PACMAN

Path **A**ssembling **C**artographer, **M**apping under **A**utonomous **N**avigation

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Team 5 - Very Good Robotics

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Purpose / Problem Statement

- Navigate sidewalks around campus autonomously
- Create HD Maps
- Geolocate sidewalks
- Collect data for other autonomous devices on campus (RT 1000 autonomous snow plow)

Specific Achievements

Functional Requirements

- Has both an autonomous and manual mode.
  - Can detect and stay on paths while in autonomous mode.
- Shall cause no damage to either persons or personal property while under operation.
- Emergency stop capability
- Host control watchdog timer
- Can acquire GPS points of paths traveled.

Performance Requirements

- ❑ Autonomously travel paths at a minimum speed 1 m/s.
- ❑ Will fully stay in path.
- ❑ Be able to sense objects and stop if any object is within 2 m.
- ❑ Maintain operation for minimum of 3 hours.
- ❑ Inform operator when at low battery.
- ❑ Has less than 5 m GPS accuracy.

Elective Requirements

- More noticable audible or visual presence.
- Creating a 2D image of the paths and area it has traversed.
- Interfacing with a GPS beacon to acquire sub-centimeter accuracy.
- Measure width of the sidewalk traveled.

Attributes

- ❑ Reliability
- ❑ Maintainability
- ❑ Adaptability
- ❑ Safety (user must be present for autonomous mode)
- ❑ Portability
- ❑ Presentability

Comparison

- The Clearpath Husky is a ROS platform
    - Does not have sensors (just encoders)

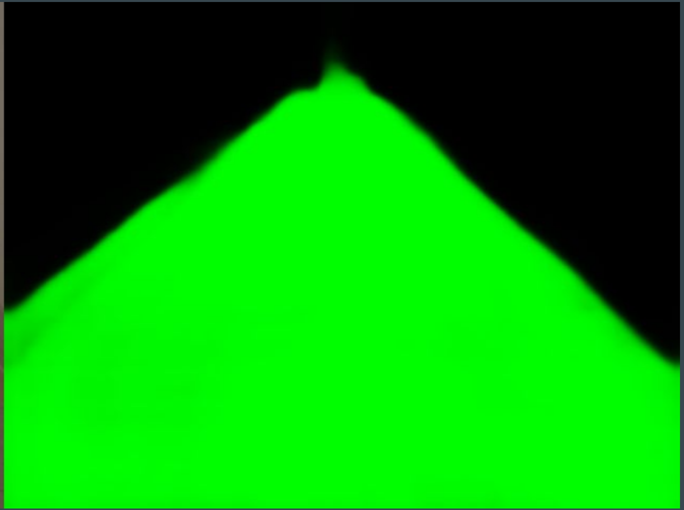
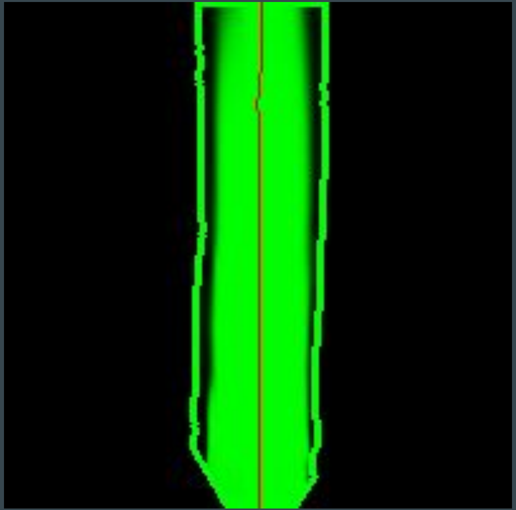
	Clearpath Husky	PACMAN
Cost	$24,000	$14,760
Max load capacity	75 lbs	450 lbs
Speed	1.0 m/s	1.66 m/s

Unique Innovations

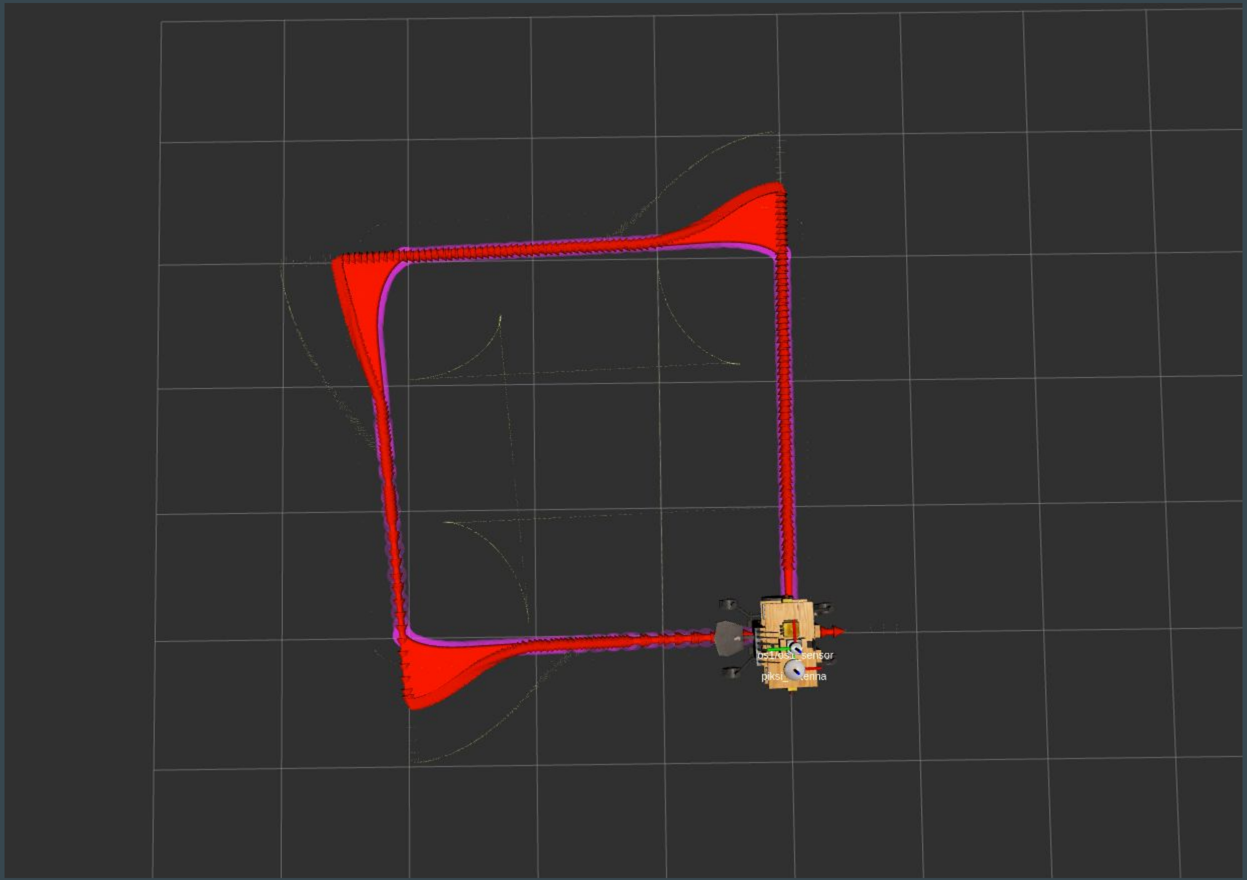
Steps Necessary for Autonomy

1. Motor Control via Non-User Input
2. Odometry
3. What is Path
4. Calibrated Camera
5. Where to Place Goal Points Within Real-World Path
6. Navigate to Goal Points

Planned Path

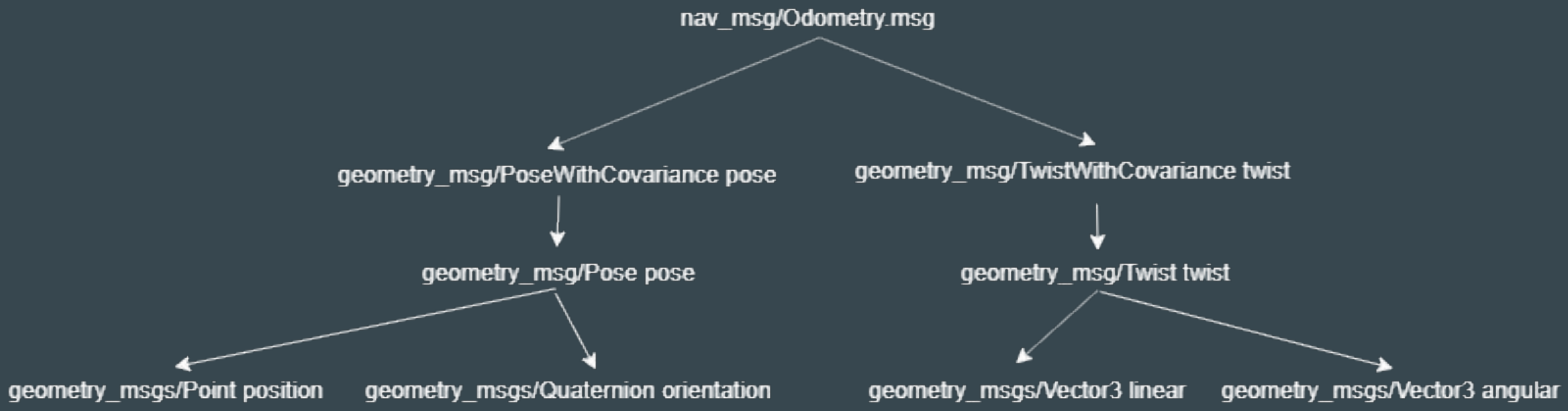




Point-to-Point Navigation in Real World



Path Navigation

- Linear and angular speed control
- Move through a queue of waypoints till end of queue.



Path Navigation (continued)

- Path Filtering

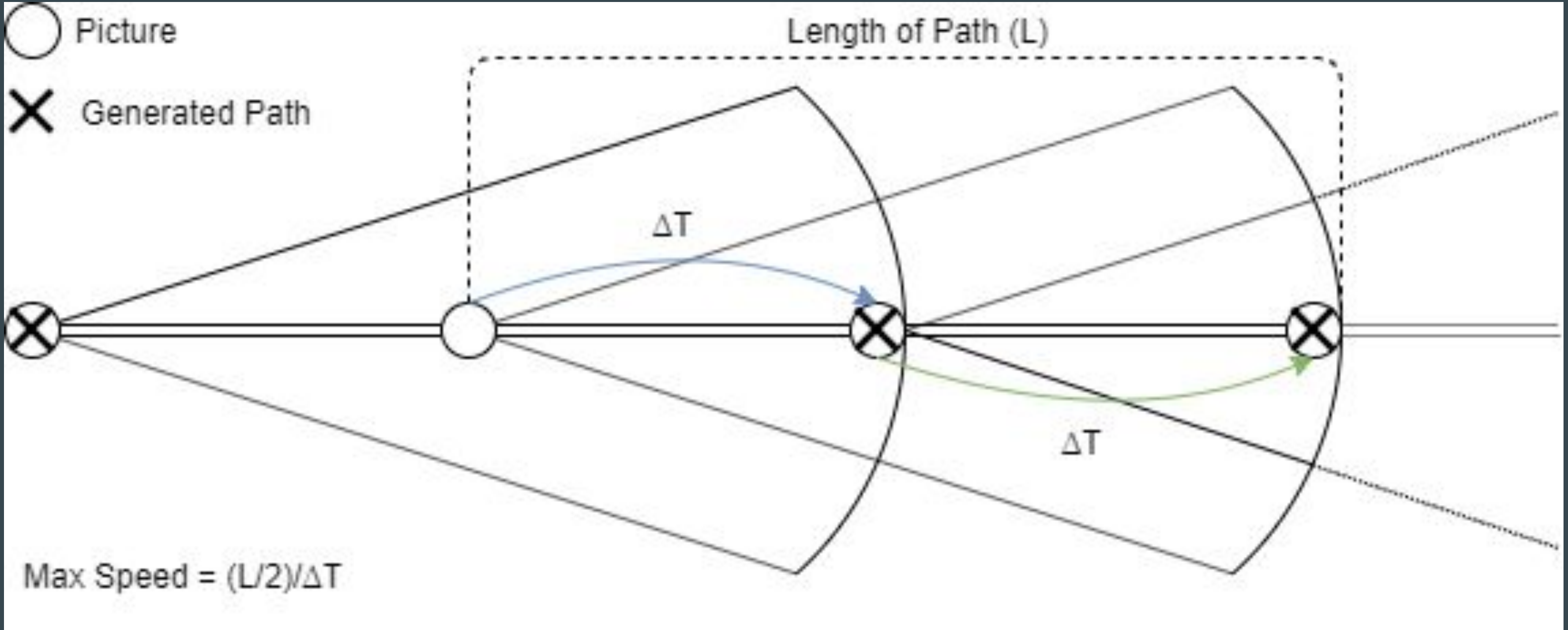


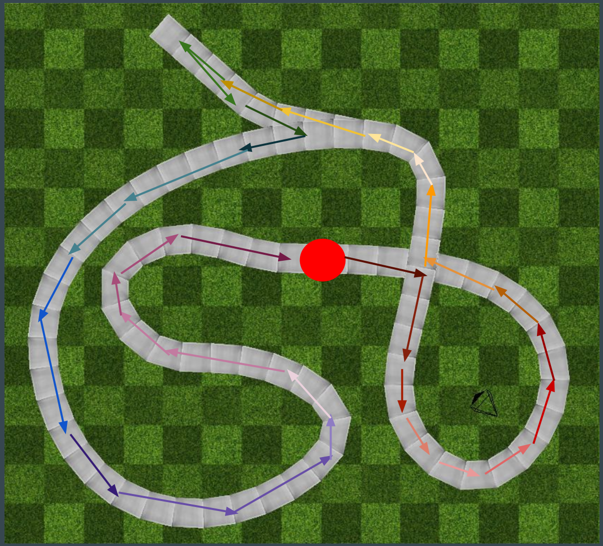
Diagram for Continuous Motion with Path Generation Latency

Simulation

- Test Path Navigation (point-to-point algorithms)
- Develop without the physical vehicle
- Create Transforms for Odometry

Testing Path Navigation

Test Path 1



Testing Path Navigation

Generating Transforms

- Maps positional/oriental data from individual components to a single base point
- Utilized in robot localization (fusion)

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<robot name="pacman">
    <link name="base_footprint"/>
    <link name="GPS_Receiver"/>
    <link name="LIDAR_Sensor"/>
    <link name="Front_Camera"/>


    <link name="base_link">
        <inertial>
            <origin xyz="0 0 0.157701488" rpy="0 0 0" />
            <mass value="62"/>
            <inertia ixx="0.0" ixy="0.0" ixz="0.0" iyy="0.0" iyz="0.0" izz="0.0"/>
        </inertial>
        <visual>
            <geometry>
                <mesh filename="file://$(arg modelDirectory)/materials/textures/base.dae"/>
            </geometry>
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        <collision>
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    <link name="left_big_wheel">
        <inertial>
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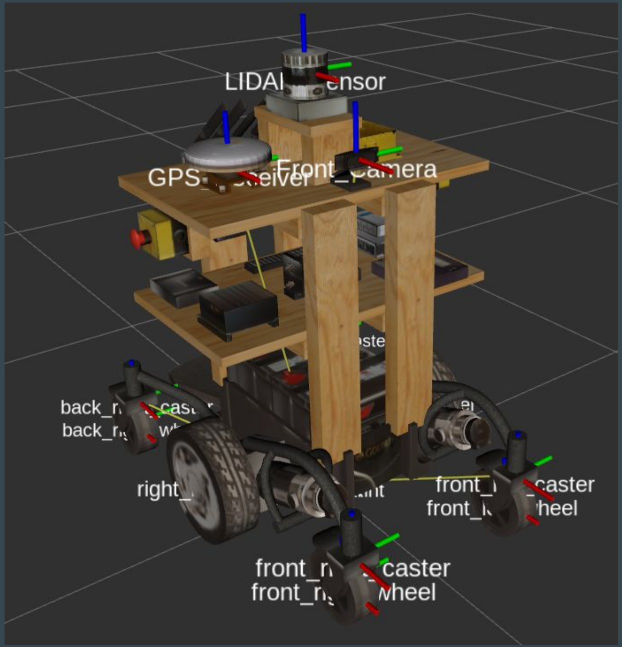

Weaknesses

Weaknesses

- Implement object detection with LiDAR data
- Improvements on Path Planning
- Build 3D maps from LiDAR data
- System latency in path prediction (2-3s)
- Segmentation in wet areas and in snow

Technology Assessment

Pacman Benefits

- Civil department:
  - Use LiDAR to capture details of surrounding geometry
  - Save high risk surveying jobs with real time autonomous mapping
- Ability to geotag locations
  - Can identify and tag pathways for other autonomous robots such as the RT1000 snow bot
- Reliable and fabricated platform

Adverse Effects

- Controversial
  - Replacing labor with robots
- Not Cyber Secure
  - ROS is not secure and can be easily hijacked
- Infinite Corner Cases

Thank You

- Professor Carroll
- Professor Khondker
- Professor Sonar
- Hannah DeFazio
- Sarmad Mehrdad
- Jake Schechter

Questions?