ELEC-E8111 Autonomous mobile robots (5p)
Home/network Exam April 13, 2021

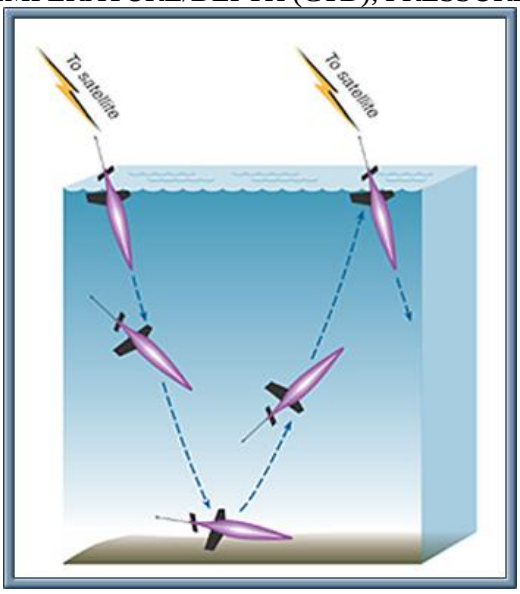
Q1.

Finite State Automata(FSA): Glider in action

After the glider has been turned on (PWR), it performs extensive initialization routine during which will check that the subsystems are working properly. If the glider passes that check-up, it will turn on a signal lamp(LAMP). If the lamp will not be turned on, the glider will not be deployed and the mission is over. However, if it is lit the glider will be deployed to the water. After detecting that it is in the water by using pressure sensor (P), it will try to get a GPS fix (GPS) and perform a simple Iridium satellite communication session with the operator (IRID). During which it will obtain its first waypoint. If the GPS fix and communication happens the glider will turn the lamp off, wait for 5 minutes (enough time to remove the safety rope) and then it will start the actual mission. Researchers guide the glider by giving it waypoints, or target positions to specified locations. The glider steers to these waypoints by controlling its buoyancy and orientation, using the lift from its wings to move horizontally. It takes 3.5 hours for the glider to reach a depth of one kilometer before it ascends to the surface, gathering data with its CTD sensor as it rises. During that time it will travel a horizontal distance of five kilometers. The glider uses a downward looking sonar (SO) to prevent a collision to the seabed. If it will detect the bottom. It will abort that particular dive, return to the surface and ask instructions from the operator. At the end of each dive, the glider obtains and records its position(GPS) and sends the current data (CTD+GPS) to the operator. It will then receive the next waypoint from the operator. The diving cycles will stop when the glider has performed the N planned dive cycles (MC) or more than M days has passed (MT) or the operator has given the ABORT command. After that the glider will stay on the surface, light the lamp, get a GPS fix every 10th minutes and send the location info to the operator. It will continue to do this up till that moment, when it detects that it has been lifted from the water (P). After that it will turn the lamp off and the mission will be considered completed.

Important components for the FSA:

- POWER(PWR), LAMP, SONAR (SO)
- GPS, IRIDIUM SATCOM (IRID)
- MISSION COUNTER (MC), MISSION TIMER (MT)
- CONDUCTIVITY/TEMPERATURE/DEPTH (CTD), PRESSURE (P)



Based on the above task and sensor descriptions, make a FSA presentation for the application..

6p

Q2.
Explain shortly the main model structures for modelling of the environment of a mobile robot. Explain shortly how LiDARs and machine vision cameras can be used in creating and updating the models?
6 p

Q3.
Explain shortly the probabilistic principles, structure, benefits and weaknesses of Fast SLAM. What happens when the loop is closed? 6p

Q4.
Describe the kinematic model of a standard differential type indoor robot. How odometry can be implemented with it? Why odometry alone is not sufficient for positioning?
6p

Q5.
D* is widely used path planning algorithm in mobile robots. Describe shortly the main ideas and features?
What similarities there are in short range path planning and Model Predictive Control (MPC)?
6p