Test Project

Module D – Navigation and Localization

Duration – 3 Hours

Autonomous Mobile Robotics

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1. Introduction

While the robot that you have setup usually follows a fixed sequence of waypoints it must visit in order — say, **Dock → Kitchen (pickup) → Table 3 → Table 7 → Bussing Station → Dock**. The client is concerned about what happens when the path between each waypoint, which is normally clear, becomes blocked, something unexpected may be sitting in the way: a chair pulled out from a table, a dropped tray, a staff member's cart, or a spill mat that wasn't there when the route was planned.

A robot that just stops and waits for a human to move the obstacle isn't solving the automation problem; a robot that swerves without checking anything risks hitting a person or another table. The robot as an example needs a *local* avoidance maneuver (steer left/right, back up) without losing track of its *global* goal (still get to Table 7 next).

2. Description of project and tasks

READ THE ENTIRE DOCUMENT BEFORE PROCEEDING.

Workplace safety procedures and protocols must be always demonstrated.

If you are advised of a safety infraction during this module, 0.5 of a mark will be deducted for each infraction. On the 3rd infraction, the Competitor will be stopped, and the evaluation will be based on work already completed.

Experts will not intervene unless there is a safety concern.

2.1 Required Components

The list of required components to complete the task.

- Competitor robot built on C1

NOTE: Competitors are allowed to use their supplied laptops for processing. No extra time or appeals can be made if the Wi-Fi between the robot and computer is interrupted or dropped.

2.1 Control Mode

Competitors are required to use autonomous control during this module.

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2.2 Schedule

The navigation and localization module focuses on section 5 of WSOS: "Navigation and Localization". Competitors have a 3-hour time block with an included 30-minute assessment time block, where competitors will have their own 15-minute time block to complete the task. This module will test the competitor's skill at simulating and performing in an unknown environment.

The total duration of this module is **3 hours**.

TIME	TASK
00:00 – 02:30	Prep-Time
02:30 – 02:45	Team 1 and 2 Evaluation time on courts 1 and 2
02:45 – 03:00	Team 3 and 4 Evaluation time on courts 1 and 2

Competitors should refer to the official competition schedule to determine the start and finish time of their allocated session. Before the end of the time block, competitors must:

- clean and organize their workstation;
- prepare for rotation to the next module;
- leave the assembled base robot on the workbench;
- leave the completed Task Allocation Report with the robot; and
- wait in the designated briefing area until released by the Chief Expert.

Note: Competitors are not **allowed** to work on the robot or anything else during the evaluation time.

2.3 Task

Competitors are required to navigate the navigation court by the robot autonomously driving to each waypoint remaining at the waypoint for a set time and continuing. At the start of the module a die will be rolled by either the expert or competitor. This roll will be 1 of 6 tasks to be completed. Each task has the same number of waypoints. One of the pathways will be blocked with an obstacle. The pathway that is blocked is unknown to the competitor until the evaluation run has started. Obstacles are placed by the expert.

Competitors are required to complete one report:

Task Allocation Report indicating which competitor is responsible for each task.

The Navigation task:

1. **Follow the known sequence** — the robot must hit each waypoint in the correct order (skipping ahead or reordering isn't allowed, just like a real order sequence: you can't buss a table before delivering to it).
2. **Detect the obstacle it wasn't told about** —the robot must recognize something is blocking its expected path *before* colliding with it.
3. **Re-route around it** — rather than stopping and waiting forever, the robot must divert (e.g., steer around, backtrack and try an alternate path) and still reach the same intended waypoint.
4. **Resume the original sequence** — after clearing the obstacle, it must correctly continue to the *next* waypoint in the list, not get confused about where it is in the sequence.

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Note: The robot must start in the home location and end in the home location. A run is not considered completed if the robot is not in the home location with a solid red light on the light tower.

2.3.1 Court Information

The Navigation court is 2m x 4m and contains internal walls. **Competitors are only allowed on the court during the evaluation run. No access is permitted before the evaluation run.**

2.3.2 Light Tower Requirements

There are some light tower requirements the robot must follow.

- When robot is not moving the light must be solid green.
- When robot is moving the light must be flashing yellow.
- When robot is at a waypoint light must be flashing green.
- When robot is done and back at the home position light must be solid red.

2.3.3 Task sequence

- At the start of the module experts or competitor roll the die to select which of the 6 runs is to be completed.
- SCM will give the competitors a USB with the .pgm, .yaml and gazebo world of the court. The competitors will also receive a printed form of the court with the waypoints and required sequence.
- Prep time (2.5 hours), no court access.
- Evaluation time, competitor will place the robot in the home start location. SCM will share the location of the obstacle to an expert to be placed. Competitor will then hit start on the robot control panel.
- At each waypoint the robot must wait a minimum of 5 seconds and follow light tower requirements.
- Run is completed when robot is back in the home position and following the light tower requirements.

- **It is expected that the robot does not contact any walls during the evaluation run.**

3 Instructions to the Competitors

3.1 Prepare during allotted prep time

Competitors will have the preparation time during the module to get the robot ready for the evaluation run. During this time the navigation courts are off limits.

3.2 Cleaning up before Evaluation

Competitors must clean up the work benches before the evaluation time starts to prepare for rotation to the next module when required.

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3.3 During Evaluation

During evaluation competitors must place the robot in the start location and wait for the ok from the experts. When the ok is given the competitor must push the start button on the robots control panel to start the run.

Competitors will indicate to the experts when the run is complete if the robot does not show the solid red light in the home location of the court.

Competitors not being evaluated must sit at their workbenches. These competitors are not allowed to work on their robot during this time.

It is expected that no part of the robot (or object attached to or carried by the robot) will contact any walls or court objects during the evaluation run. A contact is any touch, a continuous touch will be scored as multiple touches (1 per second of contact)

4 Equipment, machinery, installations, and materials required

4.1 Equipment provided by Competition Organizer

- All equipment, tooling, and materials in the Infrastructure List – see AMR Discussion Forum and Technical Description;
- USB with the .pgm, .yaml and gazebo world of the court. The competitors will also receive a printed form of the court with the waypoints and required sequence.

4.2 Equipment and material not permitted

- Non Worldskills supplied Laptop or portable computers;
- Tablet's e.g. Android, IPAD etc.;
- Memory sticks/ Digital Storage;
- Digital music Player;
- Electronic organizer/diaries;
- Wireless communication devices;
- Non approved SD Cards – approval by Experts or delegate is required for all SD Card images;
- Any additional software not supplied by Competition Organizers unless approved by Experts;
- Purchased items modified in any way prior to the Competition;
- Equipment that is similar or operates in similar manner as supplied equipment. Example – if a metal cut-off saw is provided by Competition Organizers, then no team may provide their own metal cut-off saw;
- All raw materials, components, parts, purchased item, tools and equipment not permitted in the Technical Description and List of Materials Allowed and Not Allowed of the skill.

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