BSC-ROBOTMOTION second stage plan

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2019-11-01 12:28

1 Project overview

Mobile robotics research on new AI planning algorithms is dependent on a lower level technology stack include physical and simulated vehicles, motor controllers, and motion controllers. A motion controller takes as its input a short-term desired trajectory for the robot, such as a curved path over a few meters and a few seconds, and outputs desired wheel speeds over real time to implement this trajectory. This project implements a simulation and a motion controller for a real Lincoln research robot, for use in real Lincoln robotics research. It has two main parts. First, a simulation will be developed in Gazebo to accurately reproduce the physics of a real Lincoln robot, including simulation of its masses, motor controllers, and frictions. Second, the simulation will be used to port Lincolnâs standard motion control stack (based on movebase with timed elastic bands) for use on the new robot. Once ported, the stack will be tested in simulation and optionally on the real robot. The final deliverable is the ability for a user to input a desired destination pose and have the system drive the robot to it from its start pose, for short distance trajectories with no obstacles.

2 Work package overview

WP1: Simulation

Objectives: Create 3D simulation of robot.

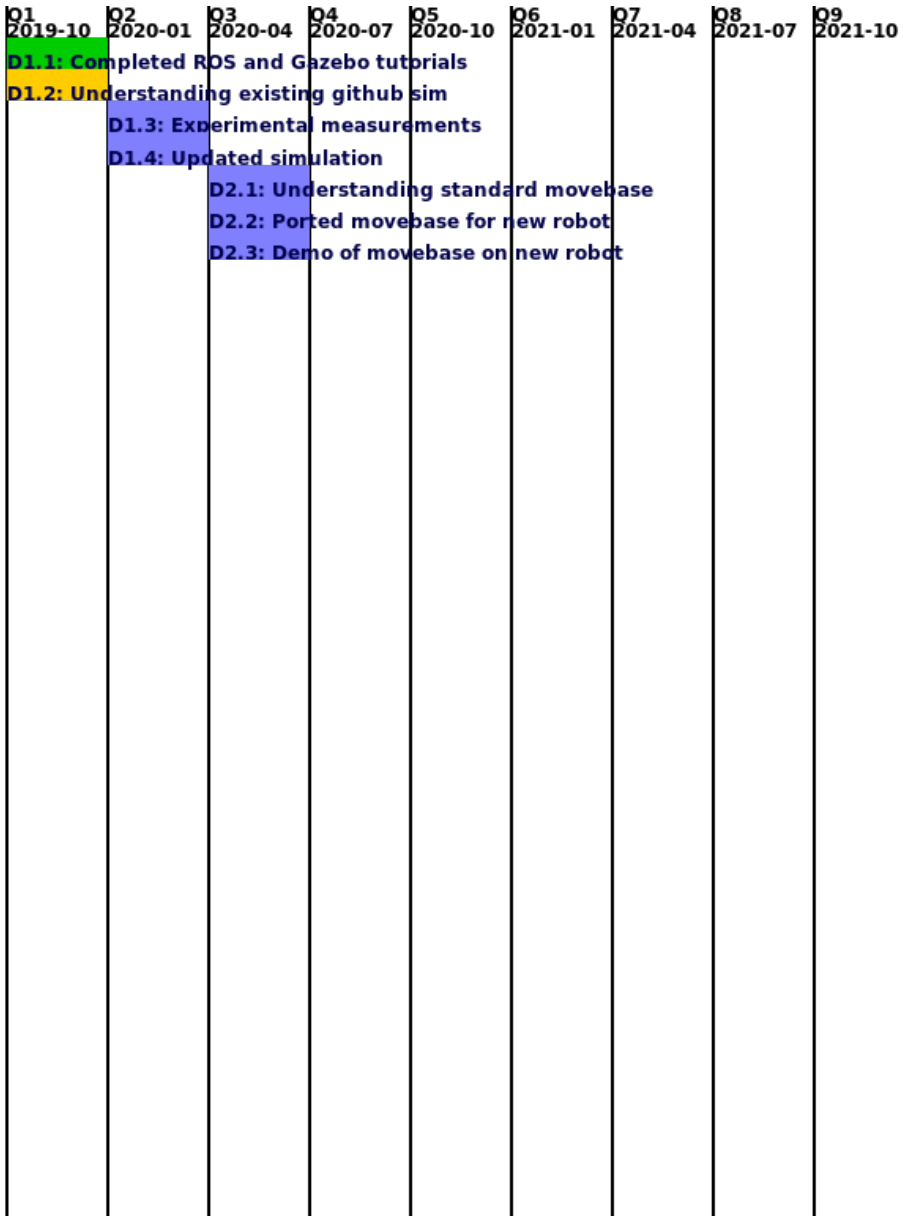
Description: Shall be developed in Gazebo robotics simulator. Shall include experiments measuring properties of the physical vehicle to ensure accurate simulation. Attention shall be paid to wheel friction in particular.

WP2: Motion control

Objectives: Port Lincoln's movebase stack to the simulated robot.

Description: The simulation shall be used to port Lincolnâs standard motion control stack (based on movebase with timed elastic bands) for use on the new robot. Once ported, the stack will be tested in simulation and optionally on the real robot

3 Gantt chart



4 Deliverables

Deliverable D1.1: Completed ROS and Gazebo tutorials

Start quarter: Q1 (2019-10-01)
End Quarter: Q2 (2020-01-01)
Leader: CHURCHILL
Status: DONE

Description of work

Demonstrate to supervisor an understanding of the complete ROS and Gazebo tutorials by running and talking through code for their final tutorials containing all taught concepts.

Associated risks:

None

Depends on deliverables:

None

Prerequisite for deliverables:

D1.2: Understanding existing github sim

Resources

Category	Partner	Cost
MATERIALS	LINCOLN	2,050.00

Total deliverable cost: 2,050.00

Per-item costs

Item	Partner	Category	Cost
Laptop PC	LINCOLN	MATERIALS	2,000.00 FORECAST
Coffee (to enhance programming)	LINCOLN	MATERIALS	50.00 FORECAST

Deliverable D1.2: Understanding existing github sim

Start quarter: Q1 (2019-10-01)
End Quarter: Q2 (2020-01-01)
Leader: CHURCHILL
Status: INPROGRESS

Description of work

Demonstrate to supervisor understanding of the existing Lincoln podcar simulation as currently on github, by running and talking through modifed version which makes the physics more realistic through modified guessed new parameters.

Associated risks:

R2: Software learning

Depends on deliverables:

D1.1: Understanding existing github sim

Prerequisite for deliverables:

D1.3: Experimental measurements

Resources

Category	Partner	Cost

Total deliverable cost: 0.00

Per-item costs

Item	Partner	Category	Cost

Deliverable D1.3: Experimental measurements

Start quarter: Q2 (2020-01-01)
End Quarter: Q3 (2020-04-01)
Leader: CHURCHILL
Status: WAITING

Description of work

Demonstrate to supervisor the accuracy of new parameters needed for the sim collected experimentally from the real robot. Likely to requrise design of suitable experiments to measure as well as some theory to understand what is needed.

Associated risks:

R1: Physical robots

Depends on deliverables:

D1.2: Experimental measurements

Prerequisite for deliverables:

D1.4: Updated simulation

Resources

Category	Partner	Cost
CAPEX	LINCOLN	200.00

Total deliverable cost: 200.00

Per-item costs

Item	Partner	Category	Cost
Usage of physical robot	LINCOLN	CAPEX	200.00 FORECAST

Deliverable D1.4: Updated simulation

Start quarter: Q2 (2020-01-01)
End Quarter: Q3 (2020-04-01)
Leader: CHURCHILL
Status: WAITING

Description of work

Design and demonstrate experiments proving that the updated simulation is accurace, eg. comparing outcomes of givign the same motion commands to the real and simulated robot. Comparisons are especially important if we want to publish this work, as they are empirical results.

Associated risks:

None

Depends on deliverables:

D1.3: Updated simulation

Prerequisite for deliverables:

D2.2: Ported movebase for new robot

Resources

Category	Partner	Cost

Total deliverable cost: 0.00

Per-item costs

Item	Partner	Category	Cost

Deliverable D2.1: Understanding standard movebase

Start quarter: Q3 (2020-04-01)
End Quarter: Q4 (2020-07-01)
Leader: CHURCHILL
Status: WAITING

Description of work

Demonstrate to supervisor running code showing understanding of standard movebase setup, eg by starting with the Clearpath Huskey simulation setup available online and modifyign some parameters based on guesswork to make it more like our robot.

Associated risks:

R2: Software learning

Depends on deliverables:

None

Prerequisite for deliverables:

D2.2: Ported movebase for new robot

Resources

Category	Partner	Cost

Total deliverable cost: 0.00

Per-item costs

Item	Partner	Category	Cost

Deliverable D2.2: Ported movebase for new robot

Start quarter: Q3 (2020-04-01)
End Quarter: Q4 (2020-07-01)
Leader: CHURCHILL
Status: WAITING

Description of work

Demonstrate ported of movebase running on the new simulated robot.

Associated risks:

R3: Running out of time

Depends on deliverables:

D2.1: Ported movebase for new robot
D1.4: Ported movebase for new robot

Prerequisite for deliverables:

D2.3: Demo of movebase on new robot

Resources

Category	Partner	Cost

Total deliverable cost: 0.00

Per-item costs

Item	Partner	Category	Cost

Deliverable D2.3: Demo of movebase on new robot

Start quarter: Q3 (2020-04-01)
End Quarter: Q4 (2020-07-01)
Leader: CHURCHILL
Status: WAITING

Description of work

Demo of movebase on new physicical robot (optional)

Associated risks:

R1: Physical robots

Depends on deliverables:

D2.2: Demo of movebase on new robot

Prerequisite for deliverables:

None

Resources

Category	Partner	Cost
CAPEX	LINCOLN	200.00

Total deliverable cost: 200.00

Per-item costs

Item	Partner	Category	Cost
Usage of physical robot	LINCOLN	CAPEX	200.00 FORECAST

5 Spend profiles

5.1 Spend profile for partner LINCOLN

X	1	2	3	4	5	6	7	8
MATERIALS	2,050.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LABOUR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAPEX	0.00	200.00	200.00	0.00	0.00	0.00	0.00	0.00
TRAVEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTHER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OVERHEADS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBCON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6 Risk register

Risk R1: Physical robots

The phyhsical robot might not be available if needed for active Lincoln research projects, or it may be broken or being upgraded.

Category: MANAGEMENT

Treatment: MITIGATE

The project is designed to promise only simulated results. It would be nice to demo on the real robot but this is strictly optional for delivery.

Impact Pre-Mitigation: 5

Probability Pre-Mitigation: 5

Score Pre-Mitigation: 25

Impact Post-Mitigation: 1

Probability Post-Mitigation: 5

Score Post-Mitigation: 5

Owner: CHURCHILL

Associated deliverables: D2.3 D1.3

Risk R2: Software learning

The project is based on real Lincoln research, it is not a greenfield project. As such there is a lot of existing code than needs to be understood before new development can begin. It will take time effort to get up to speed with the existing code base. This includes both open source ROS libraries such as movebase, and Lincoln's own simulation and control code as in the podcar github stack. There is a risk that a student will not be smart enough to get up to speed with all of this and still have time to make their own contribution.

Category: TECHNICAL

Treatment: MITIGATE

The student is one of the top in the year group and has a proven track record of delivering advnaced projects from my second year group project, which scored a perfect mark of 100. The current project should not be attempted by weaker students.

Impact Pre-Mitigation: 5

Probability Pre-Mitigation: 5

Score Pre-Mitigation: 25

Impact Post-Mitigation: 1

Probability Post-Mitigation: 1

Score Post-Mitigation: 1

Owner: CHURCHILL

Associated deliverables: D1.2 D2.1

Risk R3: Running out of time

The projcet requrires the simulation to be working before movebase can be ported. If simulation is late due to unforseen difficulty then movebase might not be delivered.

Category: TECHNICAL

Treatment: MITIGATE

This is an inherent risk in the structure of the project. A lower-scoring project report could be submitted describing only the simulation aspects in the worst case. Supervisor is knowledgable in the specifics of robotics research and may be able to assist to unblock technical problems to speed up simulation work if required.

Impact Pre-Mitigation: 3

Probability Pre-Mitigation: 3

Score Pre-Mitigation: 9

Impact Post-Mitigation: 2

Probability Post-Mitigation: 2

Score Post-Mitigation: 4

Owner: CHURCHILL

Associated deliverables: D2.2