Test Plan

Autonomous Water Taxi

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Contents

1 Introduction

This document outlines the full test plan for Spring 2016 of Team B – *Auto Pirates*. This test plan represents our proposal to incrementally improve each subsystems capability so that we can achieve the SVE goal.

2 Setup

The setup for all the field tests and SVE is discussed in the subsections below –

2.1 Location

All the tests discussed in the document will begin from the *Southside Riverfront Park* situated on the banks of the Monongahela River. The latitude and longitude of the location are 40.4321453 degree North and −79.974770 degree West.

2.2 Equipment /Arrangements

The following equipment will be used during the field test –

- Boat
- Radar
- IMU/GPS
- Fuel
- Laptop in boat
- Camera to record video
- Safety driver
- Life Jackets
- Food

2.3 Personnel

All tests will be conducted by some, or all, of the following personnel:

- Auto Pirates Team – Tushar Chugh, Shiyu Dong, Bikramjot Hanzra, Tae-Hyung Kim,
- Michael Pacilio – *Robotics Test Lead, RI*

Additionally, below is a list of personnel who will be present during SVE and SVE encore.

- John Dolan – *Course Instructor*
- Dimi Apostolopoulos – *Course Instructor*
- Jeremy Searock – *Technical Project Manager, RI*
- Ander Solorzano – *TA*
- Allen Miller – *TA*

2.4 Procedures

The procedure to test

2.4.1 Hardware Procedures

- Turn on the switch for the boat power system in the back of the boat.
- Turn on 24V for the navigation computer and network inside of the boat.
- Open the fuel valve.
- Turn on the generator.
- Turn the knob to the generator.
- Check INS is correctly calibrated.
- Open the valve of the ballast tank to let water in.
- Mount the camera on the top of the boat.
- Hit the enter key on the keyboard connected to the navigation computer.
- If it doesnt work, connect to the laptop to the USB-Serial.
- Open Putty, set the serial port to `/dev/ttyUSB0` and set the baud rate to 115200 and change the flow control to none.
- Open the port.
- Press enter on your laptop.
- Connect your laptop to ethernet.

2.4.2 Software Procedures

- Enter command, `ping 192.168.1.30`
- Enter command, `tcpdump -a`
- Run `OpenCPN`.
- Set the range of the radar to 125 meter.
- Run the launch file.
- Check `RViz` where the boat is to see radar data is properly overlaid.
- Create fake obstacles on the Occupancy Grid Map
- Put the boat to the auto mode.
- Set the final destination for path planning.
- Try the path planning.
- In the case that the boat is not working properly, ask the drive to change the boat into manual mode.

3 Test Schedule Summary

Table 1 shows the Test Schedule in conjugation with the Progress Reviews.

Table 1: Test Schedule According to Progress Reviews

S.No	Date	PR	Field Test	Key Features to test	Requirements
1	Feb 03, 2016	8	1	*a.* Integrity and reliability of the code *b.* Integration of low level controller *c.* Running path planner once *d.* Motion Primitives *e.* Inflated costs of shores *f.* OGM with pylons	MF1, MF4, MF10
2	Feb 12, 2016	9	2	*a.* Inflated cost of pylons *b.* Re-planning *c.* Adding Fake Obstacles	MF6, MF10
3	Feb 17, 2016	10	3	*a.* Integrate path planner and Radar *b.* Traverse all area in the map	MF2, MF5, MF6
4	Mar 11, 2016	11	4	*a.* Bug Fixes *b.* Performance Improvements	All Mandatory
5	Mar 20, 2016	11	5	*a.* Dry run on the same path that we would be taking during SVE	All Mandatory
6	Apr 06, 2016	12	6	*a.* Desirable requirements (Rules of the road) *b.* Final test run	DNF 1
7	Apr 13, 2016	SVE	7	*a.* Dress Rehearsal	All Mandatory
8	Apr 13, 2016	SVE	7	*a.* Dress Rehearsal	All Mandatory

4 Test 1

Tentative Field Test Date – February 03, 2016
Progress Review Date – February 10, 2016
Setup – Refer to Section 2

4.1 Objective

- Check the integrity and reliability of the code: The whole code has been rewritten and organized in modules after fall semester. The first test would be to verify that we are not getting any exceptions or errors during the field tests.
- Integration of low level controller with path planner: Verify if we are able to send commands to add and clear waypoints in low level controller.
- Running path planner once – The boat should be able to navigate the path planned by our path planning algorithms to reach the destination. We would be testing this for following cases:
  - Small path (50 mt)
  - Medium path (1 Km)
  - Long path (3 Km)
  - Paths requiring U-turns
- Verify and tune motion primitives – By giving goals to the planner which require some sharp turns and U-turns, we need to verify that the boat is able to stay on the track and is able to easily follow the trajectory generated by the planner. If that doesnt happen, then we will need to tune the motion primitives.
- Verify and fix inflated cost of shores in the OGM – We have inflated the cost of the shores so that the boat keeps some minimum distance from the shores. We need to verify during test runs that the boat is at a comfortable distance from the shore.
- Test the new OGM with pylons: We have added pylons to the occupancy grid map. We need to make sure that the locations of the pylons are correct and the boat is able to avoid these pylons.

4.2 Verification criteria

- We can successfully send commands and clear way points to the low level controller.
- The boat will be able to follow the path and reach the destination for one-time planning.
- The boat will keep a minimum distance from the shore.
- The boat will be able to avoid all the bridge pylons.

5 Test 2

Tentative Field Test Date – Feb 12 2016
Progress Review Date – Feb 24, 2016
Setup – Refer to Section 2

5.1 Objective

- The boat will keep a minimum distance from the shore.
- The boat will be able to avoid all the bridge pylons.
- The path planner can successfully navigate through the fake obstacles.

5.2 Verification criteria

- Verify and fix inflated cost for pylons – During the last test, we had not increased the cost of the pylons and we observed that the boat was taking the paths very close to the pylons. We will be fixing it and testing it.
- Test re-planning of path – We have 3-4 approaches in mind to target re-planning. During the last test run, a couple of them didnt work out. One re-planning method worked quite well but we aren't sure as we didnt get much time to test it. We would be testing a couple of more methods in this test run.
- Test planner by adding fake obstacles – During SVE, we wont have many obstacles on the river. So, we have added the functionality to add fake obstacles.

6 Test 3

Tentative Field Test Date – Feb 22 2016
Progress Review Date – March 16, 2016
Setup – Refer to Section 2

6.1 Objective

- Decrease the noise of radar perception and integrate path planner with Radar.
- Run through the 3 rivers and verify that we dont see any aberrations. This can be like missing pylons under the bridge, or the radar giving some random data (due to briges) or an island which we missed in our OGM.

6.2 Verification criteria

- The radar detects obstacles, and the path planner can successfully navigate around them.
- The noise of the radar will not inhibit the path planner.

7 Test 4

Tentative Field Test Date – March, 11, 2016
Progress Review Date – March 30, 2016
Setup – Refer to Section 2

7.1 Objective

Dry run for SVE satisfying all mandatory requirements: We would be testing the features which we have as mandatory requirements. The success criteria for this test run would be similar to the SVE with the difference that we would be more conservative with the performance requirements.

7.2 Verification Criteria

- Boat reaches the goal located at 3 km from the start location.
- Navigates through bridges and avoids pylons.
- Avoids 5 obstacles in the path (including fake obstacles and of size 1.5x1.5mt)
- Boat keeps distance of at least 10 meters from shores.
- The systems runs without throwing any error and without throwing any exception.
- The logged data is saved.

8 Test 5

Tentative Field Test Date – March 20, 2016
Progress Review Date – April 12 , 2016
Setup – Refer to Section 2

8.1 Objective

- *Rules of the road* – After finishing the mandatory functional requirements, we will target desirable requirements, the most important of which is to follow the rules of the road.
- *Better efficiency for radar* – Right now, radar data is noisy. We would be experimenting with more filtering techniques to make the data less noisy.
- *Performance of path planning* – At present, in order to deal with memory related issues we have to delete and re-initialize the environment and path planner. We would be fixing this issue and would need to test if re-planning is working in the similar way as it worked in Test 4.

8.2 Verification Criteria

- The boat follows right alignment while travelling autonomously from start to goal.
- Compare our present data from radar to this filtered version in terms of noise.

8.3 Test 6

Tentative Field Test Date – April 6, 2016
Progress Review Date – April 11, 2016
Setup – Refer to Section 2

8.4 Objective

- We would be fixing the bugs and will freeze our code after resolving all the issues during this test run. We need to make sure that all the success criteria listed for test run 4 are satisfied during this field test. This would be more of a regressive version of Test 4 where we would be testing in every possible environment (on our OGM) and for boundary cases like if there is no path existing between start and goal.

8.5 Verification Criteria

- The success criteria for this would be that boat is able reach the goal wherever there is a possible path, else it returns that there is no possible solution.

9 Test 7

Tentative Field Test Date – April 13 , 2016
Progress Review Date – Mar 30, 2016
Setup – Refer to Section 2

This test run would be the carbon copy of our SVE. We would be having the test run at the same location with same number of obstacles. Our success criteria for the SVE should be fully satisfied during this test run.

10 Spring Validation Experiment

SVE Date – April 20 , 2016
SVE Date – April 27 , 2016
Setup – Refer to Section 2

Table 2 shows the description and success criteria of Spring Validation Experiment.

Table 2: Spring Validation Experiment

Step ID	Description	Success Criteria
1	Turn on the power system of the boat.	The generator and 24v switch is on.
2	Mount the camera on the front top of the boat.	We can see the camera stream on the laptop
3	Turn on the navigation computer and calibrate INS.	We can ping the master computer and the INS is correctly calibrated.
4	Run OpenCPN and get the radar data.	Check the raw radar image
5	Run the launch file to start the navigation system	Check RViz to see where the boat is and check radar data is properly overlaid.
6	Create fake obstacles on the Occupancy Grid Map	We can use the interactive marker in RViz
7	Put the boat to the auto mode and set the final destination for path planning.	We can see a path in RViz and the boat starts moving.
8	Start recording rosbag files and stop recording when the boat arrives destination	We can replay the bag file after and see the trajectory.
9	The boat detects the static obstacles on the river	80% of Obstacles that are 2*2*2 meters will be detected and labeled as obstacles
10	The path planner generates a safe path	The boat maintains a safe distance from obstacles
11	The boat navigates successfully to the destination	The boat arrives with 15m of the destination