Robotics Club, IIT(BHU)

ORGANIZES

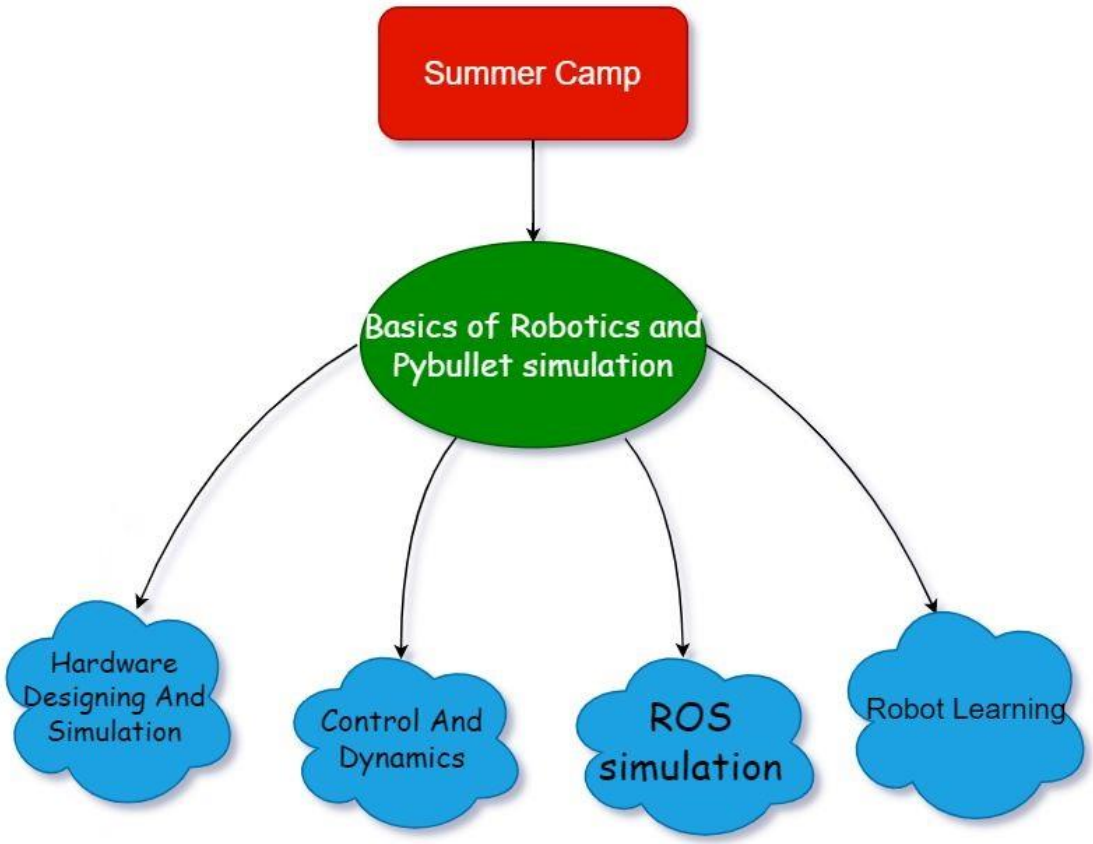
Summer Camp-2021

Overall Structure:

The camp will effectively span for a period of 6 weeks. We aim to give you a wholesome journey through the field of robotics in a more structured way starting from the very basics to state of the art work in the field. Robotics is a versatile and interdisciplinary field with the requirement of varied skill sets. Hence, we plan to provide 3 weeks of foundational course followed by 3 weeks of specialisation course which is quite crucial in any technical field that one might decide to pursue.

The main motive of this camp is three-fold:

1. Learn Robotics the right way.
2. Give you a basic foundation in the various aspects of Robotics to prepare you for your future endeavors, projects, and competitions.
3. A way for you to acquire the necessary skills and prove your passion towards the field and the effective participation in club related activities.



About the Camp

1. Phase 1 : The camp will start with basics of Robotics and Pybullet which is compulsory for everyone; it will be for around 3 weeks.
2. Phase 2: After completion of Phase 1 All Specialization tracks will start simultaneously. Candidate can choose any Specialization he/she wants and Candidates are free to take how many Tracks they want and the certificate of completion is provided based on the individual track completion

3. For the ones who are thinking about the end semester examination we will be giving a break for that.

4. Relevant Content and Exhaustive content will be provided. Activities and Tasks

will be circulated and based on the tasks performance will be evaluated.

5. All official announcements, task/content/event related queries will be directly addressed by the organizing team in the discord server created.

6. Finally, there will be a team project at the end and further information regarding the project will be shared soon.

* Phase-1 of the camp will start on 29th May(Saturday)

Curriculum Structure

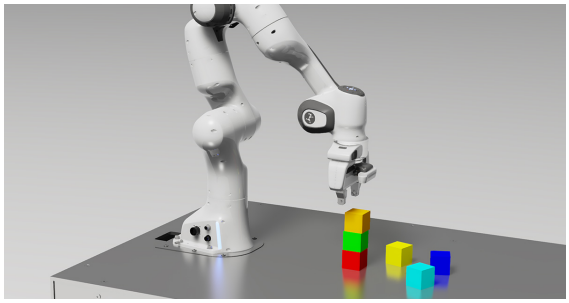
Basics of Robotics and Pybullet simulation (Foundation Track)

- Introduction to simulations, need for simulation.
- Intro to Pybullet, why PyBullet over other simulators?.
- Intro to urdf files, robot geometry, links, base, joints.
- Installation of PyBullet.
- Demonstrating some examples of PyBullet simulations.
- Basic functions in PyBullet: connect, gravity, loading urdf,saving, creating shapes, simulation, positions, and orientations in PyBullet.
- What are quaternions, rigid body orientation, DOF of robots, and dynamics.
- PyBullet functions for control of motors, apply for adding/removing constraints, getDynamics .
- User Input management, getKeyboard, getMouse functions.
- Getting an image feed from the simulation.
- Collision models, joint characteristics and real-world parameters.

Specialisation tracks

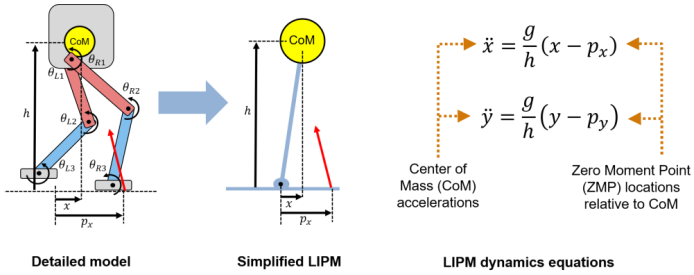
Hardware Designing And Simulation(HDS)

- Introduction to SolidWorks
  1. Parts
     - Sketching the blueprint
     - Create and modify sketch based features
     - feature based elements (fillets and chamfers)
  2. Assemblies
     - Mating
     - Relations
  3. 2D detailing
     - Appearance
  4. Motion study
     - Kinematic synthesis
     - Clearance and interference
  5. Exporting assembly as URDF



Control And Dynamics

1. Introduction to control systems and dynamics:
   - Introduction to Control and Dynamics
   - Linear Systems
   - Linear Quadratic Regulator (LQR) Controller
   - Linear Inverted Pendulum on a cart Problem



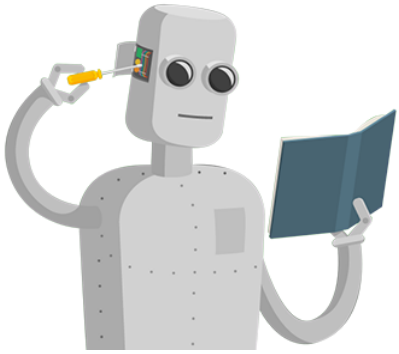
Detailed model | Simplified LIPM | LIPM dynamics equations

2. Partially Observable Systems:
   - Introduction to Kalman Filters
   - Similarities between Kalman Filters and LQR control
   - Creating a control System with Kalman Filter and LQR Control
3. Making a Balancing Robot:
   - Understanding the Dynamics of a Balancing Bot
   - Making a controller to balance the a two-wheel bot in simulation
   - Improving on the controller to make the bot mobile

ROS simulation

1. Asynchronous Comm. and TF
   - What and Why ROS.
   - Efficient Linux Commands
   - Introduction to catkin and building process
   - Introduction to basic ROS commands and tools.
   - Introduction to ROS messages and services.
   - Introduction to ROS launch and nodes.
2. RVIZ, RQT, RosWTF, Reconfigure
   - Visualization using RVIZ.
   - Introduction to TF concepts and implementation on turtlesim.
   - Debugging using RQT, ROSWTF, TF ViewFrames.
   - Dynamic Reconfiguration of Parameters.
3. Gazebo Simulation
   - GAZEBO Features: Spawning, Resizing, Joints.
   - Turtle-bot Simulation.
   - GAZEBO Models, ROSControl

Robot Learning



0. Prerequisites
    - Python
    - Basic Knowledge of Deep Learning and Neural Networks
1. What exactly is Robot Learning?
    - Introduction to Data-Driven methods
    - Intro to Robot Learning, why Robot Learning?
    - Basic Terminology: What is an environment, agent, state space, action space, policy, transitions, reward, MDP, POMDP
2. Working with environments
    - Installation of openAI gym
    - Demonstrating some examples of Environments
    - Basic Environment building and using it as a package
3. DQN algorithm
    - What is a value function/action value function
    - What are epsilon-greedy policies
    - Intuition behind the DQN algorithm
    - Using DQN/DDQN algorithm to train a robot in simulation
4. PPO algorithm
    - Introduction to policy gradients
    - What is KL-Divergence
    - Intuition behind TRPO/PPO algorithm
    - Using PPO to train an agent

Robotics Club Summer Camp 2021-Organizing Team:

- CAMP COORDINATORS
    1. S Niranth Sai
    2. Lokesh Krishna
    3. Dinesh Easwaravaka
    4. Antara Banerjee
    5. Payal Umesh Pote
    6. Karan Aditya Singh Bishnoi

- TRACK TEAMS (Technical Coursework+Task Evaluation)

1) Basics of Robotics and Pybullet Simulation
    - Ajitesh Pandey
    - Amarjeet Keshri
    - Atul Kumar
    - Prince Kumar Gond
    - Siddharth Anand Srivastav
    - Yash Upadhyay
    - Milind Prajapat

2) Hardware Designing and Simulation
    - Raman
    - Surabhit Gupta
3) Dynamics and Control
    - Kartik Garg
    - Pranav Mittal
    - Raghav Soni
    - Yatharth Bhargava
4) ROS
    - Aman Mishra
    - Chepuri Vishwas
    - Mainak Samanta
    - Somnath Sendhil Kumar
5) Robot Learning
    - Ayush Kumar Shaw
    - Vikhyath Venkatraman
    - Yash Sahijwani