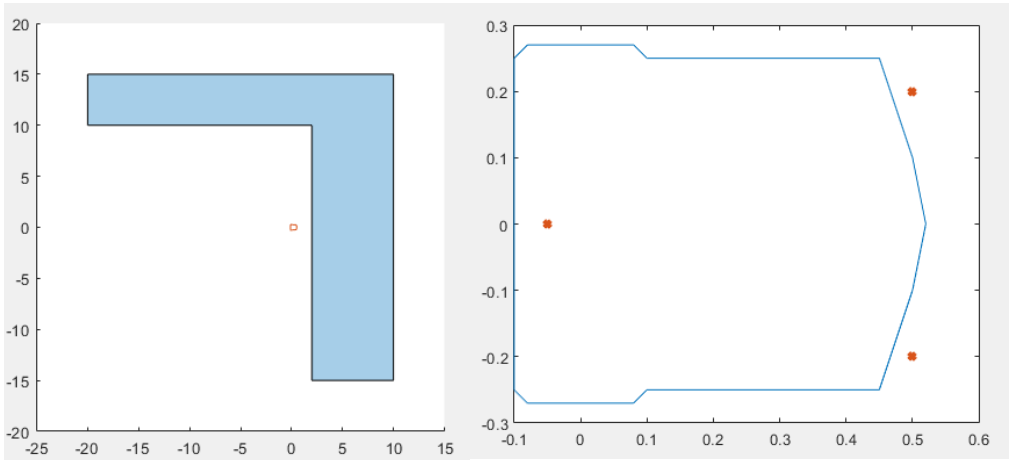
Assignment for the Course "Current Research Areas II "

You were already introduced to the iMOW robotic lawnmower and some of its functions. Now, a Matlab/Simulink model of the abstracted robot model (mobile robot with differential drive) should be created, and the so-called "Random-Walk" should be implemented.

The implementation should be done in groups, and the task will be graded based on a final presentation where you explain the algorithm you developed and presented the implementation and simulation results.

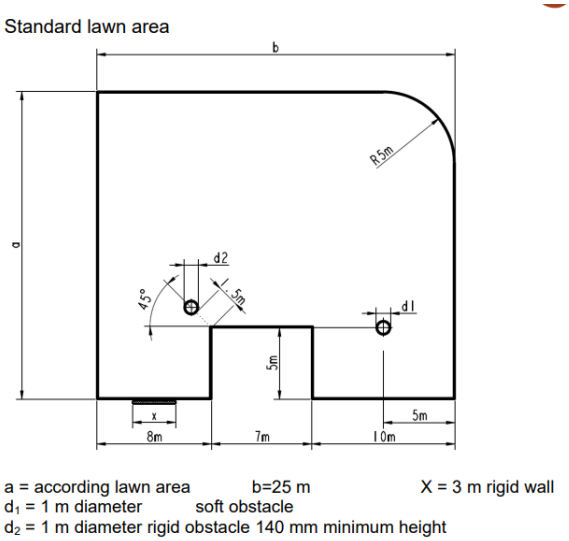
Description:

- Mobile robot with differential drive, as introduced beforehand
- Mowing area as described
- Coil arrangement according to the sketch
  - 

- Input variables are:
  - Translational speed with $\mathrm{v_{max}} = \pm\, 0.5\,\frac{\mathrm{m}}{\mathrm{s}}$
  - Rotation speed with $\omega_{max} = \pm\, 1\,\frac{rad}{s}$
- The control unit on the mower operates at a sampling rate of $\mathrm{T_s} = 10\mathrm{ms}$

Task:

- Implement the mathematical model as a nonlinear state-space model.
- Simulate the model in Simulink.
- Implement a typical garden geometry (hexagon with right angles = L-shape).
- Implement the coil signals of the robotic mower.
- The output signal should indicate "Inside" within the garden and "Outside" outside the field.
- Implement a state-flow chart with at least the following functions:
  - "Forward"
  - "Backward"
  - "Right Turn"
  - "Left Turn"
  - "Stop"

- Ensure that the mower can only operate within the garden aka Working Area (at least one coil "Inside").
    - No sensor coil should stay outside of the working area for more than 1 seconds
    - One Coil has always to be inside
    - Formulate requirements for the different involved “software modules” and also note, how you want to test against them
    - Use the state-flow chart and coil signals for the implementation
- Develop an algorithm to ensure the entire garden is mowed.
    - Only use the coil signals as input signals.
    - How do you implement “mowing” (what area is mowed, when the mower travels through the Working Area)
    - Think of ways to measure the progress and efficiency of your mowing logic
    - When do you abort your mowing session?
    - Formulate requirements for the different involved “software modules” and also note, how you want to test against them
    - Implement tests to ensure your most critical requirements are fulfilled
- Extend the Simulink model with your algorithm.
- Simulate the extended model
- Present proof for the efficiency (eg create a plot; show data) of the algorithm.
    - You could plot the % of mowed area against time and compare algorithms
- EXPANSIONS: (choose order freely); Work as before with tests and efficiency analysis
    - No straight paths are allowed → alter the driving algorithm accordingly
    - Only turn with one allowed angle. Try 45° and 50° which one is less bad?
    - Mow the upper part of the “L”first, than the right part
        - You might need to abort the upper part before achieving 100% area mown
    - Try a different working area:
        - Robotic Mower – Mowing Performance Evaluation
        - 

a = according lawn area b=25 m X = 3 m rigid wall
d_1 = 1 m diameter soft obstacle
d_2 = 1 m diameter rigid obstacle 140 mm minimum height

- Prepare the final presentation with the following contents:
    - Explanation of the algorithm's functionality
    - Simulation results
    - Findings from the EXPANSIONS section

- BONUS:
    - Proper Visualization
    - Simulink Test for Testing
    - More than one robots