MR Final Exam questions 2020

Basic operation of mobile robots Dr. Nagy István

1. Please define the following terms:
    a. Fully autonomous system
    b. Semi-autonomous system
        i. tele-operation system
        ii. tele-robotic system
    c. Mobility
2. Describe and characterize the generations of mobile robots
    a. 1,2,3,4,5 – generations, and figures
3. The mobile robot's HW structure, characterization and basic features (not detailed, just classifications)
    a. Body – basic function and tasks,
    b. Electronic components
        i. control circuit (on board, off board, combined - features)
        ii. actuators (electric motors (wheels, robot arms))
        iii. drivers and power systems (battery, motor drivers, charging)
        iv. communications (long-/short distances; wired, wireless types)
    c. Basic classification of locomotion system (legged robots-types, wheeled robots-types configurations, tracked, flying, swimming robots)
    d. Sensory system classification (internal-/external sensors)
4. The mobile robot's kinematics: the kinematic model of different types of wheeled/legged mobile robots – coordinate system's locations and its functions in case of different configurations, ICC and basic parameters of kinematic model.
    a. wheeled mobile robots differentially driven robots (3/4 wheels' characteristics, driving and castor wheels - basic features, forward/inverse kinematics)
    b. wheeled mobile robots 3 wheels' robots (3 wheels' characteristics, driving wheels, forward/inverse kinematics)
    c. wheeled mobile robots, Ackermann type robots (coordinate systems, ICC, forward/inverse kinematics, turning radius)
    d. Legged mobile robots (stability, CoG, forward/inverse kinematics)
5. Internal MR sensors and its basic operation principles, features, characterisations, basic calculations.
    a. incremental optical coders, odometers (types of errors and its eliminations, architecture, operation, distance calculations, code disc types, ...)
    b. measuring heads, its operations and architectures (compasses- different types, gyroscopes- different types, accelerometers, IMUs)
6. External MR sensors and its basic operation principles, features, characterisations, basic calculations.
    a. non visual sensors, its characterization, basic operation, measuring accuracies, basic parameters, calculations (Lidar, US, IR, Laser, RF)
    b. visual (camera) systems its characterization, basic operation, measuring accuracies, basic parameters, calculations (stereo camera systems –synchr., non-synchr.; active focusing, hybrid – camera+laser systems: synchr., non-synchr.)

7. Basic distance (range) measuring systems (TOF, phase shifting) basic math relations, figures.
8. Localisation's systems, basic mathematical calculations
    a. Tri-lateration, tri-angulation (basic mathematical calculations, operational principles, errors and its eliminations)
    b. GPS localisation (basic features, components of the system, basic GPS signals, principle of measuring, errors: user dependent, independent)
9. Mapping , basic maps and methods, SLAM, local and global maps, iconing
    a. sensory map (creation, basic features)
    b. geometric map (creation, basic features)
    c. topologic (graph-like) map (creation, basic features)
    d. error map (creation, basic features)
10. WS reasoning, partitioning (creation and basic features)
    a. configured WS (configured obstacles, point represented MR)
    b. grid partitioning (bit map of the WS, basic features)
    c. quad tree partitioning (basic features, path finding)
    d. BSP partitioning (basic features, path finding)
    e. EXACT partitioning (basic features, path finding)
11. Graph based path planning methods (creating the graph, basic operations, features, accuracy)
        i. general graph PPL method
        ii. Visibility graph method
        iii. Tangent graph method
        iv. Voronoi diagram
        v. MAKLINK
12. Potential field path planning methods (basic mathematical calculations, features)
        i. potential field creating (advantages, disadvantages, mathematical relations)
        ii. VFF, VFH – methods
13. Link based path planning methods
        i. BUG algorithms (BUG1, BUG2-tangent bug, algorithms; basic features, advantages, disadvantages)
        ii. Reeds-Shepp algorithm – basic operation, advantages, disadvantages
14. Wave propagation and probabilistic path planning methods
        i. wave propagation on grid WS (operation, advantages, disadvantages)
        ii. horizontal/vertical double wave propagation (operation, advantages, disadvantages)
15. Spline based path planning (operation, advantages, disadvantages)
        i. Lagrange interpolation
        ii. Bezier approximation
        iii. B-spline methods