Team VICHARAKA : URC 2024

Autonomous and Software Subsytem Module Technicalities

Forging history's uncharted path, a groundbreaking project redefines the realm of possibilities at IISc

Software Expertise

Broadly, we would be requiring proficiency in the following soft-wares (subject to modification)

- Robot Operating System (ROS)
- AutoCAD, CATIA and SOLIDWORKS
- Ansys
- Gazebo and Simulink (MATLAB)
- Moveit
- SLAM

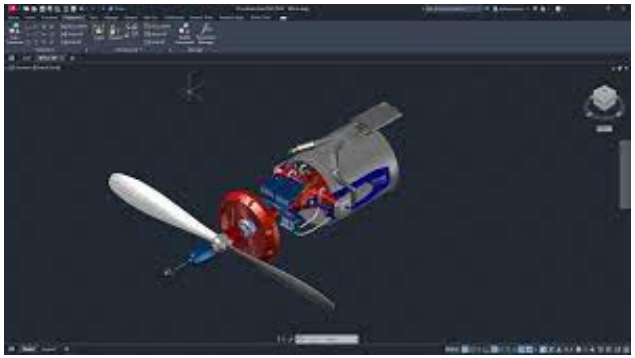
In the coming slides, the importance and utility of each of the aforementioned softwares would be specified. Along with the aforementioned Soft-wares, we need familiarity with Python,Embedded C, C++ and relevant libraries (for example Numpy, Scipy, OpenCV, DI [deep learning] ones like Pytorch)

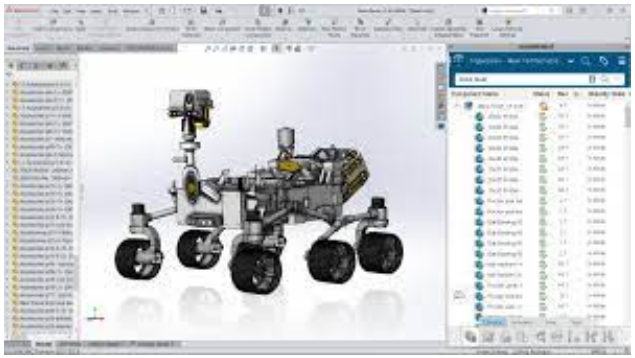
Robot Operating System

The most important by-far used software would be ROS.

- ROS is an open-source middleware framework which would be used in robotics and automation so as to provide tools, libraries and conventions to facilitate the development of robot applications.
- It enabls to create individual software components (nodes) which can communicate and work together seamlessly using topics, promoting code reusability and flexibility.

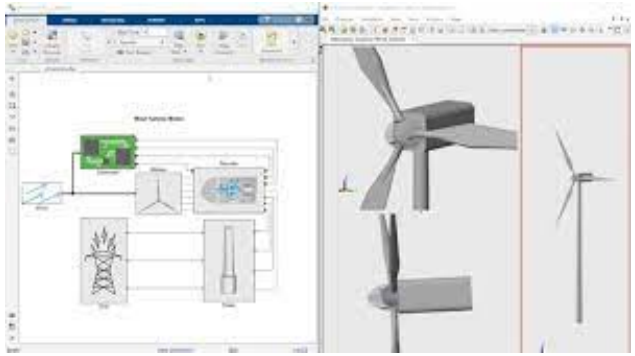
AutoCAD and SOLIDWORKS (Modelling)





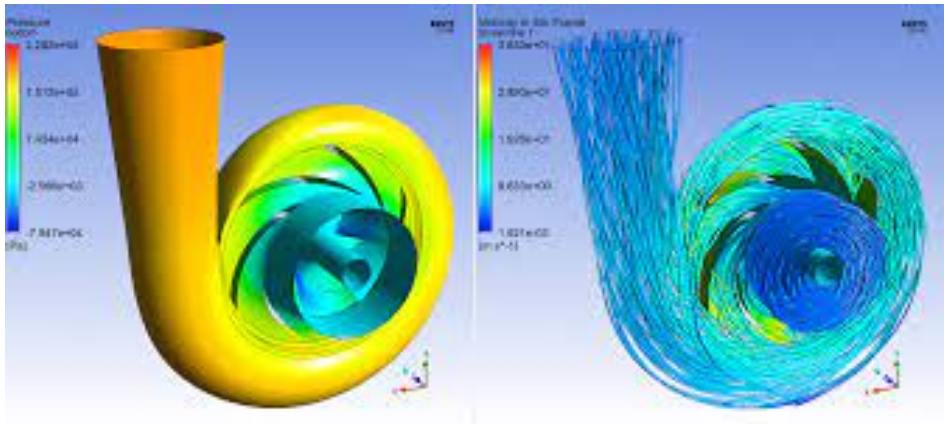
- AutoCAD is a commercial computer-aided design and drafting software application and is primarily used to create detailed 2D and 3D drawings, plans, and models in a variety of industries, such as architecture, engineering, and construction. It allows designers and drafters to create precise and accurate drawings using a range of tools and features.
- SOLIDWORKS is a solid modeling computer-aided design and computer-aided engineering application and is used for everything from rapid prototyping to designing, and is crucial to many engineering and drafting methods.

Gazebo and Simulink (Simulations)



- Gazebo is an open-source 3D robotics simulator. It integrated the ODE physics engine, OpenGL rendering, and support code for sensor simulation and actuator control. It helps developers rapidly test algorithms and design robots in digital environments
- MATLAB is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems. It enables rapid construction of virtual prototypes to explore design concepts at any level of detail with minimal effort.

Ansys (Simulation Contd..)



Ansys is an engineering simulation and 3D design software that delivers product modeling solutions with unmatched scalability and a comprehensive multiphysics. It is used to perform structural analysis using advanced solver options, including linear dynamics, nonlinearities, thermal analysis, materials, composites, hydrodynamic, explicit, and more.

Theoretical CS aspects

Three primary aspects we will be focussing on include :

- Algorithms such as SSSP
- Computer Vision and Image processing
- Machine Learning and Deep learning models involving datasets and networks (end-to-end deep learning models are also necessary for detecting life forms)

We will explore these aspects further in the slides to come !

Navigation and Path Planning

Autonomous Navigation and path planning via terrain models developed with the help of sophisticated deep learning models and computer vision is an important aspect of the challenge.

- **Objective :** Transportation of Rover from point A to point B in an optimal path, while avoiding all obstacles in between

This forces us to come up with several types of strategic algorithsm. The best ones have been listed :

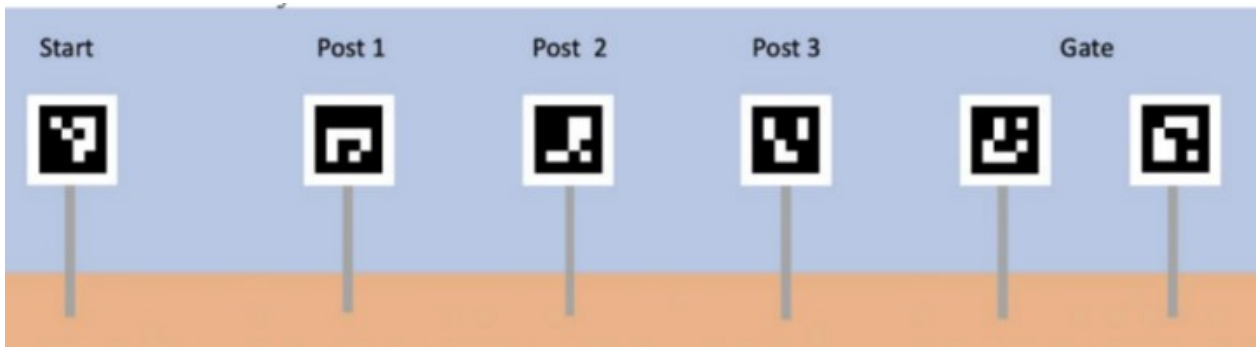
- **Algorithms :** A*, Dijkstra, Hybrid A*, D*, Flloyd - Warshall

Thereby, the task involved would be:

- **Involves :** Localisation, Planning and Terrain Mapping

Control and geometric path algorithms such as PID, Pure Pursuit, Stanley are also included.

Computer Vision and Image Classification



- Most competition tasks include detection of arrows or AruCo tags in autonomous tasks in the mission course, making Computer Vision a necessity.
- We would be needing to develop several approaches to this. (for example - CNNs (convolutional neural network), Segmentation models, YOLOv3 model)