ROBOTIC PLANT MEASUREMENT SYSTEM

GROUP MAY15-27

SENIOR DESIGN I

Team Advisers

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Team Members

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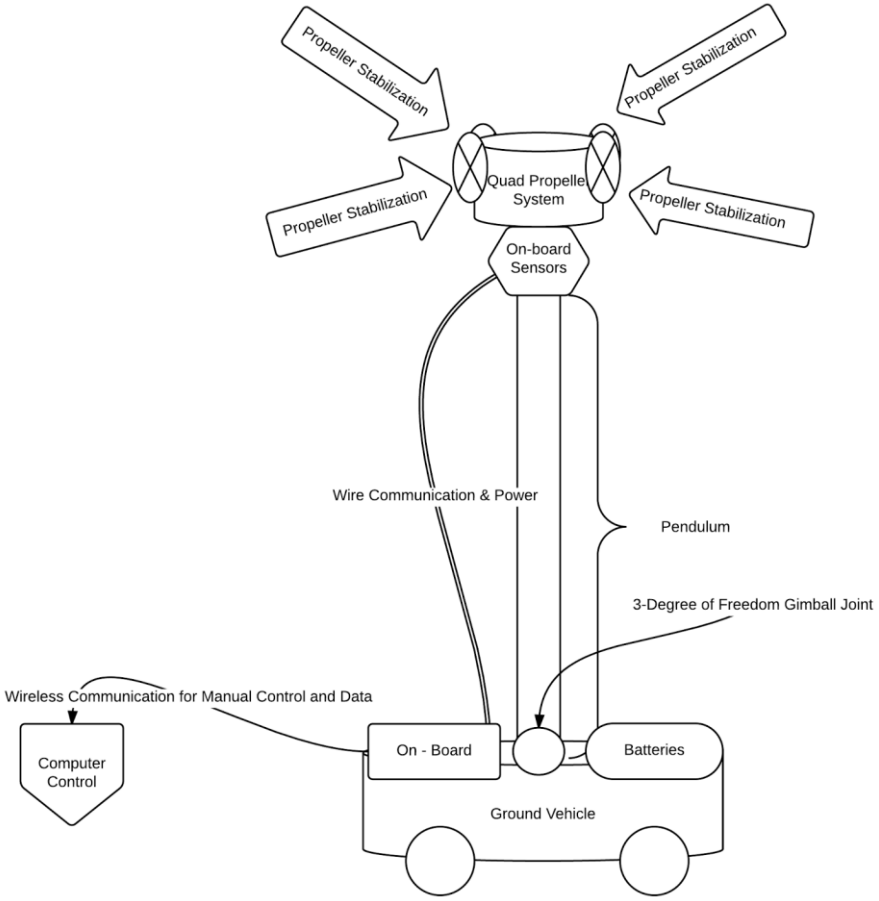
PROBLEM STATEMENT

- Agricultural experiments
  - Experimental crop fields
  - Measure growth and analyze progress
- Automation of tasks with robotics
  - Saves time, money and personnel

- GOAL: Demonstrate a proof of concept of a cooperative robotic system

CONCEPTUAL SKETCH

- Ground vehicle
  - On-board computation
- Quad-propeller system
  - On-board sensors
- Instrumentation arm
  - Mounted cameras



FUNCTIONAL REQUIREMENTS

- Autonomous system
- Stable camera equipment during motion
- Height greater than 12 feet
  - Proof of concept will be 7-9 feet
- Sufficient hardware for control and measurement

NON-FUNCTIONAL REQUIREMENTS

- Easily modifiable control system
- Useful documentation
- Data collection and analysis
- Ability to send commands from external computer
- Safety features in field
  - Subset of safety features in proof of concept

CONSTRAINTS & CONSIDERATIONS

- Future constraints
  - Width of crop row – 30 inches
  - Height of crop – 12 feet
  - Movement in field

POTENTIAL RISKS & MITIGATION

- Damage to system
  - Testing
  - Implementation
- Exceeding budget
- Time constraints

COST ESTIMATE

Item Description	Estimated Cost
Brushless Motors, Motor Controllers, Propellers	$300
Battery Packs	$75
Ground Robot System	$3,000
Gimbal Joint	$100
Sensor System (Gyroscope/Accelerometer)	$50
Camera System	$15,000
Total	$18,525*

*All items will be sponsored by the client

PROJECT MILESTONES

- System Modeling
  - Fall
    - Characterize system's physics
    - Model 1-D instrumentation arm system
    - Validate experiment with simulation
  - Spring
    - Model 2-D instrumentation arm system
    - Validate experiment with simulation

PROJECT MILESTONES

- Ground Robot
  - Fall
    - Revive ground robot (Eris)
    - Generate custom PWM outputs
    - Integrate with new camera system
    - PID control of PWM outputs
  - Spring
    - Testing
    - Integrating fully with instrumentation arm

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PROJECT MILESTONES

- Instrumentation arm
  - Fall
    - Build instrumentation arm
    - Mount motors
    - Control 1-D instrumentation arm system
  - Spring
    - Control 2-D instrumentation arm system
    - Design & build base joint

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PROJECT MILESTONES

- Data Acquisition
  - Fall
    - Design data logging format
    - Build MATLAB parsing script
    - Design MATLAB analysis tool
  - Spring
    - Build MATLAB analysis tool
    - Add useful features

PROJECT SCHEDULE

ID	Task Name	2014			2015			
		Oct	Nov	Dec	Jan	Feb	Mar	Apr
1	Balance 1-Degree of Freedom Pendulum							
2	Data Logging for Prototypes							
3	Establish Reliable Ground Platform							
4	Basic Data Logging for End-Product							
5	Balance 2-Degree of Freedom Pendulum							
6	Develop Stable Mount on Ground Vehicle for Pendulum							
7	Control GUI							
8	Refine Data Logging for End-Product							
9	Balance 2-Degree of Freedom Pendulum on Moving Gound Vehicle							

SYSTEM DESIGN

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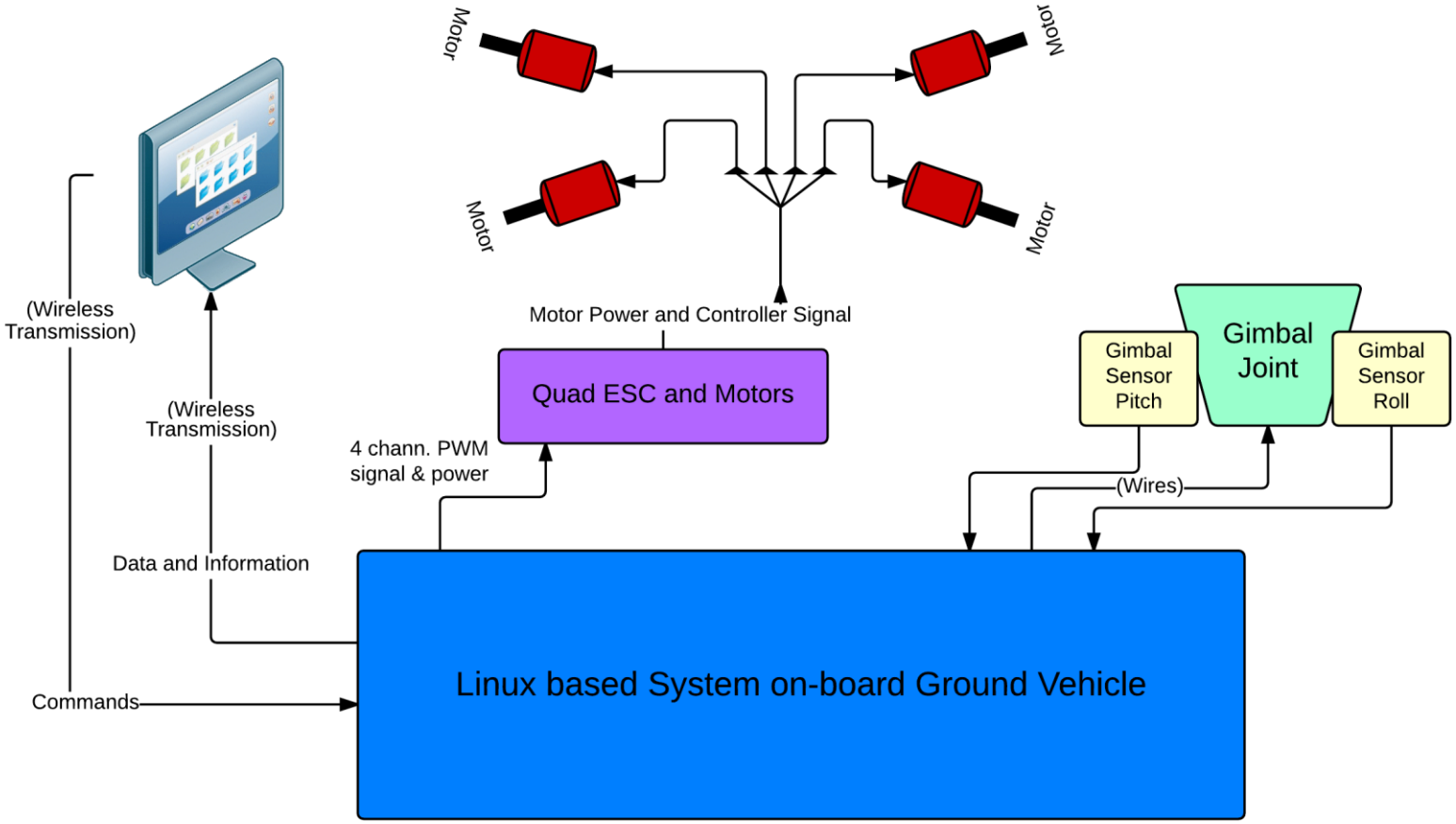
DETAILED DESIGN



FUNCTIONAL DECOMPOSITION

- Camera System
  - Read location of physical body using IR tracking
  - Relays location data to ground robot
- Ground Robot
  - Analysis of camera data to create controller inputs
  - Run the control algorithm to create ESC commands
- ESCs
  - Converts ESC command to motor voltage
- Motors
  - Generate torque and force to actuate the physical body
- Physical Body
  - Sensed by cameras as it moves

HW/SW TECHNOLOGY & PLATFORM

- Eris (ground robot)
  - Pluto PC
  - PC-104+ Adapter
  - Mesa 4i68
  - Motors
- Instrumentation arm
  - Inverted pendulum
  - Motors
- Software
  - C, C++
  - AI substructure
  - GUI

TEST PLAN

- Use Simulink models to design controller
- Use actual hardware to test the entire system
- Collect data from inputs and outputs for analysis
- Refine controller and Simulink models

DIFFICULTIES & RESOLUTIONS

- Software design based on previous team
  - Changing the functionality of modules
  - Designing a system without previous experience on field
- Expansion of specialized codebase
  - Code has very little portability
  - Update the old system for easier expansion
- Hardware
  - Custom mount for system of propellers
  - Base joint on ground robot for instrumentation arm

CONCLUSION

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CURRENT STATUS

- System modeling
  - Completed modeling of 1-D instrumentation arm
- Ground robot
  - Successfully revived
  - Able to generate custom PWMs
  - Working on integrating new camera system
- Instrumentation arm
  - Successful construction (1-D)
  - Control of 1-D system
- Data acquisition
  - Able to log and parse data
  - Building analysis tool

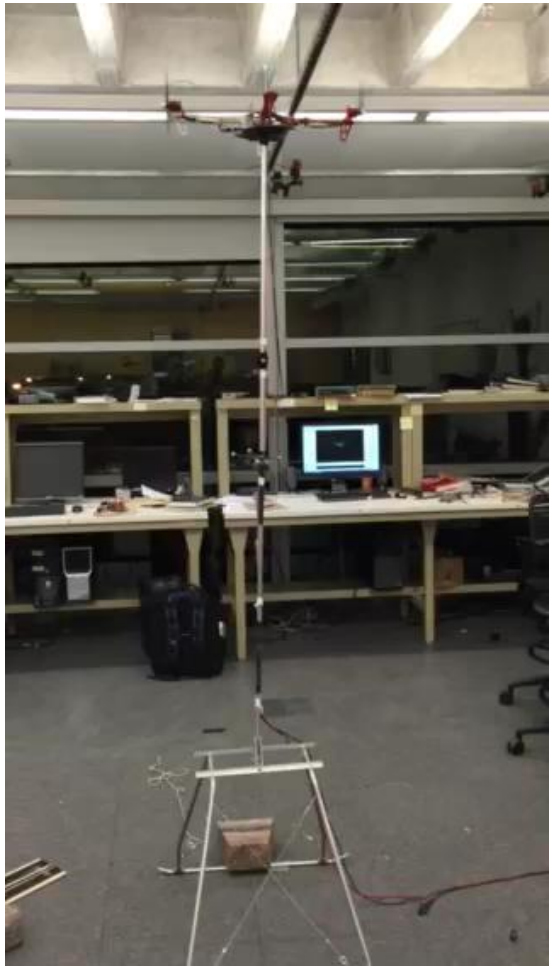
TASK RESPONSIBILITIES & CONTRIBUTIONS

- Robert Larsen – Project Manager
- Ian McInerney – Technology Lead (Key Concept Holder)
- Dylan Gransee – Webmaster
- Alberto Di Martino – Assistant Webmaster
- Aaron Pederson – Communications
- Fengxing Zhu – Assistant Communications
- Rohit Zambre – Team Secretary

NEXT SEMESTER PLANS

- Integrate Eris with instrumentation arm
- Derive 2-D instrumentation arm Simulink model
- Design/Test controller to balance 2-D instrumentation arm
- Expand data acquisition tool
- Expand ground robot GUI

DEMONSTRATION



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THANK YOU!

QUESTIONS?