Post-Graduation in
Electrical and Computer Engineering

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TOPICS ON ADVANCED ROBOTICS
2020/21
Homework 3

Hand-out: 17 May 2021 **Due:** 07 June 2021

1. **Plan Representation**: draw the representation of a plan for the following task (informally described), defining the task events, predicates and primitive actions (i.e., the robotic task model) beforehand, and using
   a. a state machine
   b. a Petri net
   c. a Behavior Tree

   An assistive domestic robot named *Ambrosio* is at home helping its owner, Granny Annie. Its default sub-task is to vacuum clean, but it may be interrupted at any time to perform one of three sub-tasks, depending on the occurring event: i) when the front door bell rings, it checks (using a networked camera) who is the visitor and lets him/her in, if recognized; otherwise just says "Goodbye" to the visitor; ii+iii) when Annie asks for assistance, it moves close to her, asks for a speech command, recognizes Annie command, which can be one of {pick up an object, close the living room motorized blinds} and moves to the object location, recognizes the object using an on board vision system, picks it up and brings it back to Annie's location; or uses the wireless network to close the blinds remotely, respectively. *Ambrosio* always returns to the default sub-task after finishing each of the above three sub-tasks.
2. **Motion Planning**: write (in Matlab or any other programming language you may prefer) one of the motion planning algorithms learned in class (RRT or FM). Apply the implemented algorithm to a gridmap discretized environment (all cells are squares with the same size) with 50 x 50 cells, with 30% of the cells occupied by obstacles, trying out different start/goal location pairs, as well as obstacle geometries, so as to demonstrate some of the method features.
3. **Formation Control**: apply the graph-based formation control method to a formation of 4 robots (modelled as holonomic integrators) that start from some initial positions in a 2D environment and end-up in a square geometry at positions $(x_1,y_1) = (0,0)$, $(x_2,y_2) = (1,0)$, $(x_3,y_3) = (0,1)$ and $(x_4,y_4) = (1,1)$. Plot the robot trajectories in (x,y)-space (with different colours per robot) by numerically integrating the closed loop equation for the state (suggestion: use Matlab). Play with different initial conditions and (always bidirectional) link topologies between the formation members (where links represent available communication channels or relative measurements between the linked robots) so as to demonstrate some of the method features.