Class Project 1

Line Following

Inspired by and based on: *RoboCupJunior Rescue Line – Rules 2018*

Summary: An autonomous robot should follow a black line while overcoming different problems in a modular Field formed by tiles with different patterns. The floor is white in color and the tiles are on different levels connected with ramps. The end of the field will be marked with a strip of reflective silver tape on the floor. Teams are not allowed to give their robot any advance information about the field as the robot is supposed to recognize the field by itself.

Note: *It is not whether you win or lose, but how much you learn that counts!*

Details: Carefully go through the following details to complete the project. You can treat them as specifications.

1 Field

1.1 Description

1.1.1 The field is made up of modular tiles, which can be used to make an endless number of different courses for the robots to traverse.

1.1.2 The field will consist of 30 cm x 30 cm tiles, with different patterns. The final selection of tiles and their arrangement will not be revealed until the day of the competition. Competition tiles may be mounted on a hard-backing material of any thickness.

1.1.3 There will be a minimum of 8 tiles in a competition field.

1.1.4 There are different tile designs (examples can be found under rule "1.3 Line").

1.2 Floor

1.2.1 The floor is white in color. The floor may be either smooth or textured (like linoleum or carpet) and may have steps of up to 3 mm height in between tiles. Due to the nature of the tiles, there may be a step and/or gap in the construction of the field. These are not intentional and will be minimized as much as possible by the organizers.

1.2.2 Competitors should be aware that tiles may be mounted on thick backing or raised off the ground, which may make it difficult to get back on a tile where the robot comes off the course. No provision will be made to assist robots that drive off of a tile to get back onto the tile.

1.2.3 Tiles will be used as ramps to allow the robots to "climb" up to and down from different levels. Ramps will not exceed an incline of 25 degrees from the horizontal.

1.2.4 Robots must be designed so that they can navigate under tiles that form bridges over other tiles. The minimum height (space between the floor and the ceiling) will be 25 cm.

1.3 Line

1.3.1 The black line, 1-2 cm wide, may be made with standard electrical insulating tape or printed onto paper or other materials. The black line forms a path on the floor. (The grid lines indicated in the drawings are for reference only and competitors can expect tiles to be duplicated, added and/ or omitted.)

1.3.2 Straight sections of the black line may have gaps with at least 5 cm of straight line before each gap as measured from the shortest portion of the straight portion of the line. The length of a gap will be no more than 20 cm.

1.3.3 The arrangement of the tiles and paths may vary between rounds.

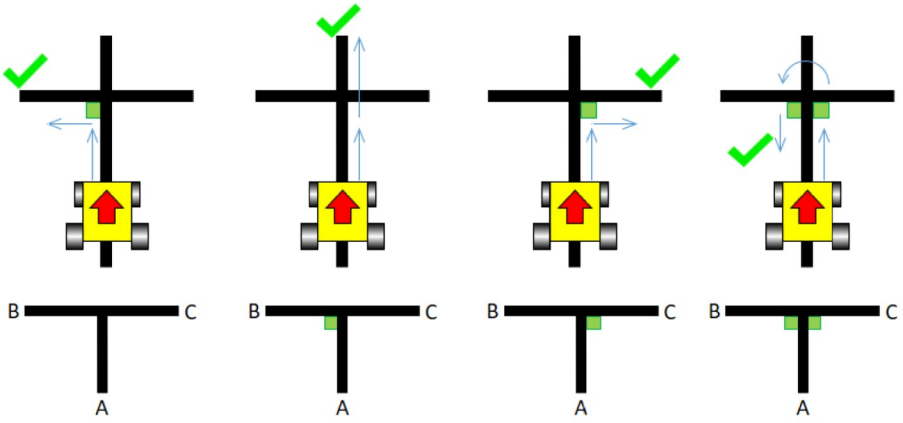
1.3.4 The line will be 10 cm away from any edge of the field.

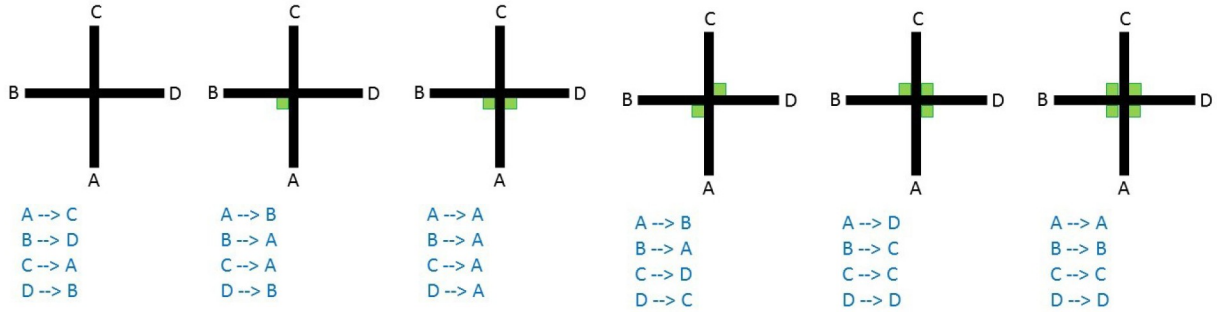
1.4 Speed Bumps, Debris and Obstacles

1.4.1 Speed bumps will have a height of 1cm or less and will be white. When the speed bump is placed over any black line, the overlap between the speed bump and the black line will not be colored black.
1.4.2 Debris will have a maximum height of 3 mm. It will not be fixed to the floor. Debris consists of small materials such as toothpicks or small wooden dowels, etc.
1.4.3 Debris may be adjacent to walls.
1.4.4 Obstacles may consist of bricks, blocks, weights and other large, heavy items. Obstacles will be at least 15cm high.
1.4.5 An obstacle may not occupy more than one line.
1.4.6 A robot is expected to navigate around obstacles. The robot may move obstacles but it should be noted that obstacles may be very heavy or fixed to the floor.

1.5 Intersections and dead ends

1.5.1 Intersections can be placed anywhere except in the evacuation zone.
1.5.2 Intersections markers are green and 25 mm x 25 mm in dimension. They indicate the direction of the path the robot should follow.
1.5.3 If there is not a green marker at an intersection, the robot should continue straight ahead.
1.5.4 A dead end is when there are two green marks before an intersection (one on each side of the line), in this case the robot should turn around.
1.5.5 The intersections are always perpendicular but may have 3 or 4 branches.
1.5.6 Intersection markers will be placed just before the intersection. See the images below for possible scenarios.





1.6 Doorway

1.6.1 The field layout may have doorways. If present in a field, doorways will be at least 25 cm wide and 25 cm high.
1.6.2 Doorways are located on straight sections of the line.
1.6.3 Doorways will be fixed to the floor.

1.7 Environmental Conditions

1.7.1 The environmental conditions at a tournament will be different from the conditions at home practice field. Teams must come prepared to adjust their robots to the conditions at the venue.
1.7.2 Lighting and magnetic conditions may vary in the rescue field.
1.7.3 The field may be affected by magnetic fields (e.g. generated by under floor wiring and metallic objects). Teams should prepare their robots to handle such interference. Organizers and referees will do their best to minimize external magnetic interference.
1.7.4 The field may be affected by unexpected lightning interference (e.g. such as camera flash from spectators). Teams should prepare their robots to handle such interference. Organizers and referees will do their best to minimize external lighting interference.
1.7.5 All measurements in the rules have a tolerance of ±5%.

2 Game Play

2.1.1 Robots will start behind the joint in between the start tile and the next tile along the course towards the evacuation zone. Correct placement will be checked by the referee.
2.1.2 Modifying the robot during a run is prohibited, which includes remounting parts that have fallen off.
2.1.3 Any parts that the robot loses intentionally or unintentionally will be left in the field until the run is over. Team members and judges are not allowed to remove parts from the field during a run.
2.1.4 Teams are not allowed to give their robot any advance information about the field. A robot is supposed to recognize the field elements by itself.
2.1.5 The robot must follow the course completely.
2.1.6 The robot has visited a tile when more than half the robot is within that tile when viewed from above.
2.1.7 A run begins at the scheduled starting time whether or not the team is present or ready. Start times will be posted around the venue.
2.1.8 Once the scoring run has begun, the robot is not permitted to leave the competition area.
2.1.9 Each team will be given a maximum time of 8 minutes to calibrate the sensors, select the checkpoints and let the robot complete the course. The time for each run will be kept by the referee.
2.1.10 Calibration is defined as taking sensor readings and modifying the robot's programming to accommodate such sensor readings. Any and all pre-mapping activities will result in immediate disqualification of the robot for the round.
2.1.11 Teams may calibrate their robot in as many locations as desired on the field, but the clock will continue to run. Robots are not permitted to move on their own while calibrating.
2.1.12 Once a team is ready to start a scoring run, they must notify the referee. To begin a scoring run, the robot is placed on the starting tile of the course as indicated by the referee. Once a scoring run has begun, no more calibration is permitted, this includes changing of code/code selection.
2.1.13 Obstacles may be removed, added or changed just before a run starts to prevent teams from pre-mapping the layout of the fields.

2.1.14 Individual tiles may be changed or switched just before a run starts to prevent teams from pre-mapping the layout of the fields. This may happen on the basis of a die rolled by the referee or with another method of randomization announced by the organizers.

2.1.15 The difficulty of the run and the amount of points that can be reached will be the same or usually the same for every team in a given round on a particular field.

3 Robots

3.1 Control

3.1.1 Robots must be controlled autonomously. The use of a remote control, manual control, or passing information (by sensors, cables, wirelessly, etc.) to the robot is not allowed.

3.1.2 Robots must be started manually by the student.

3.1.3 Any pre-mapped type of dead reckoning (movements predefined based on known locations or placement of features in the field) is prohibited.

3.1.4 Robots must not damage any part of the field in any way.

3.1.5 Robots must have a kill switch that disconnects the power source and is easily accessible.

3.2 Construction

3.2.1 Any robot kit or building blocks, either available on the market or built from raw hardware, may be used as long as the design and construction of the robot are primarily and substantially the original work of the students. (Use components available in the lab)

3.2.2 Robots that do not comply will face immediate disqualification from the tournament. If there is any doubt, teams should consult the instructors prior to the competition.

3.2.3 For the safety of participants and spectators, only lasers of class 1 and 2 are allowed. This will be checked during inspection. Teams using lasers must be able to show the sensor's data/information sheet.

3.2.4 Robots may incur damage by falling off the field, making contacts with another robot, or making contacts with field elements. The instructors cannot anticipate all potential situations where damage to the robot may occur. Teams should ensure that all active elements on a robot are properly protected with resistant materials. For example, electrical circuits must be protected from all human contact and direct contact with other robots and field elements.

3.2.5 When batteries are transported or moved, it is recommended that safety bags be used. Reasonable efforts should be made to ensure that robots avoid short circuits and chemical or air leaks.

3.3 Inspection

3.3.1 The robots will be scrutinized by the instructors before the start of the tournament and at other times during the competition to ensure that they meet the constraints described in these rules.

3.3.2 It is illegal to use a robot that is very similar to another team's robot from a previous year or the current year. *Similarly, copying of the project report will also lead to zero marks for both students.*

3.3.3 It is the responsibility of the team to have its robot re-inspected, if the robot is modified at any time during the tournament.

3.3.4 Students will be asked to explain the operation of their robot in order to verify that construction and programming of the robot is their own work. The complete design should also be well documented. *Student adopting proper modeling mechanism will be given bonus marks depending upon the modeling quality.*

3.3.5 Students will be asked about their preparation efforts and may be requested to answer surveys and participate in video-taped interviews for research purposes.

3.3.6 All teams have to submit their source code prior to the competition. The source code will not be shared with other teams without the team's permission.

4 General Rules

4.1 Teams

4.1.1 Each team must have only one robot on the field.
4.1.2 Each team must have only 1 member, unless a special permission was granted.
4.1.3 Each team member will need to explain his/her work with proper technical details.
4.1.4 A student can be registered on only one team.
4.1.5 Mentors/parents are not allowed to be with the students during the competition. The students will have to self-govern themselves (without mentor's supervision or assistance) during the long stretch of hours at the competition.

4.2 Violations

4.2.1 Any violations of the inspection rules will result in lost points.
4.2.2 If needed modifications must be made within the time schedule of the tournament and teams cannot delay tournament play while making modifications.
4.2.3 Copying of the work, source code, report will lead to significant deduction of marks/points.

4.3 Rule Clarification

4.3.1 If any rule clarification is needed, please contact your lab instructor.

4.4 Submission

4.4.1 Each team has to present their robot during an event referred to as "the tournament" in this document.
4.4.2 The tournament will take place during the last lab of the semester.
4.4.3 Each team has to submit their code through Git-Hub.
4.4.4 Each team has to submit a written report as a separate PDF file.
4.4.5 All submitted files must also be submitted to the lab instructor or through Brightspace.
4.4.6 Grading scheme will be provided separately later on.