Version: 2026A

RoboCupRescue Robot League

2026 Championship, Icheon, South Korea

The RoboCupRescue Robot League gathers teams of researchers capable of developing robotic systems that enable emergency responders to perform extremely hazardous tasks from safer stand-off distances. These mobile robots need to demonstrate assistive and autonomous behaviors that can increase their reliability when operating remotely within complex environments, including even partially collapsed structures when necessary.

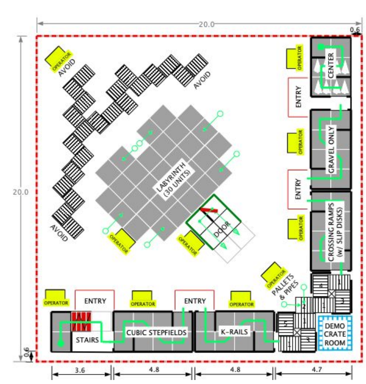
Established just prior to the World Trade Center collapse in New York City more than twenty years ago, the RoboCupRescue Robot League has hosted robot evaluations annually all over the world. In addition to demonstrating the state-of-the-science in robotics for unstructured environments, we help develop the standard test methods emergency responders use to objectively evaluate commercial robots, train with measures of remote operator proficiency, and compare results no matter where or when the evaluations happen.

This is just the first step out of the laboratory for many of these robots and researchers. It is a long process to harden and commercialize robots for deployment into such difficult environments. But these League participants are determined to use their skills and energy to help emergency responders stay safe as they save lives.

Bringing Robotics Researchers Together to Collaborate

The RoboCupRescue Robot League conducts comprehensive evaluations involving essential mission tasks required by emergency responders worldwide. The arenas include a variety of reproducible terrains, obstacles, and tasks with increasing difficulty to challenge even the most capable robots.

- ***Mobility (MOB)*** refers to a robot's ability to move reliably and effectively through its environment. This includes navigating different types of terrain, overcoming obstacles, maintaining stability, and positioning itself where tasks need to be performed. The reproducible tests measure how well a robot can get from place to place under real-world conditions.
- ***Dexterity (DEX)*** refers to a robot's ability to manipulate objects with precision, control, and flexibility. Dexterity tasks are embedded within various terrains and obstacles, including objects mounted on linear rails to evaluate manipulator reach and omni-directional objects to assess orientational dexterity. These tasks may be performed with *any* part of the robot—for example, legs pressing buttons or flippers turning valves. Inspection tasks may also be completed using a chassis-mounted camera
- ***Autonomy (AUTO)*** is designed to reduce the operator's cognitive load by providing reliable, precision-focused autonomy that supports multi robot operations, even in degraded radio-communication environments. Its behaviors enhance mission effectiveness by maintaining consistent performance and ensuring robots can operate dependably with minimal operator intervention for rescue operations. This includes the generation 2D and 3D maps of the environment while identifying objects of interest in the labyrinth as well as autonomous navigation and manipulation in the lanes.



Competition Features

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Robot: Each paid registration allows **one robot to compete**. Robots must weigh under **80 kg**. To qualify as a small-sized robot, the robot must be able to pass through a **30 cm square opening**. All robots must be equipped with secure, safe handles to move the robot. All robots must have an e-stop.

Remote Operator Stations are used because the robot operator should not have direct visual contact with the robot within a test lane. No communication between team members and the operator is allowed unless reset. The operator must receive all situational awareness through the system interface as if the robot is down range or in a structure. **One operator at a time only! Switching operators is OK. Operators must stay at the operator station and must not watch the robot during the trial.**

Tethers are always allowed because they can provide secure communications and ongoing power to drive the robot or recharge batteries over time. To avoid getting snagged on obstacles, tethers should be spooled on the robot and act as a winch when necessary to help descend stairs then climb back up if necessary. If tethers are dragged behind the robot within the test lanes, the tether must be managed from the lane entrance by a designated cable handler. Tethers may not be guided over the lane walls. **Only one cable handler is permitted during the mission. The cable handler must remain at the lane entrance (except in the labyrinth), and the use of sticks or similar tools to aid in cable management is prohibited.**

Difficulty Settings for Test Lanes may increase going from preliminaries to semis finals/finals by raising the lane slope to a 15 degree incline for increased difficulty. Apparatus difficulty setting is the same for all teams, and the time limit is the same, the trial results are comparable.

Trial Time Limits are not intended to make it a race. Rather, there is enough time for a capable robot to demonstrate a statistically significant number of task repetitions. This provides a measure of reliability that the task can be performed. Trials begin every 30 minutes:

- 5 minutes to set up
- **20 minutes of operation**
- 2 minutes for sensor assessment (victim box)
- 3 minutes to exit

Autonomous Behaviors are encouraged by additional points (see score form) for maneuvering through complex environments with no guidance from the remote operator –**hands-off the interface from end-end** . No QR code will be placed at the start point. The robot must rely on mapping to navigate from the end zone back to the start point. A single QR code will be located in the end zone to enable the robot to identify the end zone. After preliminaries one or two QRs codes may be placed at the **end zones** of the sequence. Pre mapping is allowed outside of the Maze (labyrinth). Teams may map the arena in advance, including for the semi-finals/finals. The Maze is the only exception—no pre mapping is permitted inside the maze.

Radio Communications Degradation Assistive or autonomous behaviors can improve the effectiveness and reliability of the robot. We provide additional points to robots that work reliability within intermittent and unpredictable communication conditions. To train for radio degradation in advance, follow the build instructions of the Radio Degradation Box published by the Communications Network Institute of TU Dortmund University here: https://github.com/tudo-cni/vsting-sa

Teams must be dressed appropriately to enter the arena area; closed toed shoes and long pants.

Test Methods within the Arena

MOBILITY LANES

Terrains
- Crossing Ramps (with Slip disks) (0° or 15° slope)
- K-Rails (0° or 15° slope)
- Gravel (15° slope)
- Cubic Stepfield (0° or 15° slope)

Obstacles
- Traverse & Center (15° incline, variable width)
- Pallet Hurdles with Pipes (20cm elevations)
- Stairs (35°/40°/45° incline with 0, 2 or 4 barriers)
- Doors

AUTONOMY
- Avoid Holes Lane (elevated path to follow)
- Mapping Labyrinth (maze) (round fiducial, objects) (not a lane)

DEXTERITY (included in all lanes)

Classification Tasks
- Inspect (linear 1 pts, omni 2 pts)
- Touch (linear 2 pts, omni 4 pts)
- Insert (linear 3 pts, omni 6 pts)

Operational Tasks
- Push E-Stops (omni 10 pts)
- Rotate Valves (omni 10 pts)
- Insert Keys (omni 10 pts)

Sensing Tasks (Victim Crate)
- Thermal Image Acuity (5 pts)
- Partial Image Recognition (4 pts)
- Motion Detection (4 pts)
- Proximity Sampling (3 pts)
- QR Code Acuity (2 pts)
- Visual/Color Acuity (1 pt)
- 2 –Way Audio Acuity (1 pt)

The primary goal for teams is to push the capabilities of their robotic systems and improve their methods. Through this process, they gain an understanding of what their robots need to succeed in real-world situations.

Inclusiveness: Teams get as many trials as possible within the time available, so they can rigorously evaluate their robots across the terrains, obstacles, and tasks that support their research objectives. Teams schedule their own test plan each day to manage their own risks.

Resilience to Failure: During a trial, robot resets may be declared by the operator or team member. Resets will last at least 2-minutes. This allows the robot to be safely carried and reset in the **previous end zone** to continue the trial. Robot repairs must be performed in the arena area (**not in the team paddock**). **Touching the robot during the trial is an automatic reset.** Configuration changes **are not** allowed during a trial (ie removing the arm).

Between trials, configuration changes **are** allowed to optimize the robots performance for particular terrain or task. **Locomotion must remain the same**.

If a robot is unable to continue the competition, the team may proceed with another robot; however, the score for the new robot will be set to zero. If the robot is identical, consideration may be given to team to not zero their score.

Additional Challenges:

Negotiate Leaning Obstacles:
Perform additional maneuvering tasks in the any lane to earn additional points (See Mission Form). Forces larger robots with advantages in the terrains and step-over obstacles to steer precisely and crouch at times. Small robots simply steer clear. All bars are magnetized in place so that any touched bar falls. Hitting the walls hard can also do it, so precise control is rewarded.Fallen bars act as debris so are not removed until the robot has moved past them to the next repetition or terrain. Extra points can be given for the number of bars left intact for each repetition (reset at the start).

Carry a payload: Carry the payload in your gripper in all test lanes for additional points (See Mission Form). Note: this may be a pipestar or other object determined at the start of the competition.

Radio Comms Degradation:
Perform the mission under increasingly challenging network conditions over time in all test lanes by using the league's Radio Degradation Box to earn additional points (See Mission Form).
To train for radio degradation in advance, follow the build instructions of the Radio Degradation Box published by the Communications Network Institute of TU Dortmund University here: https://github.com/tudo-cni/vsting-sa

Negotiate Leaning Obstacles

Carry a pipestar in the test lane

Every team has the opportunity to fully evaluate their robot. Teams that accumulate high scores are eligible to receive Best-in-Class awards in recognition of their achievements.

1st, 2nd, and 3rd Place Awards (trophies) are given to teams that combine all three categories of capabilities to demonstrate the best performance across the entire arena. These teams perform the most challenging mission sequences on the final day. Both teleoperation and autonomous points count toward the championship awards.

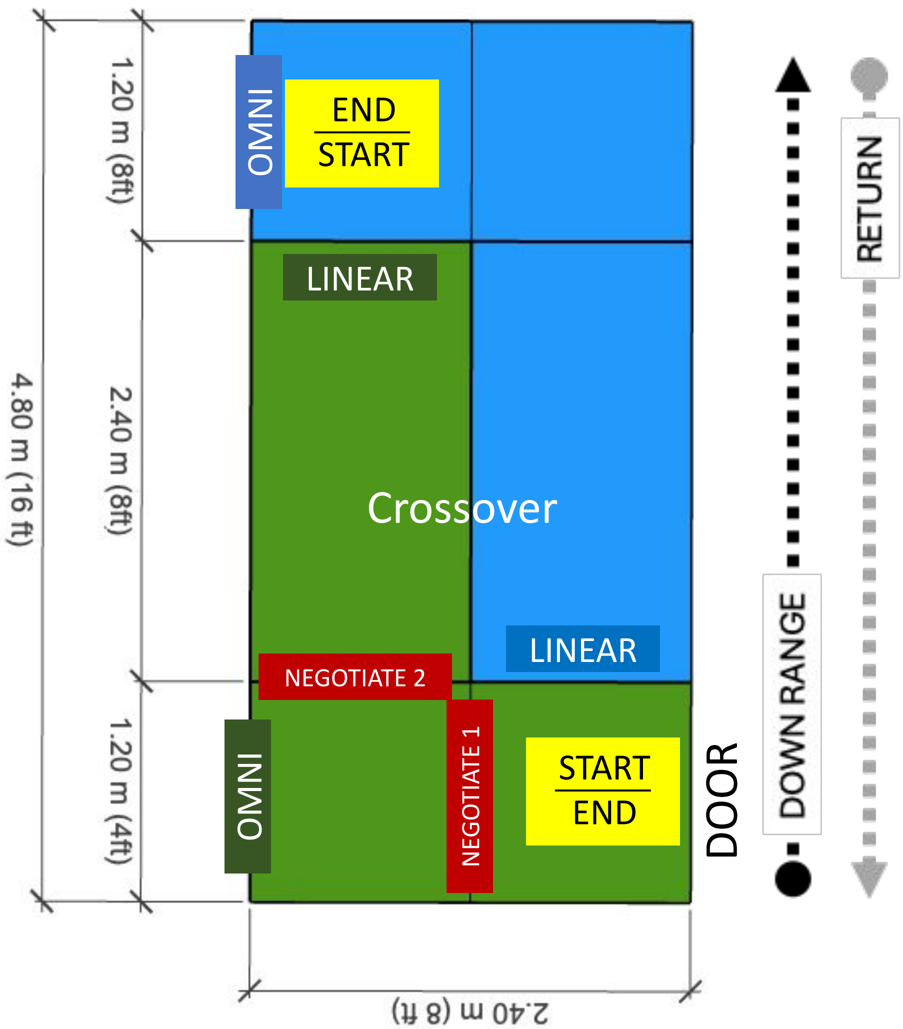
BEST IN CLASS AWARDS (certificates) are based on scores recorded during the semi-finals, when experienced judges are proctoring the trials. **If the scores of teams in the semifinals are within 10% of one another and those teams advance to the finals, the Best in Class award will be determined based on the cumulative total of each team's semifinal and final scores.**

- **Best-In-Class Award** for Autonomy is given for the team that demonstrates the most capable and reliable autonomous robot. All autonomous points are included. Sensor crate will not be included.
- **Best-In-Class Award** for Autonomous Mobility given for team that demonstrates the most capable and reliable autonomous mobility. Only **autonomous mobility points** count toward the best-in-class award. Scores from the maze and sensor crate will not be included.
- **Best-In-Class Award** Autonomous Dexterity are given for team that demonstrates the most capable and reliable autonomous dexterity. Only **autonomous dexterity points** count toward the best-in-class awards. Scores from the maze and sensor crate will not be included.
- **Best-In-Class Award** for Autonomous Mapping is given for team that demonstrates the most capable and reliable autonomous robot within the maze. Only **autonomous mapping points** count toward the best-in-class award. Only scores from the maze will be included.
- **Best-In-Class Award** for Small Robot is given for team that demonstrates the most capable and reliable robot that fits thru a 30 cm square passage to be considered for this award. All scores (teleop and autonomous) will count towards the award. 1st, 2nd and 3rd may be awarded according to RoboCup Award criteria.

Bracket Classification Awards will be given to compare like-kind of robots, this will alleviate fairness concerns between fundamentally different robot types. At the beginning of the competition robots will be placed in their respective bracket. **Robots will only be in one bracket.** Depending on the number of robots in a bracket will determine the number of certificates awarded in each bracket.Brackets will consist of the following:

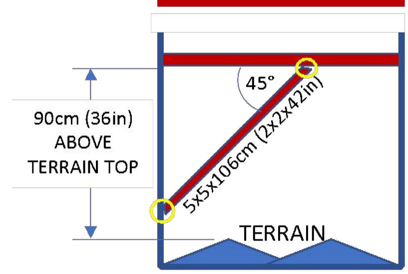
- **Best Tracked Platform**
- **Best Wheeled Platform**
- **Best Bipedal Platform**
- **Best Quadruped Platform**
- **Best Open Platform (those that do not fit in any other category)**

Additional Certificate Awards recognize important contributions across the league such as the most **intuitive operator interface** or particularly **effective design functionalities**.

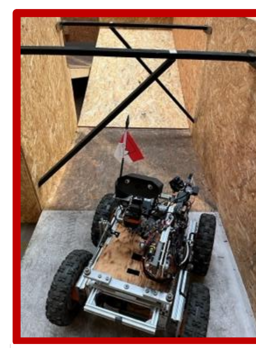


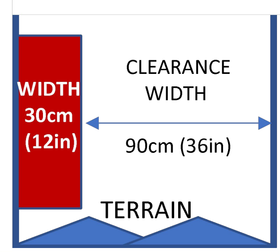
NEGOTIATE

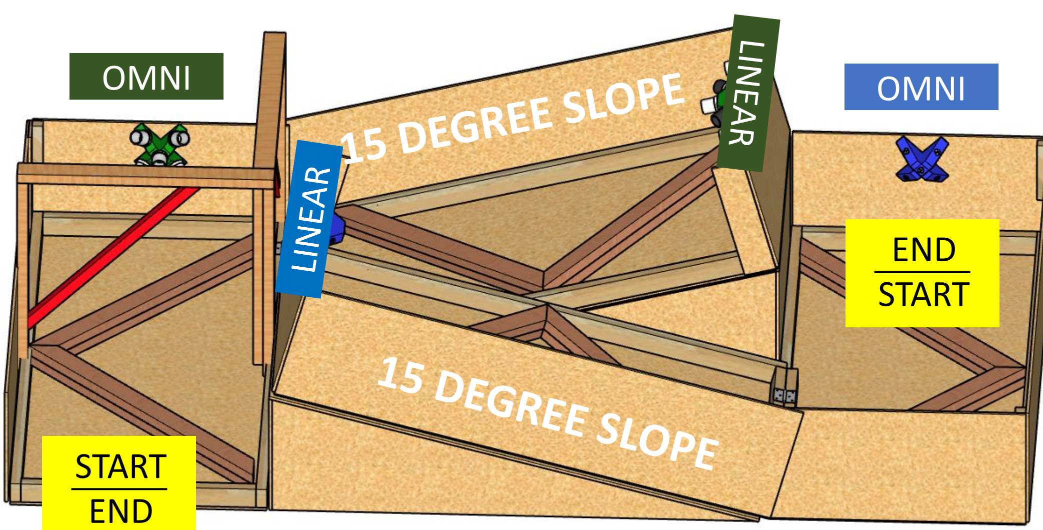
ROBOT VIEW OF "NEGOTIATE" OBSTACLES



ANGLED BEAM HANGS FROM THE CROSSBAR AND IS AFFIXED TO THE SIDE WALL WITH A MAGNET AND WASHER SO IT CAN RELEASE IF BUMPED.







Scoring Mobility

- Mobility scoring is based on continuous driving **end-to-end traverses** in the lane. The robot must **start** and **end** each traverse completely within the designated squares (Lane Overview).
- Driving teleoperatively **scores 1 point** for successful completion in each direction.
- Driving autonomously (hands off the interface) **scores 10 points** for successful completion in each direction. The remote operator may take over control at any time to finish a traverse teleoperatively for 1 point and try again autonomously on the next repetition.
- Additional points are available for carrying a payload, Negotiate thru Leaning Obstacles and Radio Comms Degradation. Teleoperation is allowed in both end zones in any case to set waypoints, create maps, etc.
- *Single Lane Missions* perform up to **10 end-to-end traverses** in the first 10 minutes of the trial. If finished early, use the elapsed time as a measure of efficiency. Wait for the Dexterity time to start before performing any Dexterity tasks.
- Mobility scores are normalized for comparison.

Scoring Dexterity

- **In order to score any dexterity points, you must score at least 2 points during the mobility portion**.
- Perform the Dexterity tasks starting anywhere and in any order. **No repeated tasks are allowed.**
- Dexterity tasks may be performed with **any** part of the robot.(Legs may press buttons/Flippers may turn valves)
- Inspection tasks may be done with a chassis-mounted camera.
- Performing dexterity tasks autonomously will score additional points. The attempt must start outside the hallway which contains the dexterity task (around at least one corner as noted in the diagram to the right). While inside the hallway, if the robot successfully performs a task with the manipulator being autonomous (no teleoperation of the manipulator), a score multiplier of 4 is applied (TA = teleoperated approach, autonomous manipulation). If both manipulation and driving are performed autonomously (completely hands off the interface), a multiplier of 8 is applied (AA = autonomous approach, autonomous manipulation). Teams may map, scan, and/or mark targets for manipulation at any time during the run.
- Dexterity scores are normalized for comparison.

Scoring Exploration/Mapping

- See Section on Mapping and Object Detection (pg17).

Single Lane Missions

Prelims (30-minute rotations, 20-minute trials)

Each test lane can be conducted individually to capture a statistically significant set of repetitions from end-to-end. This enables teams to refine their systems and tactics for the challenges in each test lane.

There are 10 concurrent start points and operator stations at each lane. Teams schedule their own test plan each day to balance their objectives with related risks. Teams typically try every lane in the Preliminaries, but several scores can be dropped from the totals.

Each team provides a "Proctor" to score and attest to the results of other team trials. This ensures all teams go home with experience conducting objective evaluations for their ongoing development process.

Multiple Lane Missions (Sequence)

Semis (30-minute rotations, 20-minute trials)

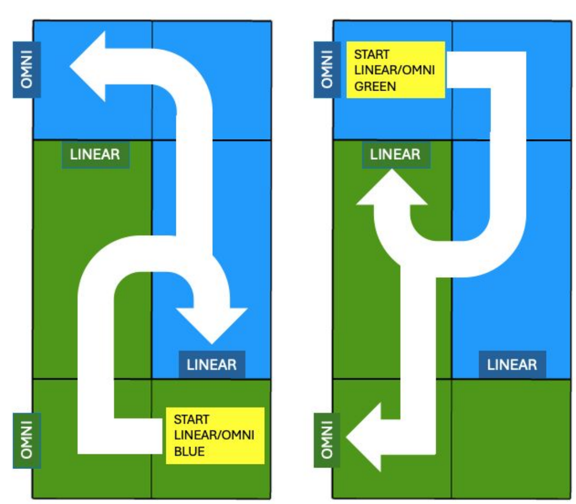
These sequences challenge teams to optimize their systems across different capabilities. There are 4 concurrent lane sequences with different operational objectives. **The lanes are conducted in any order** but no repeats are allowed until all lanes are completed. Below are examples of **semi final** sequences. **Finals may contain more or all lanes.** Note: this may change due to the layout of the lanes in the arena.

Sequence 1
- Crossing Ramps (Slip disks)
- Gravel
- Traverse & Center

Sequence 2
- Cubic Stepfield
- K-Rails
- Pallet Hurdles

Sequence 3
- Avoid Holes
- Stairs
- Doors

Sequence 4
- Labyrinth



Approaches for Autonomous Dexterity Tasks

Scoring Mobility

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ROUND	DATE	TIME	TEAM / COUNTRY	PROCTOR: FULL NAME / COUNTRY
P1	7/15	10:00	TEAM A/COUNTRY	Jane Doe/USA

TERRAINS (TER)		OBSTACLES (OBS)		EXPLORATION (EXP)
☒ Crossing Ramps	☐ K-Rails	☐ Incline/Center	☐ Stairs	☐ Avoid Holes
☐ Cubic Stepfields	☐ Gravel	☐ Pallets with Pipes	☐ Doors	☐ Mapping Labyrinth

CIRCLE SUCCESSFUL TASKS AND STRIKE THROUGH UNFINISHED OR PENALIZED TASKS.

MOBILITY: Drive TELEOPERATVELY or AUTONOMOUSLY (no hands-on interface) end-to-end in the lane.

10 minutes

		TeleOp (Choose all that apply)			Auto (Choose all that apply)			
CIRCLE A SINGLE LANE IN THE LIST ABOVE OR WRITE SEQUENCE OF LANES IN ORDER	TELEOP ONLY	TELEOP + PAYLOAD	TELEOP + NEG	TELEOP + COMMS	AUTO ONLY	AUTO + PAYLOAD	AUTO + NEG	SCORE PER LAP
1	1	2	2	2	10	2	4	1
2 RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	2
3	1	2	2	2	10	2	4	4
4 RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	6
5	1	2	2	2	10	2	4	10
6 RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	12
7	1	2	2	2	10	2	4	14
8 RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	16
9	1	2	2	2	10	2	4	1
10 RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	1

52 AUTO POINTS

67 TOTAL POINTS

Embedded Dexterity Tasks/Scoring

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Sensor Crate (White) Prelims/Semis/Finals

- QR Code Acuity, Visual/Color Acuity, Proximity, Hazmat, Motion, Thermal, 2-Way Audio

Inspect Tasks (Green) Prelims/Semis/Finals

- Linear – 1 point each (does not include multiplier)
- Omni – 2 point each (does not include multiplier)

Touch Tasks (Blue) – Prelims Only (easier, use your own tool)

- Linear – 2 point each (does not include multiplier)
- Omni – 4 point each (does not include multiplier)

Insert Tasks (Blue) - Semi and finals only (add the grasp shaft tool in center)

- Linear – 3 point each
- Omni – 6 point each

Operational Tasks (Black) – Semi Finals and Finals only

- **Omni – 10 point each**

DEXTERITY: Perform the available SETS OF TASKS starting anywhere and in any order. No repeated tasks.

CIRCLE SUCCESSFUL TASKS AND STRIKE THROUGH UNFINISHED OR PENALIZED TASKS.

TT = Teleop Approach/Teleop Dex | CM = Comms | TA = Teleop Approach/Auto Dex | AA = Auto Approach/Auto Dex

LINEAR TASKS		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA
INSPECT	L 90°	01	02	04	08	L 45°	01	02	04	08	Center	01	02	04	08	R 45°	01	02	04	08	R 90°	01	02	04	08
TOUCH (P)		02	04	08	16		02	04	08	16		02	04	08	16		02	04	08	16		02	04	08	16
INSERT (S/F)		03	06	12	14		03	06	12	14		03	06	12	14		03	06	12	14		03	06	12	14

OMNI TASKS		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA
INSPECT	Left Bottom	02	04	08	16	Left Top	02	04	08	16	Center	02	04	08	16	Right Top	02	04	08	16	Right Bottom	02	04	08	16
TOUCH (P)		04	08	16	32		04	08	16	32		04	08	16	32		04	08	16	32		04	08	16	32
INSERT (S/F)		06	12	24	48		06	12	24	48		06	12	24	48		06	12	24	48		06	12	24	48
PUSH E-STOPS		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80
CLOSE VALVES		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80
INSERT KEYS		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80

P = Prelim Only
S = Semi
F = Finals

VISUAL ACUITY PTS: IDENTIFY 3C'S | THERMAL PTS: IDENTIFY 2C'S

SENSOR TASKS	VISUAL Cs	AUDIO	VISUAL QR	PROXIMITY	MOTION	HAZMAT	THERMAL
VICTIM CRATE (ALWAYS)	1	1	2	3	4	4	5

[DEX TELEOP POINTS] + [COMS POINTS] + [DEX AUTO POINTS] + [SENSOR CRATE] = [DEXTERITY TOTAL POINTS]

TEAM LEADER SIGNATURE

Scoring Sensing Tasks

In order to score sensor points (victim crate), you must score at least 2 points mobility and 2 points in dexterity.

The victim crate must be placed in the lane.

The victim crate must be placed in an **upright position.**

Any sensor on the robot may be used to score points.

After a reset the arm must be in a stowed position.

If the manipulator is broken, you **are not** allowed to manually place the manipulator over the victim box to score.

A - THERMAL IMAGE ACUITY (5 pts)
Hand warmer with 3D printed Concentric Cs
Process: Using a thermal camera display on operator's screen the heat signature in the pattern of the Concentric Cs 2 levels deep.

B- **PARTIAL IMAGE RECOGNITION (4 pts)**
Random hazmat labels from a known set.
Process: **Autonomously** detect hazmat label. Display bounding box around hazmat label and display name of label.

C - MOTION DETECTION (4 pts)
Rotating disk with target
Process: **Autonomously** detect the rotating target square or other shapes. Display on operator's screen a bounding box around square and track while the target is in motion for 360 degrees

D - PROXIMITY SAMPLING (3 pts)
Magnet
Process: Using magnetometer attached to the tool tip/ manipulator to detect the presence of the magnet

E - QR CODE ACUITY (2 pts)
QR Code
Process: **Autonomously** QR code. Display text on the operator's screen .

F – 2-WAY AUDIO ACUITY (1 pt)
MP3 Player with alpha-numeric sequence to identify
Process: Using your speaker/microphone, detect sound at the operator station and at the robot. Must clearly detect one line of the alpha-numeric sequence .

G - VISUAL/COLOR ACUITY (1 pt)
Concentric Cs
Process: Concentric Cs Identify the gap in the ring 3 levels deep.

Available in Prelims/Semis/Finals

- Visual acuity tasks in linear/omni tasks will be **QR codes or partial image recognition**
- Remote alignment is QR detection / partial image recognition
- Teams must submit results with an overlaid image and decoded message

Note: LINEAR RAIL or OMNI may not be colored green. It may be the color of raw wood.

LINEAR

OMNI

Scoring matrix is found on the mission form

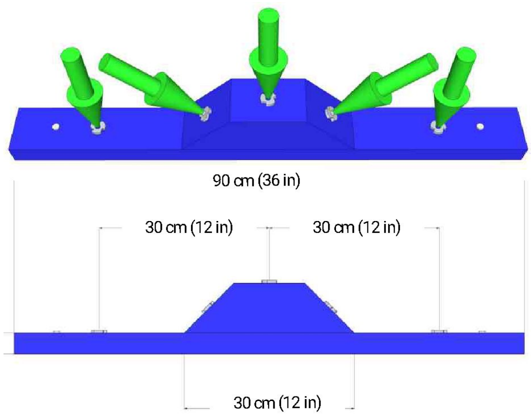
CLASSIFICATION TASK – TOUCH or INSERT TOOLS (Blue)

TOUCH = Sustained contact of shaft tip to hole interior in any orientation Easier – Only in Preliminaries

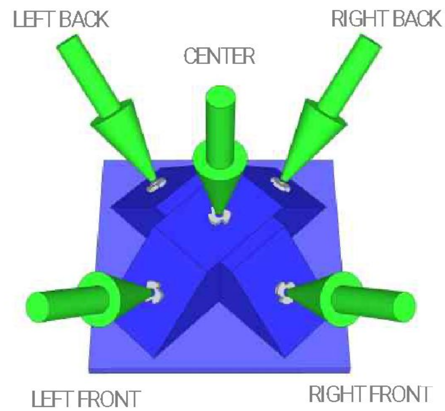
INSERT = Perpendicular penetration of shaft into hole at least 25mm (1in) Harder – In Semis and Finals

Note: LINEAR RAIL or OMNI may not be colored green. It may be the color of raw wood.

LINEAR



OMNI



One of the standard dexterity tests is “Touch” tools which is conducted in every terrain. See the blue apparatuses shown in both Linear (easier) and Omnidirectional (harder) configurations.

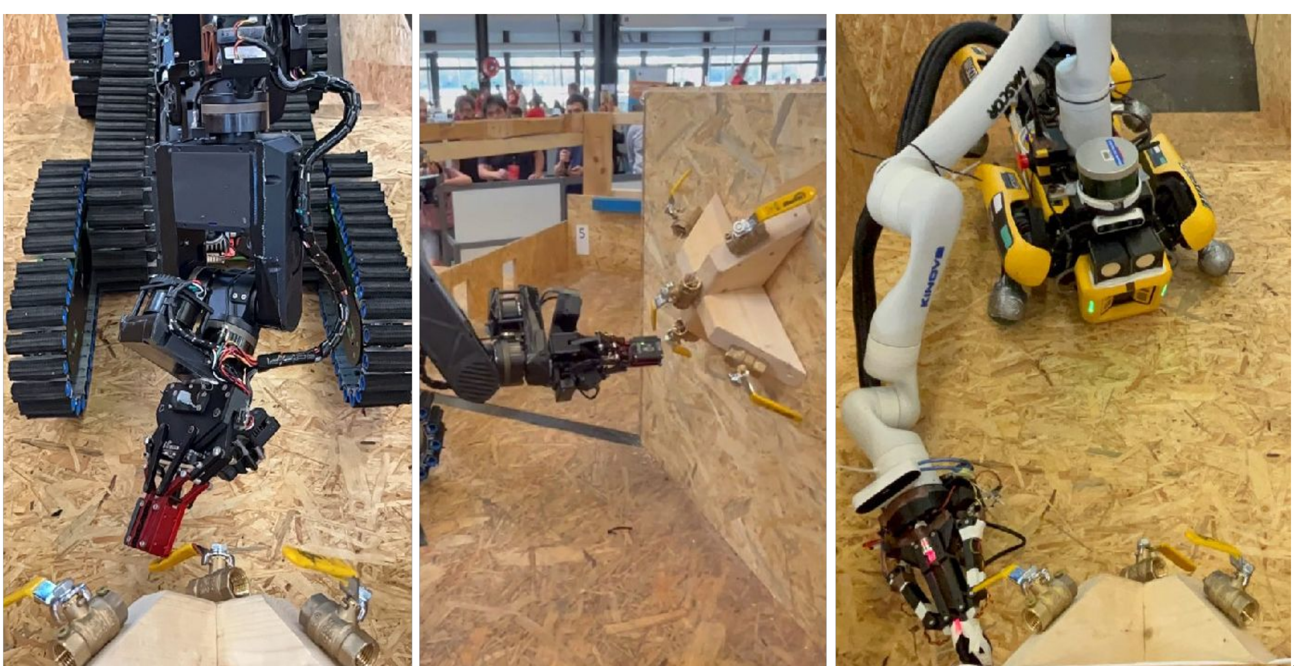
Scoring matrix is found on the mission form

OPERATIONAL TASK – PRESS BUTTONS (Black)

Harder due to force, friction, or precision. Omni configuration only

OPERATIONAL TASK – TURN VALVES (Black)

Harder due to force, friction, or precisions. Omni configuration only



Single Lane or Multi Lane Mission Form

Version: 2026A

ROUND	DATE	TIME	TEAM / COUNTRY	PROCTOR: FULL NAME / COUNTRY

TERRAINS (TER)		OBSTACLES (OBS)		EXPLORATION (EXP)
❑ (10) Crossing Ramps	❑ (9) K-Rails	❑ (1) Incline/Center	❑ (5) Stairs	❑ (4) Avoid Holes
❑ (2) Cubic Stepfields	❑ (3) Gravel	❑ (8) Pallets with Pipes	❑ (6) Doors	❑ (7) Mapping Labyrinth

CIRCLE SUCCESSFUL TASKS AND STRIKE THROUGH UNFINISHED OR PENALIZED TASKS.

MOBILITY: Drive TELEOPERATVELY or AUTONOMOUSLY (no hands-on interface) end-to-end in the lane.

			TeleOp (Choose all that apply)			Auto (Choose all that apply)			
CIRCLE A SINGLE LANE IN THE LIST ABOVE OR WRITE SEQUENCE OF LANES IN ORDER		TELEOP ONLY	TELEOP + CRATE	TELEOP + NEG	TELEOP + COMMS	AUTO ONLY	AUTO + CRATE	AUTO + NEG	SCORE PER LAP
1		1	2	2	2	10	2	4	
2	RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	
3		1	2	2	2	10	2	4	
4	RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	
5		1	2	2	2	10	2	4	
6	RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	
7		1	2	2	2	10	2	4	
8	RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	
9		1	2	2	2	10	2	4	
10	RETURN UP RANGE TO START POINT	1	2	2	2	10	2	4	

AUTO POINTS

TOTAL POINTS

DEXTERITY: Perform the available SETS OF TASKS starting anywhere and in any order. No repeated tasks.

CIRCLE SUCCESSFUL TASKS AND STRIKE THROUGH UNFINISHED OR PENALIZED TASKS.

TT = Teleop Approach/Teleop Dex | CM = Comms | TA = Teleop Approach/Auto Dex | AA = Auto Approach/Auto Dex

LINEAR TASKS		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA		TT	CM	TA	AA
INSPECT	L 90°	01	02	04	08	L 45°	01	02	04	08	Center	01	02	04	08	R 45°	01	02	04	08	R 90°	01	02	04	08
TOUCH (P)		02	04	08	16		02	04	08	16		02	04	08	16		02	04	08	16		02	04	08	16
INSERT (S/F)		03	06	12	14		03	06	12	14		03	06	12	14		03	06	12	14		03	06	12	14
OMNI TASKS		**TT**	**CM**	**TA**	**AA**		**TT**	**CM**	**TA**	**AA**		**TT**	**CM**	**TA**	**AA**		**TT**	**CM**	**TA**	**AA**		**TT**	**CM**	**TA**	**AA**
INSPECT	Left Bottom	02	04	08	16	Left Top	02	04	08	16	Center	02	04	08	16	Right Top	02	04	08	16	Right Bottom	02	04	08	16
TOUCH (P)		04	08	16	32		04	08	16	32		04	08	16	32		04	08	16	32		04	08	16	32
INSERT (S/F)		06	12	24	48		06	12	24	48		06	12	24	48		06	12	24	48		06	12	24	48
PUSH E-STOPS		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80
CLOSE VALVES		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80
INSERT KEYS		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80		10	20	40	80

P = Prelim Only
S = Semi
F = Finals

VISUAL ACUITY PTS: IDENTIFY 3C'S | THERMAL PTS: IDENTIFY 2C'S

SENSOR TASKS	VISUAL Cs	AUDIO	VISUAL QR	PROXIMITY	MOTION	HAZMAT	THERMAL
VICTIM CRATE (ALWAYS)	1	1	2	3	4	4	5

[DEX TELEOP POINTS] + [COMS POINTS] + [DEX AUTO POINTS] + [SENSOR CRATE] = [DEXTERITY TOTAL POINTS]

TEAM LEADER SIGNATURE

Overall Score Calculation

Version: 2026A

Raw Scores

CONTINUOUS RAMPS			
MOB	Auto MOB	DEX	AUTO DEX
20	10	0	0
49	0	10	0
40	40	50	40
20	0	4	0
0	0	0	0
29	0	28	0

Max Score

=IF(B$25=0,0,B4/B$25)

MOB	Auto MOB	DEX	AUTO DEX
49	40	50	40
41%	25%	0%	0%
100%	0%	20%	0%
82%	100%	100%	100%
41%	0%	8%	0%
0%	0%	0%	0%
59%	0%	56%	0%

Normalize Scores for Mob and DEX are combined for total score.
Note: MOB includes AUTO MOB and DEX includes AUTO DEX

Normalize Scores

MOB	Auto MOB	DEX	AUTO DEX
49	40	50	40
41%	25%	0%	0%
100%	0%	20%	0%
82%	100%	100%	100%
41%	0%	8%	0%
0%	0%	0%	0%
59%	0%	56%	0%

MOB + DEX = Lane Score (max 200%)

Sum of all lane scores = Total Score (max 2000%)

For all BEST IN CLASS certificates individual scores are normalized separately eg. autonomous dexitery

Best in Class Autonomy score is calculated by using the sum of all **Normalized Lane Scores** for AUTO MOB and AUTO DEX

Best in Class **Autonomous** Mobility score is calculated by using all **Normalized Lane Scores** for AUTO MOB

Best in Class **Autonomous** Dexterity score is calculated by using all **Normalized Lane Scores** for AUTO DEX

Best in Class **Autonomous** Mapping score is calculated by using only autonomous mapping points from the maze and then normalized.

Best-In-Class Award for **Small Robot** is normalized between small robot missions. The sums of all scores count

Bracket Classification Awards are normalized together. (ie using the overall competition score). Because the overhead of normalizing for each bracket is too high.

Mapping and Object Detection

Submission Specifications

Mission:

- Teams will be given a period of **20 minutes** to create maps of the area.
- A mapping run begins from a designated start position, and ends when a map is saved and cleared on the robot.
- Teams may reset their mapping run if they choose, and they may perform as many mapping runs as possible within their allotted time. Each subsequent mapping run must start from the same designated start position.

During preliminary rounds, teams will be expected to submit the data from what they believe to be their best mapping run ***(Subject to discussion)***.
In later rounds, multiple maps up to a maximum of 3 will be accepted for scoring.

Teams will be required to submit the following for each mapping run:

2D Map:

Submitted in the specified GeoTIFF format.
An open-source implementation for ROS is available at http://wiki.ros.org/hector_geotiff.
Does not contribute to mapping score.

3D Point Cloud Map:

Submitted in the specified [.PLY] format.
Recommended to use PCL to convert and save point cloud files.

Identified Objects CSV File:

Submitted in the specified CSV format.
The list of official object names will be provided during the competition.

Hand-in:

The files have to be automatically created - no editing by hand is allowed. The files have to be copied from the robot/ operating station **within 5 minutes after the run**.

Mapping and Object Detection

Scoring Specifications

2D Map:

- Mandatory to submit, but will not be scored.
- Will not be scored directly, but may be used to help visualize other scoring metrics.

3D Point Cloud Map:

In comparison to our 3D ground truth cloud, two metrics will be calculated to score your point cloud:

- **Global Error (GE)** - Computed as average cloud-to-cloud distance (in meters).
- **Coverage (CV)** - Computed as the percentage of ground truth points for which the 3D Cloud contains a point within a threshold distance.
- **Bonus multipliers** will be awarded for having sensible RGB color data and/or heat data included in your map. (1.25x and 1.6x respectively, 2x for both) ***(Subject to discussion)***
- Scores will be combined as: **CV * (1 / (1 + GE)) * Bonus** ***(Subject to discussion)***

Please note:

- *These metrics require cloud alignment and identical scaling.*
- *Teams will be responsible for proper scaling of their 3D Cloud (see specification).*
- *Judges will be responsible for map alignment using ICP and manual point-pair alignment if necessary.*
- *The alignment used for evaluation will be made available to teams.*

Identified Objects CSV File:

Teams will be expected to detect several different kinds of objects and localize them within their 3D map. These objects may include AprilTags (Standard41h12 family), Hazmat signs, physical objects (i.e. Backpack, Hard hat, fire extinguisher, victim (baby doll), propane tank (empty)), and a heat signature. Each object is unique in the arena - do not report multiple of the same type (in which case each additional detection will be discarded). Two metrics will be calculated from the list of detections:

- **Localization Error (LE)** - For all detections, this metric will represent the average difference in distance (in meters) between all detection pairs compared to the ground truth.
- **Detection Score (DS)** - The sum of various point denominations will be awarded (based on difficulty) for detections that are within an error threshold. (i.e., AR = 1, Hazmat Signs = 2, Object = 10, Heat = 15). Additionally, points will be subtracted for each detection above this error threshold (i.e. -3 points).
- Scores will be combined as: **DS / (1 + LE)** ***(Subject to discussion)***

Please note:

- *Detection coordinates should correspond to the center of mass of the detected object.*
- *These metrics are not impacted by global alignment between the ground truth and 3D Cloud.*
- *There will be an additional Detection Score penalty for reported detections for objects which are not present in the mapping area.*

Overall mapping score will be the average normalized score contributions from 3D Map (0.5), Detection CSV (0.5). 2D Map must be submitted to receive a mapping score.

Autonomy Bonus Multiplier (4x):

Teams which perform the mapping task autonomously will receive a **(4x) mapping score multiplier.** To qualify for this, both mapping and object identification must be performed without any operator intervention. The autonomous mapping run ends when the robot is stopped and the map is saved. To receive autonomy points, the system must either return to the starting position or transmit it's map wirelessly to the operator station. If team members need to enter the mapping area or interact with the robot while attempting an autonomous run, the autonomy multiplier is voided.

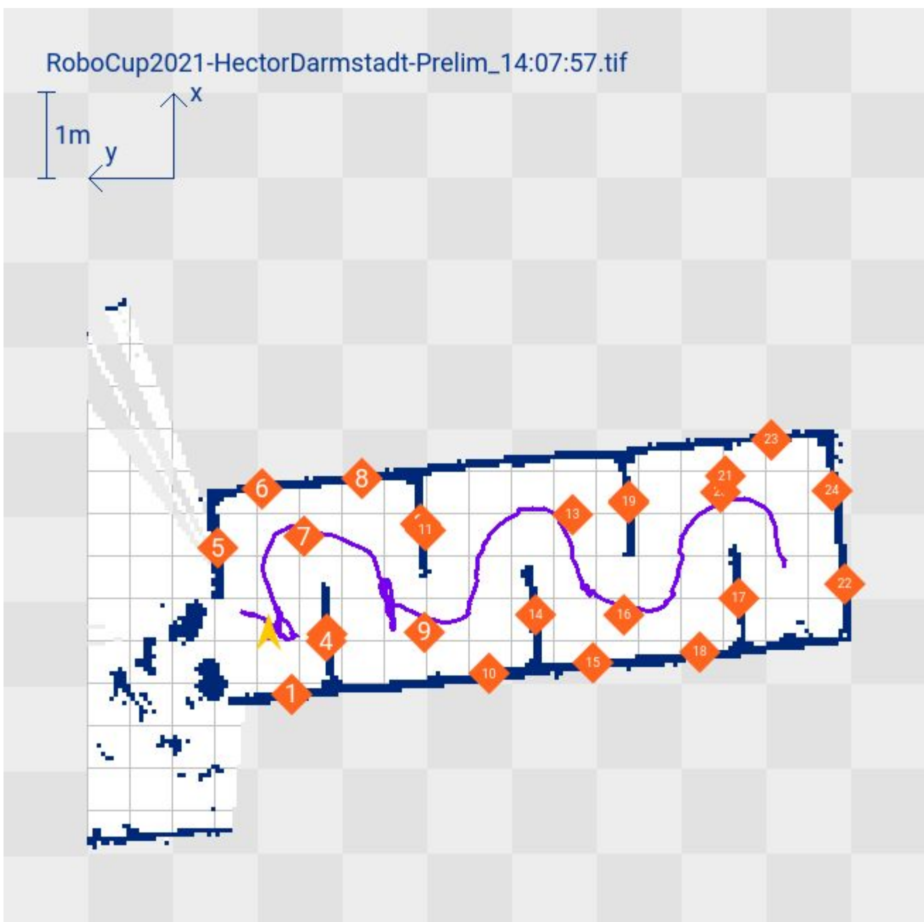
Mapping and Object Detection

Format Specifications

2D Map Format

2D maps have to be submitted in the specified GeoTIFF format. An open-source implementation for ROS is available at http://wiki.ros.org/hector_geotiff.

Example map:



In the following, all elements of the map are described:

- **Fileformat:** GeoTIFF
- **FILENAME:** DARK BLUE (RGB: 0, 44, 207) TEXT
  For example, “RoboCup2025-TeamName-Mission1.tiff” displayed in the upper left corner to identify the map, make it sort properly in a directory, and findable on a computer.
- **MAP SCALE:** DARK BLUE (RGB: 0, 50, 140) TEXT AND EXACTLY 1 METER LONG LINE
  Display this in the upper right corner to indicate the scale of the map.
- **MAP ORIENTATION:** DARK BLUE (RGB: 0, 50, 140) TEXT (“X” AND “Y”) AND ABOUT 50 cm LONG ARROWS
  Display this next to the map scale. It gives the orientation for the victim location in the victim file. Must be a right handed coordinate system: X points upwards, Y to the left.
- **UNEXPLORED AREA GRID:** LIGHT/DARK GREY (RGB: 226, 226, 227/RGB: 237, 237, 238) CHECKERBOARD WITH 100CM SQUARES
  This solid checkerboard pattern should show the unexplored area and provide scale on all sides of the mapped area. It should also print in black and white without ambiguity with other areas potentially turned grey in the process.
- **EXPLORED AREA GRID:** BLACK (RGB: 190,190,191) GRID WITH 50CM GRID AND ABOUT 1 CM THICK LINES (use a one pixel line in the map)
  This grid should only appear in the explored area, behind any walls, victim locations, or other information. The grid should be aligned with the checkerboard pattern of the unexplored area, but twice as fine to allow visual inspection of wall alignments.
- **INITIAL ROBOT POSITION:** GREEN (RGB: 0, 240, 0) ARROW
  This should mark the initial position of the robot and always be pointed toward the top of the map.
- **WALLS AND OBSTACLES:** DARK BLUE (RGB: 0, 40, 120) FEATURES
  This should indicate the walls and other obstacles in the environment. The color should make the walls stand out from everything else.
- **SEARCHED AREA:** WHITE CONFIDENCE GRADIENT (RGB: 128, 128, 128 to RGB: 255, 255, 255)
  This should be based on the confidence that the area is really free. It should produce a clean white when seen as free by all measurements and nearly untouched when undecided, that is, nearly equally seen as occupied as free, to produce a dither effect.
- **APRILTAG LOCATION:** SOLID YELLOW (RGB: 255, 200, 0) CIRCLE WITH ABOUT 35CM DIAM CONTAINING WHITE (RGB) TEXT “#” REPRESENTING THE LABEL ASSOCIATED WITH THE APRILTAG
- **HAZMAT LOCATION:** SOLID ORANGE (RGB: 255, 100, 30) DIAMOND WITH ABOUT 30CM SIDES CONTAINING WHITE (RGB) TEXT “@@” REPRESENTING THE FIRST TWO LETTERS OF THE HAZMAT LABEL
- **REAL OBJECT LOCATION:** SOLID RED (RGB: 240, 10, 10) DIAMOND WITH ABOUT 30CM SIDES CONTAINING WHITE (RGB) TEXT “@@” REPRESENTING THE FIRST TWO LETTERS OF THE IDENTIFIED OBJECT
- **ROBOT PATH:** MAGENTA (RGB: 120, 0, 140) LINE ABOUT 2CM THICK
  This should show the robot path.

NOTE: If a team wishes to deviate from this 2D format in order to make **improvements** on the understandability and usefulness of their generated 2D map, they will not be penalized for doing so. The submitted map should contain all of the same information (scale, detections, physical barriers, robot path, etc.), but stylistic choices may be made to make it more presentable. The important capability to demonstrate is producing a clean, useful 2D map for field operations.

Identified Objects CSV Format

In addition to indicating identified objects in the map, they have to be submitted in a CSV list. In the following, the structure of the file is given:

Filename: RoboCup[Year]-[Teamname]-[Mission]-[Start Time]-pois.csv
([Start Time] should be formatted as HH-MM-SS)
Format for the file header:

```
"pois"
"1.3"
"[Your team name]"
"[Your country]"
"[Start Date]"
"[Start Time]"
"[Mission #]"

detection,time,type,name,x,y,z,robot,mode
```

Replace the placeholders “[...]” with your data. Please leave the quotes in the file, but not the brackets.

The file body contains one line for each found object in the following format:

```
[detection],[time],[type],[name],[x],[y],[z],[robot],[mode]
```

- **[detection]:** Unique integer counter for each object that is also printed on the geotiff map
- **[time]:** Time stamp when the object was found
- **[type]:** Type of the object: [ar_code, hazmat_sign, real_object, heat_sig]
- **[name]:** Unique ID for detection (i.e. ar_code number, hazmat label, object name)
- **[x], [y], [z]:** Coordinates of the object in meters
- **[robot]:** Name of the robot that found the object
- **[mode]:** Mode of the robot when it found the object: **A** for autonomous, **T** for teleoperated

Strings which include spaces should be enclosed with double quotes. Here is an example of a file which might be named “RoboCup2025-ReskoKoblenz-Prelim1-pois.csv”:

```
"pois"
"1.3"
"Resko Koblenz"
"Germany"
"2018-06-23"
"14:37:03"
"Prelim1"

detection,time,type,name,x,y,z,robot,mode
1,14:28:01,”ar_code”,”2”,-8.2992,-2.2904,0.49,"Robbie 1",A
2,14:28:02,”ar_code”,”34”,-8.2993,-2.2902,0.4563,"Robbie 2",T
3,14:28:05,”hazmat_sign”,”poison”,-5.7452,-7.0849,0.2130,"Robbie 1",A
4,14:30:14,”real_object”,”gloves”,-6.0845,-0.1251,0.3561,"Robbie 1",A
5,14:32:56,”heat_sig”,”0”,-9.2817,0.04968,0.7561,"Robbie 2",T
```

IMPORTANT: There will only be **one** instance of each object included in the mapping area at any time. Teams must only include **one** detection per unique object. If duplicate objects are contained in the submitted CSV, only the first instance of that object will be used for scoring.

A list of object labels will be provided to teams. **Mislabelled objects and submissions not following the specified format will not be scored.**

3D Point Cloud Map

Teams will submit a 3D pointcloud representation of the mapped area to be scored with respect to a generated ground truth map. The submitted map should adhere to the following specification:

Filename: RoboCup[Year]-[Teamname]-[Mission]-[Start Time]-map.ply
([Start Time] should be formatted as HH-MM-SS)

Your point cloud should be formatted as an ASCII file.

The header of your file should adhere to the PLY file format.

At a minimum, your file should include float type fields for x, y, and z.

Teams may include additional fields such as:
- RGB Color Information
- Heat Information
- Point Normal Information
- Confidence Scalar

Maps which contain sensible color and/or heat data will be awarded a bonus point multiplier.

IMPORTANT: The scale of your map coordinates are expected to be in meters. (i.e. A distance of 1 unit in the submitted point cloud should correspond to 1 meter in the real world). **Improper scaling will severely penalize your score.**

The origin location (0,0,0) of the 3D Cloud should be set to the starting position for the robot which will be marked on the floor in the mapping area. More specifically, the origin should be set to be the center of the front of the robot, at floor height. Rotationally, the starting position will point the robot in the +Y direction, and the vertical axis will be Z.

More information on PLY format can be found here.
The format for the PLY header that should be included is shown below.
NOTE: You are not required to include all fields if you are not collecting those kinds of data

```
ply
format ascii 1.0
comment {Team Name}
comment {Start time}
comment {Mission #}
element vertex {Number of Vertices}
property float x
property float y
property float z
property uchar red
property uchar green
property uchar blue
property float nx
property float ny
property float nz
property float temp
property float confidence
end_header
{DATA}
```