HOMEWORK 2 – COMBINING ROBOT BEHAVIORS

As we have discussed, behaviors for behavior-based autonomous robots are usually built up incrementally. This assignment requires you to construct robot control code with multiple behaviors. The resulting robot will have 3 behaviors: avoid_obstacles, wander, and go_to_beacon. These behaviors will be based upon motor schemas, with outputs of individual behaviors being vectors that are cooperatively summed to generate the resultant output control vector for the robot. The final robot behavior should cause the robot to wander around avoiding obstacles until it detects a beacon, at which point it will travel to the location of the beacon using the go-to-beacon behavior. Once the beacon is reached, the robot has completed its sequence.

A. SETTING UP EVERYTHING. In this exercise, your robot is equipped with a laser scanner and a beacon-finder. The world map in which the robot will navigate is defined by the following parameters:
Origin x_position y_position
        Defines the starting (x,y) position of the robot
Beacon x_position y_position
        Defines the (x,y) location of a beacon
Obstacle x_position y_position width height
        Defines the width and height of an obstacle, starting at (x,y)
Laserrange max_range
   Defines the maximum sensing range of the laser with respect to obstacles in the environment
Beaconrange max_range
        Defines the maximum sensing range with respect to the beacon

And example "Room.wld" as provided on t-square, and the corresponding map "Room.jpg" is as shown.

Origin 0 0
Beacon 5 5
Beacon 15 10
Obstacle 8 12 5 3
Obstacle 1 7 2 2
Obstacle 11 0 1 6
Laserrange 5
Beaconrange 3
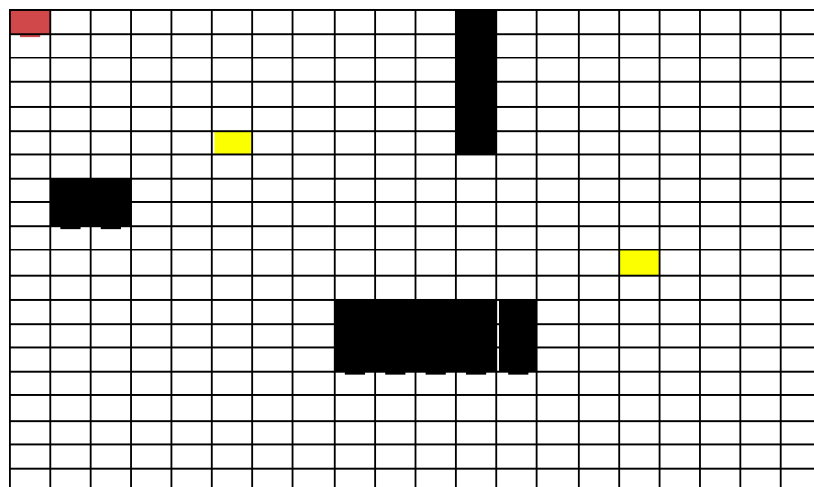
B. DEFINING BEHAVIORS

    B.1. Avoid_obstacles. Write an "avoid_obstacles" robot behavior that uses the laser scanner to avoid obstacles. The perceptual schema for this behavior is the detection of a nearby obstacle in the direction of motion of the robot. The motor schema for this behavior is the generation of an output vector that moves the robot away from the obstacle.

    B.2. Wander. Write a "wander" robot behavior. The perceptual schema for this behavior is a potential field that occasionally changes the robot motion by some random direction and velocity amount, within pre-specified turning and velocity ranges. The motor schema for this behavior is the generation of an output vector that moves the robot in the specified random way.

    B.3. Go_to_beacon. Write a "go_to_beacon" robot behavior. The perceptual schema for this behavior is the detection of a nearby beacon in the direction of motion of the robot. The motor schema for this behavior is the generation of an output vector that moves the robot toward the beacon position. Assume that the robot has arrived at the beacon when it reaches within 1 meter of that beacon.

C. COMBINING MULTIPLE BEHAVIORS. Write a function called "vector_combine" that accepts output vectors from multiple behaviors and generates a summed output vector by multiplying the individual behavior vectors by a gain matrix (G), and then using vector addition. It is up to you to define the gain matrix so that your robot behaves well.

D. CONVERSION OF OUTPUT VECTOR TO MOTION COMMANDS. Write code that accepts a resultant output vector from the behavior combination function and converts it to a "Move" command to control the robot's motion.

E. TEST COMPLETE SYSTEM. Test your complete system using the world map setup described earlier. Your resulting code should cause the robot to wander around, avoiding obstacles, and eventually visit and stop at a beacon.

F. WRITE UP THE FOLLOWING (submit as a single pdf file called *yourlastname*.pdf): 1) The definition of the specific mathematical functions you used to generate the output vectors for avoid obstacles, wander, and go_to_beacon. 2) The definition of the specific gain matrix you used to weight the output vectors from the various behaviors. 3) The definition of the specific mathematical function you used to convert the resultant output vector to a robot "Move" command. 4) 3 screenshots of your program in operation (from 3 separate runs) that illustrate your program's ability to find a beacon while wandering and avoiding obstacles. These runs should be different from each other, due to the randomness of the wander behavior.

G. SUBMISSION. For homework credit, turn in your code, a README documenting how to run your code, and your .pdf writeup.