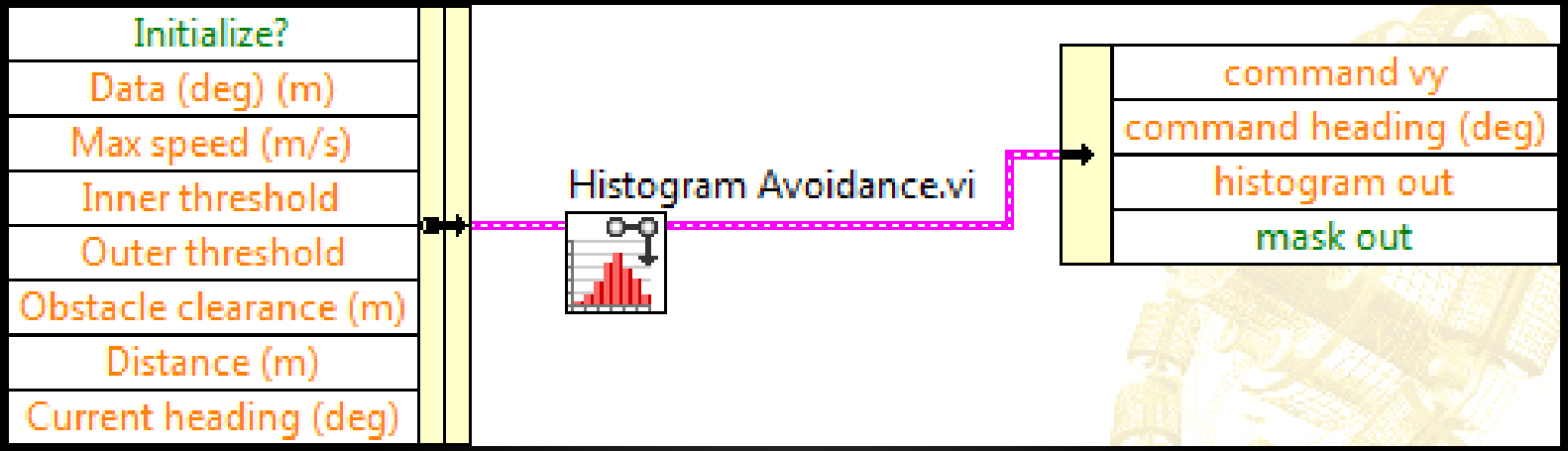




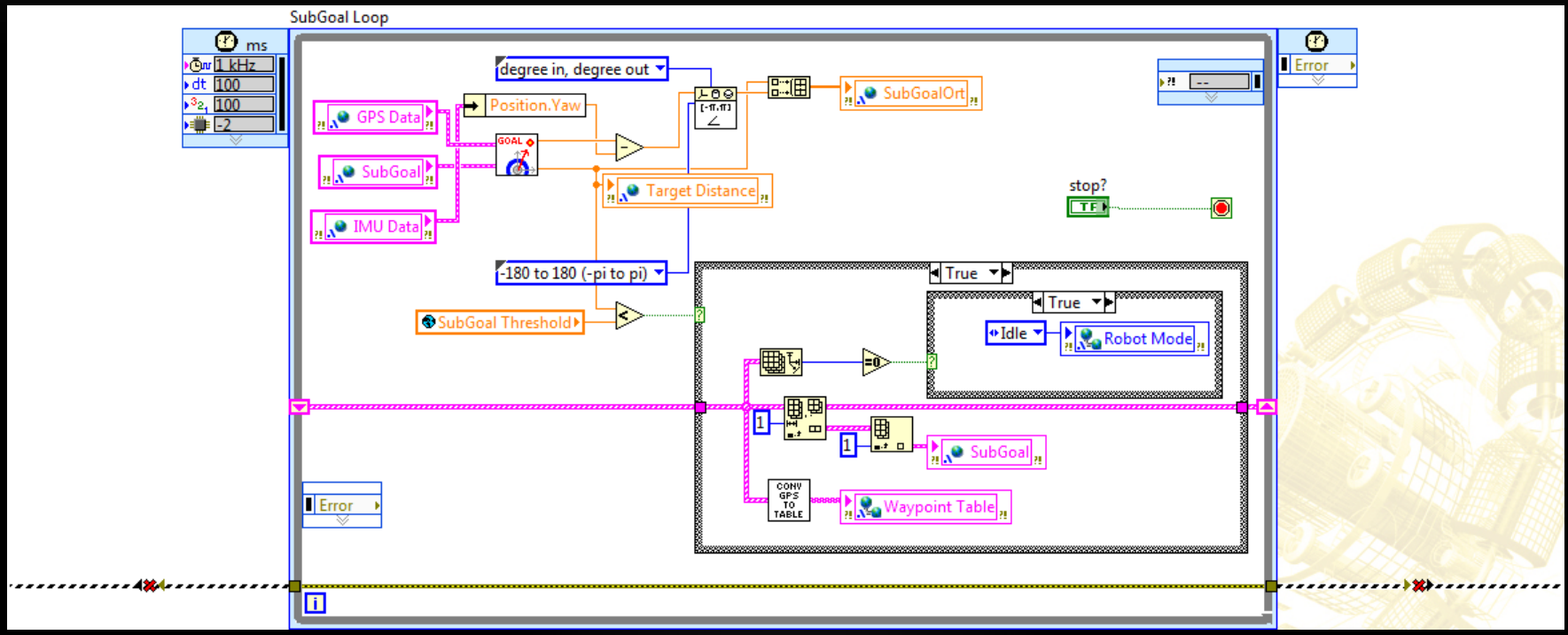


OBSTACLE DETECTION



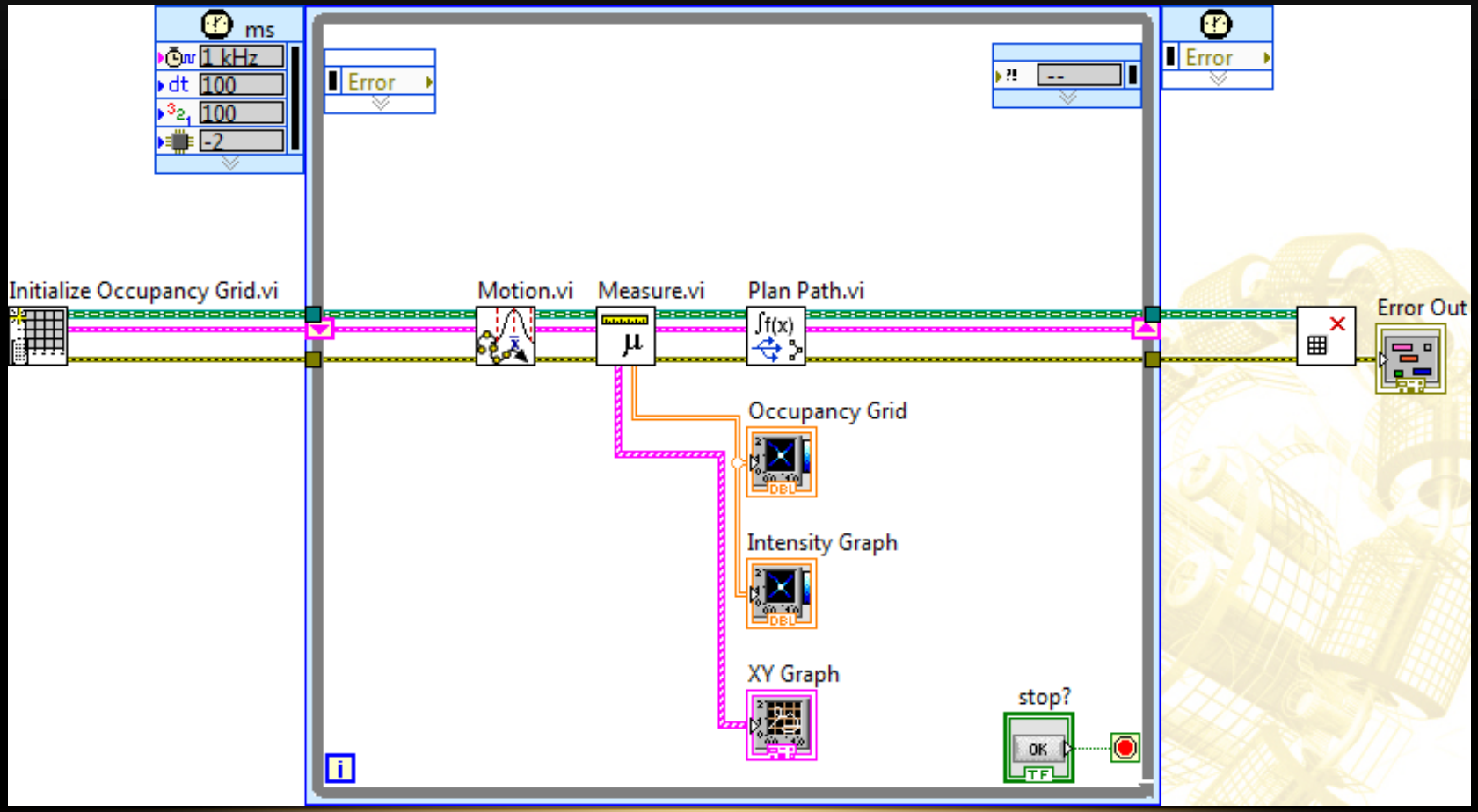


WAYPOINT TRAVEL



OCCUPANCY GRID

Sense → Think → Act



CONCLUDING REMARKS

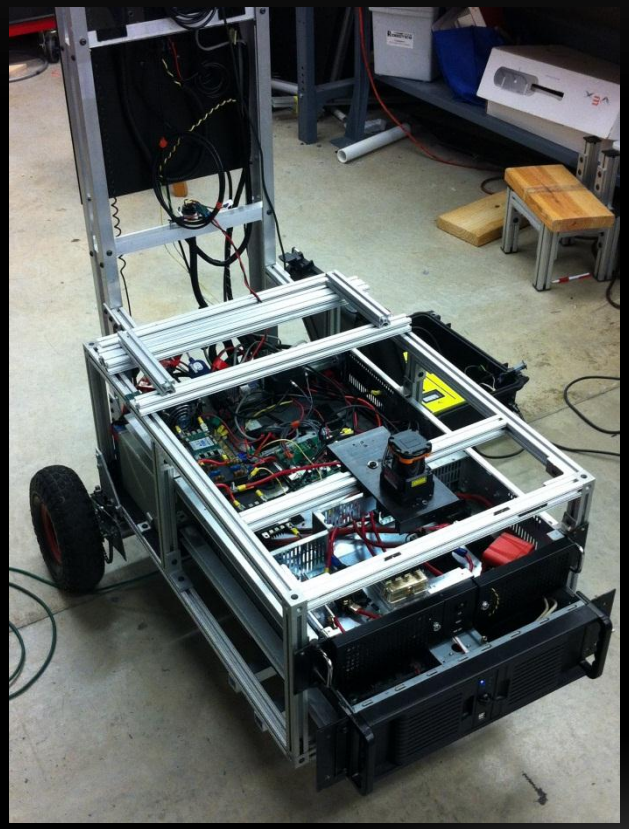
Strengths of Moxom's Master

- Original design
- Unique and strong software design
- Capacity to meet all objectives
- Easy to make changes
- Reliable safety mechanisms
- On-board monitor and router

Drawbacks of Moxom's Master

- Heavy and tall on the back
- Mechanically unstable
- Small drive wheels for off-road terrain
- Low power output
- Expensive design

FUTURE PLANS



Keep improving software

Need stronger and reliable frame

Change weight distribution

Increase power output

Construct new robot design

ACKNOWLEDGEMENTS

Partner

Rockwell Collins

Other Sponsors

PRECISE PATH

CLEARPATH ROBOTICS™

Robotics AT ROSE-HULMAN

Student Government Association