IIT KHARAGPUR

INTER IIT TECH MEET 10.0

25-27TH MARCH 2022

DRDO'S UAV-GUIDED UGV NAVIGATION CHALLENGE

Mountain roads generally run across hills with deep valleys on either side, and they are cramped so tightly that it is very difficult for more than one vehicle to pass through it at a time. After the snowfall the road becomes invisible, and during the snow clearing process, occasionally dozers go off the road and crash into the valley. Dozers cannot rely solely on GPS coordinates since there is an inherent inaccuracy of a few meters in their placement. The challenge is to develop a combination of an Unmanned Earth-Moving Ground Vehicle (UGV) and a guiding Unmanned Aerial Vehicle (UAV) capable of mapping and navigating a mountainous terrain without collapsing.

| MID PREP

PROBLEM STATEMENT

The problem statement is to map an area via UAV aerial imagery and aid a UGV in navigating a complex static environment. This requires the team to map the mountain road in the worlds using a UAV and guide a UGV through the area, navigating across various turns, altitudes, and depth of terrain.

- The major components include vehicle consideration (sensors), computer vision development, path planning, vehicle control, integration of multiple systems, and finally the validation and testing of the algorithms in standardized environments.
- The UAV is tasked to map the area following which the original image overlay of the terrain would be replaced with a plain overlay. The UGV then has to traverse the mountain road with aid from the UAV.
- The UGV should traverse along the center of the road.
- The UAV should not fly higher than 20m. The UAV is allowed the use of a downward-facing RGBD-camera, IMU sensor, and GPS.
- No sensors are allowed on the UGV.
- The integration of all the algorithms is to be ensured for the program to efficiently gather and process data to map and give the path planning information.
- The task is considered to be completed when the UGV successfully navigates across the terrain to the end of the road with aid from the UAV.

SOFTWARE SPECIFICATIONS

- Ubuntu 18.04
- ROS Melodic
- Gazebo 9
- Python or C++
- ArduPilot Firmware
- Any extra library used must be specified in the documentation and must be open-source

The submission must conform to the aforementioned specifications for facilitating testing on a standardized environment and computer system.

GUIDELINES

- The task must be completed in simulation using ROS and Gazebo with ArduPilot Flight Controller software.
- Use Ubuntu 18.04, ROS Melodic and Gazebo 9 (any others will not be accepted).
- Installation instructions (Ardupilot) will be provided alongside a package with the drone model (with given sensors) and a UGV model.
- 3 Gazebo worlds will be provided to test the algorithm. They will be released in a phased manner.
- Teams are required to work on an algorithm that fits all the three worlds provided.
- The final Gazebo worlds used for evaluation will be similar to the worlds given and will not be shared.
- The submission format must be a ROS package and everything needed to run must be within a single bash script or a launch file.
- If any extra dependencies or packages are needed for the simulation, proper documentation to install the same must be provided. Only open-source packages are allowed.

RELEASE DATES

World 1: 8th March, 2022

World 2: 12th March, 2022

World 3: 16th March, 2022

EVALUATION CRITERIA

The evaluation will be done based on the ease of installation of the ROS package along with dependent libraries, and concise documentation and presentation skills (100 Points). The marking scheme is divided into 3 components :

Note: If at any point the deviation of UGV from the mean path is more than 5m it will be considered a failure and zero marks will be given for all three components of that particular world.

COMPONENT 1

- Deviation of the UGV from the mean path

WORLD	M	MARKS ALLOTED
World 1	100	(1-C)*M
World 2	200	(1-C)*M
World 3	300	(1-C)*M

C: coefficient of deviation
It is computed between the path taken by the UGV and the mean path.

COMPONENT 2

- Time taken to traverse the path: For each world, the time taken by the UGV to traverse the path will be noted (only for the teams who have completed the world).

TEAM	TIME TAKEN TO TRAVERSE THE PATH	MARKS ALLOTED
Team 1	T1	0.5 * (M)
Team 2	T2	0.4 * (M)
Team 3	T3	0.3 * (M)
Team 4	T4	0.2 * (M)
Team 5	T5	0.2 * (M)

EVALUATION CRITERIA

- 0.1 * (M) for the rest of the teams who complete the task.
- T1 < T2 < T3 < T4 < T5
- M : Max. marks allotted for particular World on completion.
- M = 100 for World 1
  M = 200 for World 2
  M = 300 for World 3

COMPONENT 3

- The computational power used: lesser power implies better performance (Jetson TX2 Module is the upper limit).

TEAM	COMPUTATIONAL ELEMENT UTILISED (CPU, GPU, RAM)	MARKS ALLOTED
Team 1	F1	0.5 * (M)
Team 2	F2	0.4 * (M)
Team 3	F3	0.3 * (M)
Team 4	F4	0.2 * (M)
Team 5	F5	0.2 * (M)

- 0.1 * (M) for the rest of the teams who complete the world.
- F1 < F2 < F3 < F4 < F5
- M : Max. marks allotted for particular World on completion.
- M = 100 for World 1
  M = 200 for World 2
  M = 300 for World 3

TOTAL MAXIMUM POINT DISTRIBUTION PER TASK

- WORLD 1 - 200
- WORLD 2 - 400
- WORLD 3 - 600

The sum of the total maximum points of the three worlds would be scaled down to 150 points.

SUBMISSIONS

ROS PACKAGE AND DOCUMENTATION

- The team has to submit their final ROS package along with proper documentation for its installation. Documentation must also include working principles and algorithm explanations. Only one final submission will be accepted.
  - Due Date - 22nd March

FINAL TESTING AND PRESENTATION

- The team would be required to test their algorithm on the worlds provided during the live-testing round of the evaluation. For the presentation round, the team would be required to explain the logic and methodologies used, followed by a Q&A session.

Please note that the final presentation should wrap up within 10 minutes which will be followed by Q&A (5 min).
Send your submissions at this email: submissions@interiit-tech.org

Team size for this event is maximum 8 participants.
Participation awards shall be awarded to all participants.