IEEE R5 Robotics Competition

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Overview

- Competition between the 90+ student bodies within IEEE Region 5
- Autonomous Robot
- Sort cubes based on stencilled-on letters
- Avoid obstacles placed throughout course

Market

Pick and Place Robots → Speed & Consistency

Uses in manufacturers

- Assembly
- Packaging
- Bin picking
- Inspection

Social

IEEE (Institute of Electrical and Electronics Engineers)

- Latest technology
- Networking
- Career development

SLU IEEE Student Chapter

IEEE Region 5 Conference

IEEE Region 5 Robotics Competition

Ethics

Robo-ethics

- Poses no threat
- Simulated environment
- No human robot interaction
- No decision making tactic from data

Design Parameters

Robot

- Fit within 12” x 12”
- Total Weight < 40 lbs

Obstacles & Blocks

- Avoid gray pipes
- Pick up lettered blocks

Competition Board

- Multiple pieces will be cut and they will be placed as required

Corner Lights

- Blue LEDs
- Signals vehicle orientation

Mothership

- Stores sorted blocks

Specifications

- 10 minutes prep time
- No repairs/changes after start time
- No explosive/volatile liquid
- Only wheeled/tracked/legged robots allowed
- Always one point in contact with competition board

Solution Approach

- Simple, 4-wheel chassis design
- Optical character recognition (OCR) to identify cubes
  - Using OpenCV & Tesseract
  - Detect letter orientation & rotate
- Claw
  - Concept based on rack & pinion gear
- Navigation
  - Path found based on supplied JSON file
- Power supply
  - Needs to power all subsystems for ~2x the length of the competition

Alternate Solutions

- Navigation
  - Computer vision + obstacle detection
    - To computationally intensive for our processor
    - Would require multiple cameras for 360 degree vision
  - Sonar
    - Unreliable detection of small obstacles
    - Would be unable to distinguish between cubes/obstacles/mothership
- Claw
  - “Scissor” design
    - Would potentially push the cube out of range

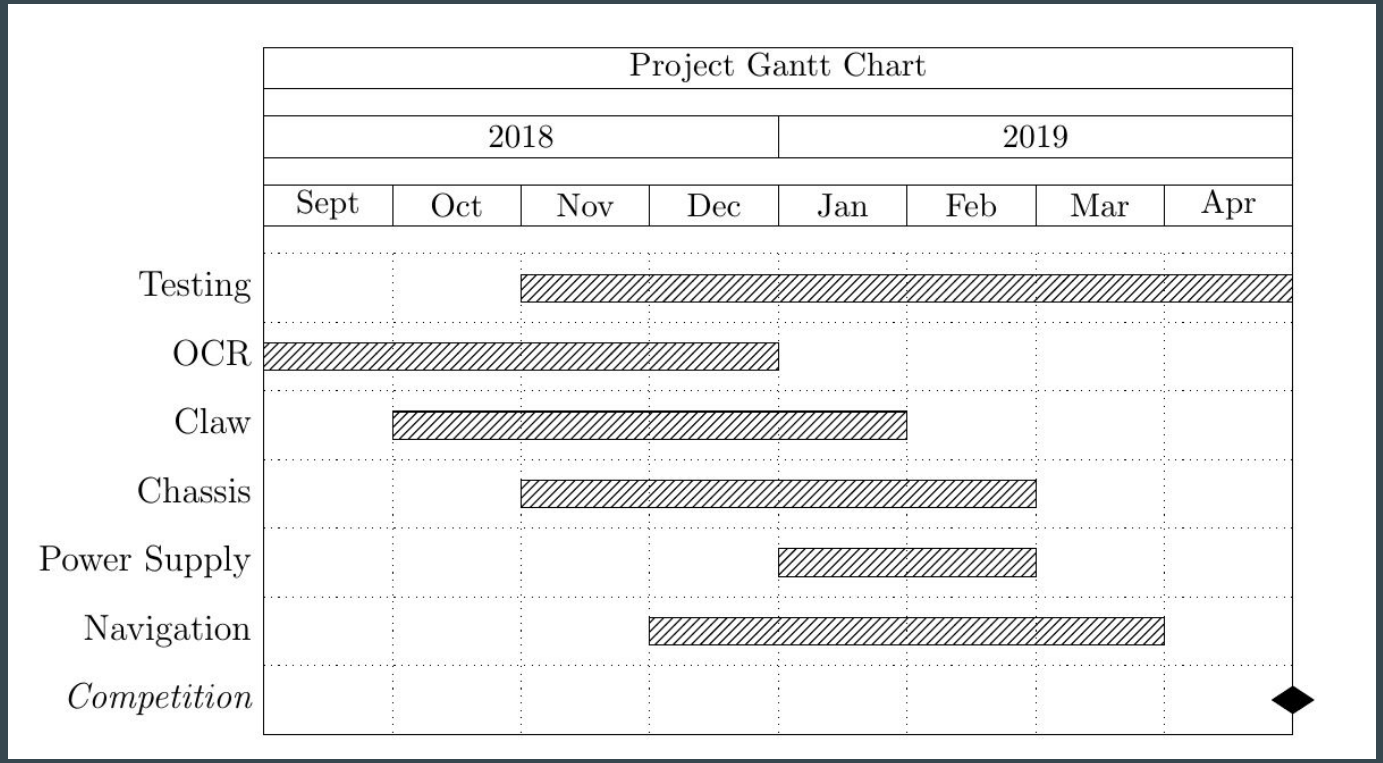
Testing Plan

- OCR
  - Computer generated images based off stencil
  - Images taken with RPi camera
  - Running on RPi w / camera
- Claw
  - Test on/off chassis, needs high reliability
- Navigation
  - Test on competition board
  - Use JSON files formatted like examples given
  - Tested at all difficulty levels
- Completed Robot
  - Test all subsystems individually again
  - Replicate competition scenario
  - Record time and points according to competition rules

Implementation Plan

- Milestones
  - Optical Character Recognition (OCR)
    - Accuracy improvement, Rotation detection
  - Navigation
    - Obstacle avoidance, cube/mothership detection
  - Chassis
    - Mounting Raspberry Pi, cameras, battery, etc.
    - Match rules for robot design given in competition rules
  - Claw
    - Mounted on robot
    - Reliable picking & placing of cube
  - Power supply
    - Power all subsystems for length of competition, with plenty of room for error

Gantt Chart


Project Gantt Chart
2018
2019
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Testing
OCR
Claw
Chassis
Power Supply
Navigation
Competition

Resources

- Facilities
  - Fabrication Lab
  - Senior Design Lab
  - Electronics Lab
  - Microprocessors Lab
- Lab Equipment
  - Laser cutter
  - Digital Multimeter
  - Power Supply
  - Oscilloscope
- Computer Applications
  - OpenCV
  - Tesseract OCR
  - Raspbian
- Specialized Hardware
  - Raspberry Pi
  - Raspberry Pi Camera Module
  - Servo Motors
  - DC Motors
- Communication Protocols
  - Universal Serial Bus
  - Camera Serial Interface

References

Robert Shapiro, IEEE Region 5 Website, 2018, http://ieeer5.org.

IEEE Region 5 Robotics Competition, 2018, http://r5conferences.org/competitions/roboticscompetition/.

Robotics Online Marketing Team, Pick and Place Robots: What Are They Used For and How Do They Benefit Manufacturers?, 03/13/2018, https://www.robotics.org/blogarticle.cfm/Pick-and-Place-Robots-What-Are-They-Used-For-and-How-Do-TheyBenefit-Manufacturers/88.

IEEE, The Benefits of Membership, https://ewh.ieee.org/reg/3/IEEE_member_value.pdf.