Topics for today's revision (week 9)

1.forward and inverse dynamics of robot.

Robot dynamics refers to the study and analysis of the motion and forces involved in the movement of robots.

Key concepts within robot dynamics include:

1. **Kinematics**: Describes the motion of robots without considering the forces involved.

2. **Dynamics**: Considers the forces and torques to explain the resulting motion of the robot.

3. **Forward Dynamics**: Predicts the robot's motion based on given inputs and dynamics.

4. **Inverse Dynamics**: Computes the required forces and torques for achieving a desired motion.

Forward Dynamics:

Forward dynamics involve predicting the motion of a robot given the forces or torques applied to it. It calculates the resulting motion, such as the position, velocity, and acceleration of each part of the robot, based on the applied forces and torques.

Reverse Dynamics:

Reverse dynamics, on the other hand, determines the forces or torques required at each joint of a robot to achieve a specific motion or trajectory. It's the inverse of forward dynamics and helps in control strategies and trajectory planning.

2. Joint and task space control schemes.

Joint Space Control:

Definition: Joint space control involves directly controlling the individual joint positions, velocities, or torques of the robot.

Process: The control algorithm computes control commands for each joint independently based on the desired joint space trajectory or goal.

Advantages:

- Simple to implement, especially for robots with well-understood dynamics and kinematics.
- Well-suited for tasks where precise control over joint movements is required.

Task Space Control:

Definition: Task space control, also known as operational space control, focuses on controlling the end-effector's position and orientation (the "task") of the robot in the workspace.

Process: It involves transforming the desired task space trajectory or goal into corresponding joint space commands using the robot's kinematics.

Advantages:

- Provides a more intuitive way to specify and control the robot's behavior in terms of the task it performs.
- Effective for tasks that require precise control of end-effector position and orientation.

3.Use AI in robotics.

- Artificial Intelligence or AI gives robots a computer vision to navigate, sense and calculate their reaction accordingly.
- Robots learn to perform their tasks from humans through machine learning which again is a part of computer programming and AI.
- When a robot integrates AI algorithms, it does not need to receive orders to make a decision, but is able to work on its own.
- Self driving cars, humanoid robots, industrial robots, surgical robots are the examples for AI robots.
- AI uses edge computing, computer vision, NLP, CEP technologies.
- a) Robotics in Household - Robot vacuum cleaner can navigate around furniture using artificial intelligence. There is robot on wheels uses artificial intelligence and camera to navigate autonomously around the home, acting as eyes and ears when the owner of the house is not around.
- b) Robotics in manufacturing - In manufacturing AI is used for robot to algorithmically navigating its way around a busy warehouse to perform complex tasks. It is also used to patrol a construction site, scan the project and analyze data for possible quality issues
- c) Robotics in business - Equipped with mapping systems, sensors and AI, the little robot on wheels can figure out the best route to take on the fly, and can avoid the dangers of the outside world.

- d) Robotics in healthcare - Robotics are capable of performing operations with incredible accuracy and a steady hand, these can be used as substitute for tried medical professionals. Robot can be used to administer needleless vaccination without needing any kind of human supervision.
- e) Robotics in agriculture - AI can be used to assess the ripeness of each fruit harvested. AI with robotics can be used to increase plant yield and use less water.
- f) Robotics in aerospace - Robots are designed to assist astronauts with their day-to-day tasks and reduce stress via speech recognition, while also operating as an early-warning system to detect problems.
- g) Robotics for military - AI can be used to design autonomous military drones
- h) Robotics also employed in volcanoes, deep oceans, extremely cold places, or even in space where normally humans can't survive.

4.Applications of robotics in Unmanned systems, Defence, Medical and Industries.

- Wearable robots

  Mobile robots

  Surveillance robots

  Robotics submarine system

  Search and rescue robots

  Combat robots
- EOD robots

  Fire-fighting robots

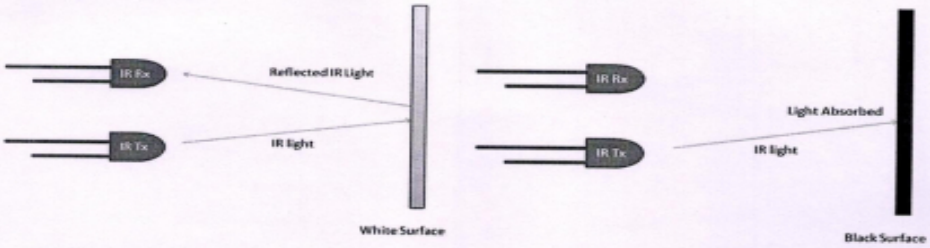
  Swarm of Drones

  Voice-controlled robotic vehicles

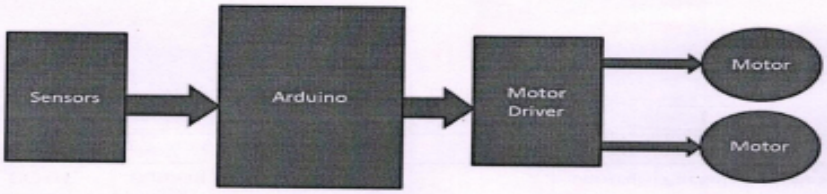
5.workig of line follower robot/ obstacle avoider or anti collision robot.

8. (a) Raw materials needs to move from the stockyard to the production line. Explain how robots can be used for this line following application. ***10 Marks***

Ans: The concept of working of line follower is related to light. We use here the behavior of light at the black and white surfaces. When light falls on a white surface it is almost fully reflected and in the case of a black surface light is completely absorbed. This behavior of light is used in building a line follower robot.



In this Arduino based line follower robot, we have used IR Transmitters and IR receivers also called photodiodes. They are used for sending and receiving light. IR transmits infrared lights. When infrared rays falls on the white surface, it's reflected back and caught by photodiodes which generate some voltage changes. When IR light falls on a black surface, light is absorbed by the black surface and no rays are reflected back, thus photo diode does not receive any light or rays. Here in this Arduino line follower robot when the sensor senses white surface then Arduino gets 1 as input and when senses black line Arduino gets 0 as input.



Block Diagram

The whole Arduino line follower robot can be divided into 3 sections: sensor section, a control section, and driver section.

Sensor section: This section contains IR diodes, potentiometer, Comparator (Op-Amp) and LED's. The potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at the comparator's second terminal. Then the comparator compares both voltages and generates a digital signal at the output. Here in this line follower circuit, we have used two comparators for two sensors. LM 358 is used as a comparator. LM358 has inbuilt two low noise Op-amps.

Control Section: Arduino is used for controlling the whole process of the line follower robot. The outputs of comparators are connected to digital pin numbers 2 and 3 of Arduino. Arduino read these signals and send commands to driver circuit to driveline follower.

Driver section: The driver section consists of motor driver and two DC motors. The motor driver is used for driving motors because Arduino does not supply enough voltage and current to the motor. So we add a motor driver circuit to get enough voltage and current for the motor. Arduino sends commands to this motor driver and then it drives motors.