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06/27/25

ITU ROVER RESEARCH HOMEWORK

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1. What's ROS :

Robot Operating System is an open source collection of software libraries and tools that makes it easier to write and manage robotic codes.

2. Explanations of certain key concepts :

- **ROS PACKAGE :** Being the most basic unit of ROS software, they contain nodes, libraries, config files, etc. combining them into a single unit.
- **ROS NODE :** ROS NODE is simply a single executable that performs calculations.
- **ROS TOPIC :** ROS Topic is a named channel over which nodes can exchange messages.
- **PUBLISHER :** Publisher is a node or part of a node that sends messages to a ROS Topic.
- **SUBSCRIBER :** Subscriber is a node that listens to a topic and reacts when it receives a message.
- **ROS SERVICE :** Service is a request-response communication system in ROS.
- **ROS LAUNCH :** Roslaunch is a tool that allows you to easily start multiple ROS nodes, whether on the same machine or remotely via SSH, and also allows you to set parameters on the ROS Parameter Server.
- **ROSBAG :** ROSBAG is a file format used in ROS to store message data.

GAZEBO : Gazebo is a physics-based simulation platform. It simulates real-world physics allowing robots to be tested in virtual environments.

RViz : RViz is a ROS visualization tool that is used to display robot states and data. Graphically represents sensor data, robot models, and robot movements.

3. Explanations of sensors :

- **LiDAR :** LiDAR uses laser beams to measure distances. It emits a laser pulse and calculates the time it takes for the pulse to return after hitting an object. By measuring the flight time, LiDAR creates a detailed 3D map of the surroundings. LiDAR can be used in mapping, navigation and environment perception in robotics. While being one of the best depth sensors it has two major downsides. One being to expansive and other one being sensitive to environment.

- **IMU :** IMU consists of accelerometers and gyroscopes to measure linear acceleration and angular velocity. It tracks changes in position and orientation based on inertial motion. IMU is used in robotics for motion tracking, stabilization and navigation. The downsides of IMU are being sensitive to vibrations and drift error.
- **GNSS :** GNSS includes systems like GPS, GLONASS, and Galileo to determine a device's position on Earth. It uses signals from multiple satellites to calculate the receiver's exact position. GNSS is used in robotics for outdoor navigation, mapping and surveying. Downsides of GNSS are signal loss and accuracy.
- **DEPTH CAMERA :** Depth cameras use technologies like structured light or time-of-flight to capture the distance of objects from the camera. They produce depth maps alongside traditional 2D images. Depth camera used in robotics in object recognition, human interaction and obstacle avoidance. Downsides of depth camera are range limitations and environmental constraints
- **ENCODER :** Encoders measure the rotation or position of a shaft or axle. There are two main types, incremental and absolute encoders. Encoders are use in robotics for motor control, odometry and precision movements. Downsides of encoders are slippage and complexity.

4. What Is Localization :

Localization is the process by which a robot determines its position and orientation within a known environment. It is a fundamental component of autonomous navigation

5. What Is SLAM :

SLAM is a technique that enables a robot to simultaneously build a map of an unknown environment and localize itself within that map. Using sensor data SLAM combines mapping and localization, enabling applications like autonomous driving and indoor robot navigation

6. Autonomous Driving :

- **Path Planning :** Path planning is the process of determining the best route for a robot to reach its destination, considering factors like safety, efficiency, and feasibility, using global and local planning techniques.
- **Costmap :** Costmap is a grid-based representation of a robots environment, where each grid cell is assigned a numerical "cost" indicating the difficulty or risk of traversing that area. Costs are calculated based on proximity to obstacles, terrain difficulty, or dynamic factors like moving objects.

7. Robotic Arm :

Forward kinematics calculates a robotic arms end effector position from given joint angles, while inverse kinematics determines the joint angles needed for the end effector to reach a specific position.

8. Communications :

- **Frequency Comparison :**The lower the wavelength the slower the speed but because of dispersion, the signals can reach further than higher frequency waves. 900MH has grate range, works through objects but slow. 2.4GH is balanced with speed and range but downside is the interference, 2.4GH is used in many devices. 5GH fastest but short range and can't go through obstacles.
- **Line Of Sight :** Line of Sight means the transmitter and receiver can see each other directly with no obstacles in between. LoS is important for high-frequency signals because they can't go through walls well.