



## STM 2023 „Mobile Robotics“

# Module 1: Navigation

The robot must navigate a course set up in the arena in the shortest possible time. It is necessary to combine various navigation strategies:

- Follow lines (black).
- Recognize colors (fields and lines) and QR codes correctly.
- Maintain distances.

There are several course variants. Before the start of the scoring run, a dice roll determines which variant the robot must complete. The robot starts in the starting zone (oriented arbitrarily by the team) and must return there at the end of the task. Along the course, there are checkpoints to verify if the robot is still "on track." The exact location/time of the checkpoint is not visible to the robot or the team; it is solely for evaluating the task.

To assess the robot's recognition performance and avoid random results, all detected markers must be written in the order of reading into a log file and sent to a laptop. For QR codes, the number should be stored, and for color fields, either a letter 'R', 'G', and 'B', or a number 0='R', 1='G', 2='B' should be stored. The team can choose the format for separating individual pieces of information (line breaks, semicolons, etc.). A complete file contains 4 marker pieces of information at the end: QR (from T1), 2x Color (from T4.1, T4.2), QR (from T3).

During the task, the robot must not damage the field, for example, by moving walls.

The subtasks are detailed as follows:

### **Subtasks:**

**T1:** With the start signal (see "Start of the scoring run"), the timing begins. The robot must leave the starting box, read, save, and display the QR code on the laptop.

**T2:** This is the starting point of the roundabout. The QR code from T1 indicates the direction to navigate the roundabout (even number -> clockwise, odd number -> counterclockwise).

**T3:** In the middle of the roundabout, another QR code may be placed. If present, it must be read, displayed, and saved. If the QR code is absent, the value is -1.

**T4:** The robot must now visit both color fields 1 and 2, following the lines as precisely as possible. The color of the color fields must be recognized and saved along with the field number (e.g., R1 if field 1 is red).

**T5:** The robot must return to the starting box. As soon as the robot is stationary there, the time stops.



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### ***Start of a Scoring Run***

Within the presentation phase, a team can start ONE scoring run at ANY TIME. This must be announced to the jury. Before the actual start, the course to be traversed is determined by a dice roll. Subsequently, the jury prepares the arena accordingly (maximum 1 minute). The start is announced with "three-two-one-go," and at "go," only the "Start Button" in the programming software or on the robot's web interface or robot itself may be activated. In the case of an early start, the program is stopped, and the scoring run is restarted. If there is another early start, the scoring run for that presentation phase is considered consumed and will be evaluated with 0 points.

The robot is placed in the starting zone by the team before the start of a scoring run. The orientation can be freely chosen as long as the robot is fully positioned within the starting zone with all parts (the lines themselves are not part of the starting zone).

### ***During the Scoring Run***

The robot must autonomously complete the given task, meaning the program deployed is executed on the robot itself. A control computer connected via WIFI may be used by the team, but this is done at their own risk (e.g. WIFI disconnections). The scoring run must not be influenced from outside. Any attempt to influence the robot, the arena, or the optional control computer leads to the termination of the scoring run. The jury may abort and restart a scoring run under special circumstances.

### ***End of a Scoring Run***

A scoring run ends:

- when the robot has completed all tasks and comes to a complete stop within the starting zone. Only in this case is the task considered completely solved, qualifying the team for a time bonus (see evaluation), or
- after the maximum scoring run duration of 10 minutes or the expiration of the time slot of the presentation phase - whichever occurs first, or
- if the robot moves/alters the setups of the tasks in the competition arena, damages or leaves the arena, or
- if the evaluated team requests the termination of the scoring run, or
- an unauthorized interference occurs in the competition arena or on the control computer.

In the first four cases, the points achieved until the end of the scoring run are always evaluated. In the last case, the jury decides.

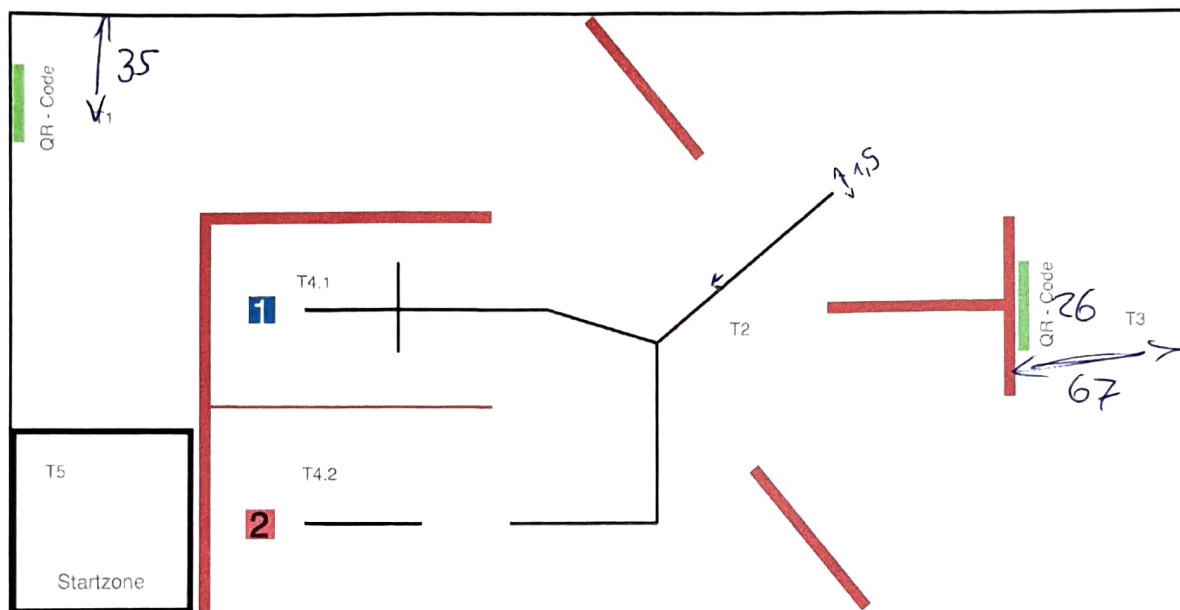
### ***Evaluation***

The task is evaluated per completed checkpoint (reached/not reached). A missed checkpoint does not automatically result in the rest of the task being scored 0 points. If the robot finds its way back to the path, it will be evaluated accordingly. Subsequent errors will not be negatively scored if they are recognizable to the jury. For example, if a robot "misreads" a QR code and chooses the wrong path (deduction of points), points can still be scored if the wrong path is subsequently completed correctly.







If at least one robot completes the entire task within a scoring run, a time bonus is awarded. This is distributed proportionally to all robots with a complete solution, weighted according to the time required.

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The following illustration is only a schematic representation of the principle. Actual distances, sizes, and angles, as well as path trajectories, must be measured directly in the arena.



Key:

	Wall		Robot camera viewing direction upwards
	black tape line		
	Colored tape line	T1 ..., T5	Notes only in the drawing, not visible on court
	QR-Code		Color field: red, blue or green

## Solution Presentation and Evaluation

Each team has **three** presentation phases for Module 1, each lasting 15 minutes, during which **ONE** scoring run of a maximum of 10 minutes can be started at any time. The **better two** of the scoring runs will be considered for evaluation. The remaining time can be used for preparing the scoring run, connecting the robots, etc. The presentation order can be found in the schedule.