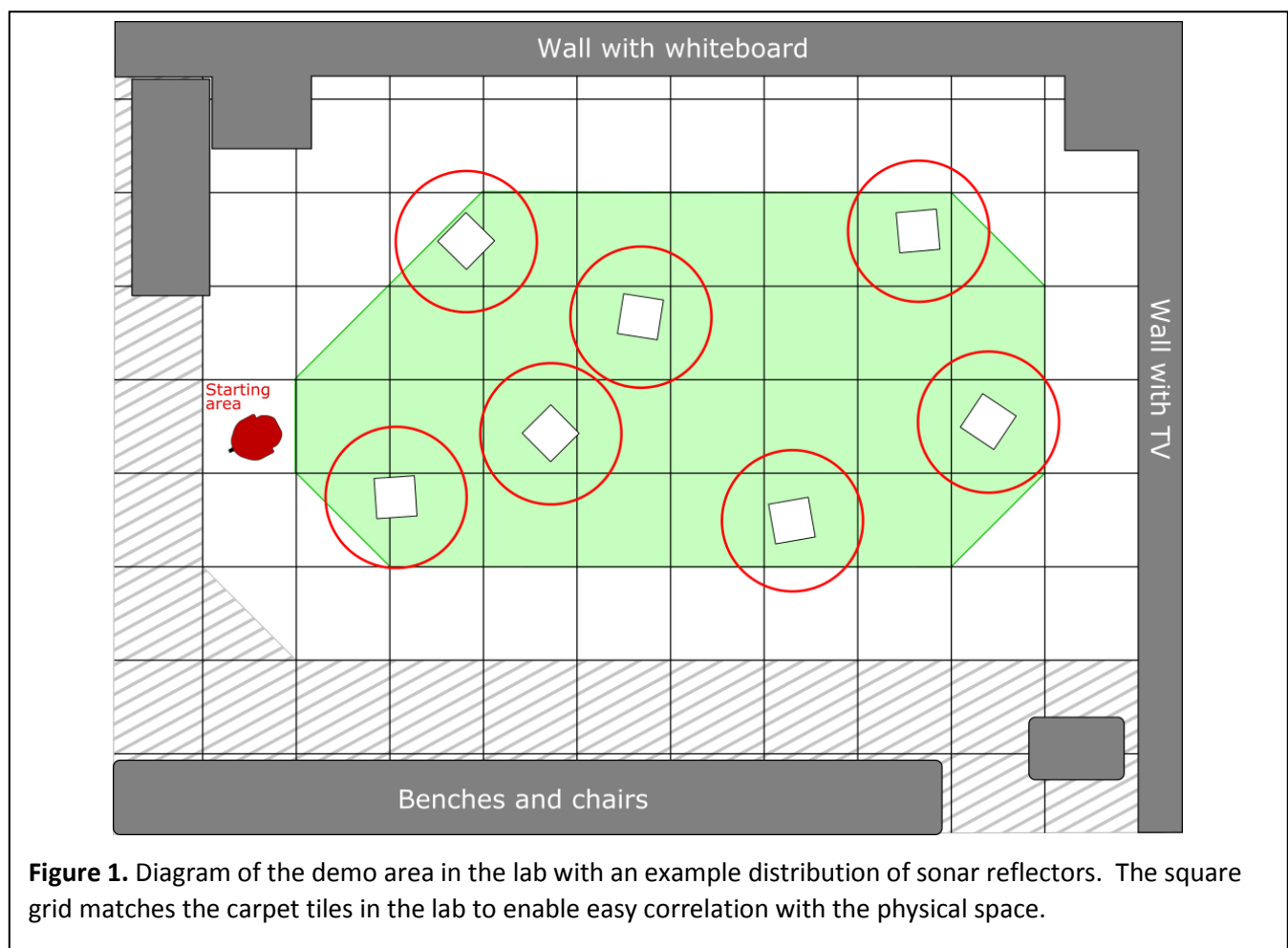# ECE 2031 Summer 2019 Design Project: Circling Objects

Project Overview

The project demo area is the space in the lab adjacent to the whiteboard, TV, and TA desk. It will contain seven sonar reflectors in random positions within the green area shown in Figure 1, but with their centers spaced at least 3' apart to allow for the DE2Bot to maneuver between them. The seven squares in Figure 1 represent sonar reflectors in an example distribution, with the red circles indicating the minimum spacing. The goal of the project is to have the DE2Bot find and circle as many of the reflectors as possible within two minutes.

Figure 1. Diagram of the demo area in the lab with an example distribution of sonar reflectors. The square grid matches the carpet tiles in the lab to enable easy correlation with the physical space.

During demos, the demo area will be clear of all objects except for the reflectors (i.e. no people, other robots, etc.). The striped regions in Figure 1 are outside of the demo area and will not be controlled.

Demo Runs

On demo day, each team will perform three "runs". A run consists of the following:

- A member of the team places the robot in the starting area (the grid square marked with a DE2Bot in Figure 1). Orientation and exact position within the square are up to the team.
- A member of the team starts the robot by pushing a button on the DE2 board (as implemented in the initial software provided for the project). The run timer begins as soon as the pushbutton is pressed.
- The robot should explore the demo area, circling as many reflectors as possible.
- The run ends once two minutes have elapsed.

At any time during a demo run, a member of the team may retrieve the robot and place it back within the starting area (and, if desired, reset or reprogram the robot). In such an event:

- The timer does not stop or reset
- Any changes that occurred in the demo area (e.g. reflectors being moved by the robot) will not be reset.
- All previous actions relevant to scoring will be nullified.

This option may be useful if, e.g., the robot gets stuck early in the run. It is up to the team to decide whether or not to reset, so they should be prepared to make that decision at run time.

Demo Rules

These rules are intended to help convey the intent of the project, not to explicitly allow or disallow every scenario that could possibly occur. Teams are encouraged to explore unique solutions, but if a plan might be in a grey area regarding the spirit of the project, the team should discuss it with the instructors well in advance.

Circling reflectors
- Successfully circling a reflector requires a reasonable assumption that doing so was intentional. For example, passing a reflector, moving to the other side of the demo area, then returning and, by chance, completing a loop around the reflector in a topological sense does not count as circling the reflector.
- Loops do not need to be smooth. Tracing a polygon or other shape around a reflector counts as circling it.
- Circling will be complete once the robot intersects its own path to close a loop around a reflector.
- Only one reflector may be encircled by a single loop. As the extreme example, traversing the perimeter of the demo area does not count as circling all of the reflectors at once.

Other rules
- The robot must act fully autonomously during a demo run; i.e. no external influence may be provided. The only interaction allowed is to reset the robot as described earlier.
- Information specific to a demo run (e.g. about the layout of the reflectors) may be provided to the robot prior to the run as long as it does not disrupt the schedule of demos (i.e. it does not take very long).
  - This is not included to encourage doing so. We think it would be of limited use for this project, but someone always asks, so we're including it here.
- The instructors will record the robot's path by sight. Because of the limited accuracy of the method, some leniency will be applied in any borderline cases (e.g. deciding if a robot did or did not fully complete a loop), but that decision is left to the instructors.

Demo Score and Grade

Each demo run will be scored as follows:

- Successfully circling a reflector awards 50 points.
- The first time that each reflector is circled awards a bonus based on how much run time has elapsed:
    - 0-30 seconds: 500 points
    - 30-60 seconds: 450 points
    - 60-90 seconds: 400 points
    - 90-120 seconds: 350 points
- Colliding with a reflector incurs a penalty of 100 points. This penalty will only apply once for each reflector.
- Colliding with a wall or other object incurs a penalty of 100 points. This penalty can only occur once per run.

Each team's overall demo score will be the sum of their best two runs.

The relevant component of the course grade is named "project demonstration" in the syllabus. That grade will be calculated by scaling the range of demo scores for all teams into an appropriate range of grades (usually ~75-100%).