Multi-Agent Collaboration for navigation in disaster zone

Team F- Falcon Eye

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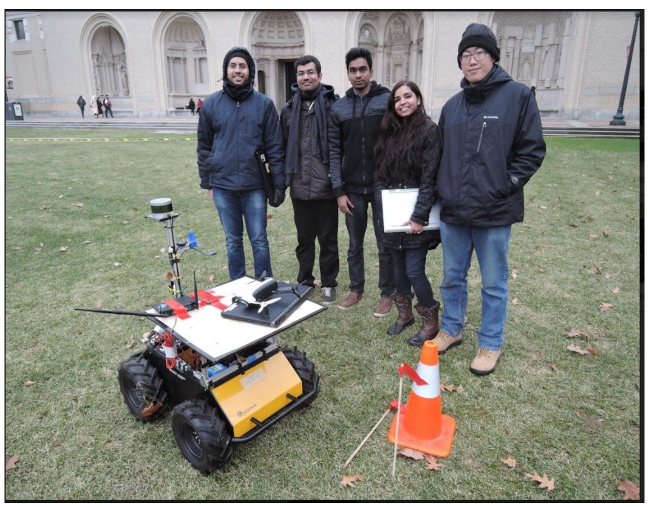

Test Plan

Feb 7, 2018

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1. Introduction:

The document explains the detailed test plan for the MRSD capstone project- Multi Agent Collaboration for Navigation in Disaster Zone, to be completed in the spring semester of 2018. Logistics aspect of the test plans are mentioned first followed by the detailed schedule of the spring semester and tasks lined up for the progress reviews. We then describe 6 test plans that progressively indicate the development of individual subsystems and final integration for demonstration in the Spring Validation Experiment.

2. Logistics:

1. Personnel: All team Personnel will be present while performing the tests. Each Test will have primary personnel in charge of the test scheduled for a particular progress review.
2. Location: All tests will be performed in the CFA lawns except 4.1.3 that will be performed on B level of NSH.
3. Equipments: Husky AGV, Bebop UAV, Razor IMU, Radiolink GPS, Velodyne LIDAR, Husky Batteries, Bebop spare propellers, Batteries, Controller and Charging station, User Laptops, Video Recording Equipment, Measuring Tapes, Location Marking Cones, April Tags. AC power Strips.

3. Schedule:

Date	PR	Capability Milestone	Associated Tests	Associated System Requirements
14 Feb	PR-8	Calibrate and integrate IMU	4.1.1	
		Integrate wireless mesh access point	4.1.2	
		Show obstacle clustering with Velodyne in RViz	4.1.3	M.P.3
28 Feb	PR-9	Perform AGV obstacle avoidance	4.2.1	M.P.3
		Implement Bebop exploration algorithm	4.2.2	M.P.4 M.P.5
21 March	PR-10	AGV platform works with drone proxy	4.3.1	M.P.3
4 April	PR-11	Integrate AGV and UAV subsystems	4.4.1	M.P.1 M.P.2
		Standalone AGV test	4.4.2	M.P.3
16 April	PR-12	Fully integrate both systems and record run through for SVE	4.5.1	M.P.1 M.P.2
25 April	SVE	Full System Capability	4.6.1	M.P.1 M.P.2

4. Tests:

4.1 Test 1: PR8

4.1.1 IMU Integration

- **Objective:** Test the functionality of the IMU module to interact with the other ROS nodes and to remain accurate after movement

- **Elements:** Razor IMU M0, Husky PC, ROS software stack update for AGV

- **Location:** CFA Lawns

- **Equipment:** Husky AGV, IMU, Rviz data verification

- **Personnel:** Danny and Pratibha

- **Procedure:**
  a. User sets up IMU on Husky outdoors with GPS signal
  b. User launches RViz which shows Husky representation and north heading
  c. User rotates and inclines the Husky at various positions
  d. The Husky representation in RViz matches the physical movements of the Husky

- **Verification:**
  a. Use a compass to verify the heading given out by the IMU
  b. Visually inspect Husky's orientation v/s IMU's Output
  c. Measure the drift in IMU readings over time.

4.1.2 Wireless Mesh Access Point

- **Objective:** Test the ability of the access point to host a mesh network of sufficient range and minimum latency

- **Elements:** Unify AC Mesh, Bebop 2, Husky PC

- **Location:** CFA Lawns

- **Equipment:** Two Unify AC Mesh, Bebop 2, Husky PC, Control Laptop

- **Personnel:** Danny

- **Procedure:**
    a. User sets up and powers the two access points already set up as a mesh configuration
    b. User connects the Bebop and Husky PC to the network
    c. User moves the AGV and Drone to test connectivity at all positions in the Test location.

- **Verification:**
    a. User connects the Laptop to the mesh network and check connectivity through the Access point controller application.
    b. User streams live video from the drone while checking the ping latency and quality of stream

4.1.3 Show obstacle clustering with Velodyne in RViz

- **Objective**: Test the clustering and localization of the obstacle in LiDAR’s view w.r.t. To Husky platform.

- **Elements**: Unit test having obstacle detection for the obstacle avoidance module using Velodyne LiDAR

- **Location**: B512 RI

- **Equipment**: Husky AGV, Velodyne LiDAR, Rviz data verification

- **Personnel**: Pulkit and Rahul

- **Procedure**:
    a. User sets up an obstacle(with height greater than certain threshold) in front of LiDAR mounted on Husky
    b. User opens up Rviz which shows the separate points of obstacle and also the clustered obstacle w.r.t. LiDAR
    c. User changes the location of obstacles
    d. The obstacle representation in RViz matches the physical movements of the obstacle

- **Verification**:
    a. Use measuring tape to measure the distance of obstacles w.r.t. Mounted LiDAR
    b. Visually inspect obstacle position and output shown on Rviz

4.2 Test 2: PR9

4.2.1 AGV obstacle avoidance

- **Objective:** Test obstacle avoidance functionality by AGV

- **Elements:** Module test having obstacle detection and avoidance using Velodyne LiDAR
- **Location:** CFA Lawns

- **Equipment:** Husky AGV, Velodyne Lidar, Husky PC

- **Personnel:** Pulkit and Rahul

- **Procedure:**
    a. User sets up 4 obstacles(with height greater than certain threshold) in front of LiDARs mounted on Husky
    b. User enters the final GPS point
    c. AGV should move towards the final goal avoiding the obstacles in the path
    d. User changes the location of obstacles and Husky reaches the goal avoiding them

- **Verification:**
    a. Visually inspects that husky is able to avoid obstacle and reaches the goal

4.2.2 Bebop exploration algorithm

- **Objective:** Demonstrate the ability for the UAV subsystem to autonomously explore, find a path, and fly to the target destination when the traversable paths are presented by April Tags

- **Elements:** Bebop 2 exploration subsystem

- **Location:** CFA Lawns

- **Equipment:** Bebop 2, 20 April Tags

- **Personnel:** Yuchi

- **Procedure:**
    a. Organize the April Tags from the start to the end such that they form a curved sequence with no two neighboring April Tags >2m apart
    b. Place the Bebop 2 at the starting location
    c. Drone Operator gives start command to Bebop 2 system
    d. Bebop 2 autonomously detects and follows the April Tags to the end destination
    e. Bebop 2 lands at target destination

- **Verification**
    a. Bebop 2 lands < 5 m of target destination
    b. RViz visualization of April Tags graph show all April Tags

4.3 Test3: PR10

4.3.1 AGV platform works with drone proxy

- **Objective:** Test the functionality of AGV to interact with the other AGV ROS nodes and avoid static obstacles as a standalone system by manually controlling the drone

- **Elements:** Husky Navigation Stack Test, Husky Communication Stack test

- **Location:** CFA Lawns

- **Equipment:** Husky AGV, LiDAR, IMU, GPS, Husky PC, Central PC, Bebop 2

- **Personnel:** Rahul, Pulkit, Yuchi

- **Procedure:**
    a. User sets up Husky outdoors with IMU, GPS and LIDAR
    b. User sends in GPS locations to the Husky
    c. Drone operator manually flies the drone over the AGV, providing the AGV with April Tag and GPS information
        i. Husky navigates to the given locations avoiding the obstacles in its path

- **Verification:**
    a. Use a measurement tape to quantify the accuracy of Husky navigation <5m from given location
    b. Avoid 4 out of 5 obstacles placed in its path

4.4 Test 4: PR11

4.4.1 AGV and UAV system Integration

- **Objective:** Test the functionality of all subcomponents coming together and working as a single system

- **Elements:** Husky Navigation and Obstacle avoidance Stack Test, Husky- Bebop Communication Stack test.
- **Location:** CFA Lawns

- **Equipment:** Husky AGV and sensors, Bebop, Husky PC, Central PC

- **Personnel:** All team personnel

- **Procedure:**
    a. Drone takes off autonomously and explores target area.

b. Drone sends the Map of the area to the Husky.
c. Husky plans its path to the target location
d. Husky moves to the target location while avoiding obstacles on the way

- **Verification:**
  a. Evaluates the accuracy of april tags detected by the drone by physically measuring their placement and distance from each other.
  b. Verify the reception of the area map to the Husky on user laptop.
  c. Verify physically and through Lidar Data that the Husky doesn't collide with any obstacles.
  d. Measure the distance between the Husky stop position and target user location.

4.4.2 AGV Standalone Test

- **Objective:** Test the functionality of AGV to autonomously navigate to any given location planning its path

- **Elements:** Husky Navigation and Obstacle avoidance Stack Test

- **Location:** CFA Lawns

- **Equipment:** Husky AGV, LIDAR, Husky PC, Central PC

- **Personnel:** Rahul and Pulkit

- **Procedure:**
  a. Husky plans its path to the target location
  b. Husky moves to the target location while avoiding obstacles and dead ends on the way

- **Verification:**
  a. Successful reach to the given location with <5m accuracy
  b. Avoid 90% of obstacles

4.5 Test 5: PR12

4.5.1 Fully integrate both systems and record run through SVE

- **Objective:** Perform the actual tests for SVE and record them

- **Elements:** Husky Navigation and Obstacle avoidance Stack Test, Husky- Bebop Communication Stack test.

- **Location:** CFA Lawns

- **Equipment:** Husky AGV, Bebop, Husky PC, Central PC

- **Personnel:** All team personnel

- **Procedure:**
    a. **Test 1:** Husky Navigates in unknown environment with the help of UAV
        - Drone takes off autonomously and explores target area.
        - Drone sends the Map of the area to the Husky.
        - Husky plans its path to the target location
        - Husky moves to the target location while avoiding obstacles on the way
- **Verification:**
        - Recordings validating that all the tests are completed successfully

    b. **Test 2:** Husky navigates independently in unknown environment
        - Husky plans its path to the target location
        - Husky moves to the target location while avoiding obstacles and dead ends on the way
- **Verification:**
        - Recordings validating that all the tests are completed successfully

4.6 Test 6: Spring Validation Experiment (SVE)

4.6.1 Heterogeneous navigation test

- **Objective:** Test the performance of the heterogeneous system to navigate through an unknown environment

- **Elements:** Husky local path planning, Husky obstacle avoidance, UAV exploration algorithm, April Tag localization subsystem, system integration

- **Location:** CFA Lawn

- **Equipment:** Husky AGV, Bebop 2, 50 April Tags

- **Personnel:** Entire team

- **Procedure:**
    a. Securely place 35 April Tags on the ground to represent a valid path that is 50m in length. Consecutive April Tags should be within 1 - 3 m of each other.
    b. Securely place 15 more April Tags on the ground to represent 3 invalid paths. These tags should branch from the valid path with each path comprising of 5 April Tags.
    c. Place 5 50×50×50 cm obstacles along the valid path
    d. Place the Husky + Bebop 2 system at the starting location
    e. User enters final destination and gives start command
    f. System autonomously navigates to final destination

- **Verification:**
    a. AGV arrives within 3 m of final destination
    b. AGV navigates the path in less than 10 mins
    c. AGV avoids 80% of static obstacles
    d. Heterogeneous system navigates faster than standalone system