Inter IIT Tech Meet 11.0

IIT Kanpur 2023

IITM Contingent Member Application

Drona Aviation: Pluto Drone Swarm Challenge

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Instructions and Conditions:

1. The applications have to be mailed in ZIP folder format or a github repository with the subject as "InterIIT_App_DronaHP_<Name>_<RollNo>".
2. Link to the original Problem Statement : LINK
3. Selection Procedure will be two-fold. A **Preliminary shortlisting** will be made based on this application, this will be followed by an **interview** after which the final team will be selected. 4. Submission Form : LINK
5. Please note that this is a high prep, offline event and the selection process is very competitive. Do not be discouraged if you are not selected.
6. Any cases of plagiarism (involving copying from someone or any direct copying from an online source) will be severely dealt with and may lead to immediate disqualification.

There are 3 Sub Modules for the Team. Namely,

- Controls
- ROS and Computer Vision
- Communications and Hardware

You are supposed to attempt **Common Questionnaire + at least one module** out of these 3. (Attempt as much as you can best to your knowledge and research).

Note:

a) Do Not write essays, be crisp and to the point. Do not repeat your points. There will be a face to face interview where you can elaborate and explain all your skills and achievements in detail. **b)** Try to use **bullet points** as much as possible instead of long paragraphs.

c) Complete whatever you can within the deadline and submit your work. Every submission will be considered. (Point being, do submit even if some parts are incomplete).

d) "With great power comes great responsibility", by being part of the team you will also be representing IIT madras , this comes with heavy responsibility. Keep this in mind while applying. **e)** The deadline for submission: **11.59 pm, 23.12.2022 (Friday)**

f) Your very own journey has just begun. Please make sure you have fun along the way. All the best.

g) Feel free to reach out to any one of the leads regarding any doubt / clarification (WhatsApp) : ● Akshat Nagar : 9997677804

Pranit Zope : 9879253473

Common Questionnaire

1. Why do you want to be a part of the Inter-IIT Tech Meet Aerial Robotics contingent? What is your vision for InterIIT tech meet?

   - I want to be a contingent in InterIIT Tech meet in aerial robotics as I have been working with robotics since last 6 months as part of a software module team member in abhiyaan, I feel inclined towards robotics and also considering pursuing masters in this field.
   - I have been part of tech meet last year also for software development problem statement, but I feel Aerial robotics demand much more time and effort compared to other tech meet events as its one of the very few offline events in the tech meet.

   There are 3 Sub Modules for the Team. Namely,

   - Controls
   - ROS and Computer Vision
   - Communications

2. Mention the major challenges that we might face while working on the PS. What would be your approach to solve them?

   Task 1:

- One of the major challenges is that we don't have any simulation environment for pluto drone yet, also as mentioned in the PS we need to use firmware API to fly the drones. As long as we don't get the product we can properly go through the API documentation to get used to it to create an efficient python wrapper.

Task 2: challenges involved:

- Hovering drone: If the drone is not hovering properly we might need to do sensor calibration.
- Moving drone in rectangle position: We might need to write efficient path planning and position estimation algorithms for smooth motion. Control algorithms like PID will also be needed to have precise control.

Task 3: challenges involved:

- The first challenge is ensuring that the following drone is able to detect and track the Aruco marker on the leading drone: We need to use an aruco detection algorithm the detects markers accurately even in noisy environments.
- The following drone must be able to estimate the distance and orientation of the leading drone relative to itself. We can use state estimation algorithms to estimate the distance and orientation of the leading drone.
- We might also need to use some collision avoidance algorithms (obstacle avoidance, trajectory prediction) with the help of sensors to prevent colliding of drones.

3. List out your software and hardware experience/knowledge, and any references, etc you may have (Ex- A core under whom you worked in a software/hardware project, teammate, etc).

I was part of CVI club as a project member last year, I have been working as a software module team member in Abhiyaan since last 6 months

4. Attach your resume/CV (Optional). It is just for us to get an idea of your previous experience.

https://drive.google.com/file/d/1Gb70-u1KOsDeLw40xpyMCMDFERwpEWG7/view?usp=sharing

[NOTE] : Go through the original Problem Statement linked in the instructions before attempting any module.

Module 1 : Controls

- **Task 1 :** You need to create a controller of your choice (Preferably LQR, LQG or PID) based on the control inputs received from the **Requests** section in the link (http://wiki.ros.org/pluto_drone), and the outputs under the **Parameters** section. You can use any software to create the controller, although we would encourage using matlab for the final submission and plots. The controller must work in the design conditions :
    - ○ Peak time is 3/4th of the uncompensated system at 30% overshoot, and zero steady-state error for a step input.
- Make Reasonable assumptions for the transfer function, physics, etc. Describe the process used to get the transfer function and the differential equation. Show the root locus plot of the TF, and finally observe the controller characteristics in a zero-mean Gaussian noise (Plot the output and input params separately to show convergence)
- Feel free to defer from the question and make assumptions. The exact controller output, physics model, etc is left ambiguous on purpose. You are encouraged to get to a solution that would be most useful for the problem statement.
- Add all the relevant files, paper calculations, etc that you used to arrive at your result.

Module 2 : ROS and Computer Vision

- **Task 2 (A) :** Use any image with an ArUco marker(or several ArUco markers with different ID) placed against a plain white background and generate a video feed for the same. You can use this website for marker generation. Publish the image to the node `/image/aruco` . Visualize the same with `rqt_image_view` (to confirm whether you get the correct output or not)

- **Task 2 (B) :** Create a subscriber node which subscribes to the node `/image/aruco` to receive the image. Develop an ArUco marker detection algorithm to get the ID(s) and the corner coordinates for each marker in the frame. Publish the ID and the corresponding centre coordinate of each marker to another node `/aruco/info` . Subscribe to this node and show the corresponding output in a separate terminal.

- Create a ROS package named `ros_cv_interiit_<your-roll-number>` with the above two scripts and their respective launch files. You are required to submit the package as a zip file along with a screen recording of the code outputs. Name the video file as `ros_cv_output_<your-roll-number>` (preferable mp4 format).

Module 3 : Communications

- **Task 3 (A) :** Both the protocols can be used to establish communication between two or more different files, with one file as a server and other files as clients. Using the `sockets` library for Python, create a simple client.py and server.py file. Use Localhost for the server. Create them using both UDP and TCP protocols. Compare the response time for both. Using the Multithreading feature of sockets, implement a single server communication with multiple clients.

- **Task 3 (B) :** A major task is to wirelessly communicate with the microcontroller from our system. Write a code for the microcontroller (ESP32) to act as a client and a python file to act as the server(use `sockets` for Python and `<Wifi.h>` library for the Arduino IDE). The Serial Monitor should clearly show the message received from the server(which can be any message of your choice) and “No Connection”, if connection isn’t established.

ALL THE BEST !!