MINESWEEPERS
TOWARDS A LANDMINE-FREE WORLD

MADRID 2018 IROS

MINESWEEPERS
TOWARDS A LANDMINE-FREE WORLD
MADRID 2018
RULE BOOK

LANDMINEFREE.ORG

7TH YEAR

MINESWEEPER 2018 Competition

PLAN AND RULES

Competition Timeline:

Registration	1 March - 1 August 2018
Regional Rounds	August 2018
Technical Report and Video Submission Phase	1 Sept. 2018
Notification of Acceptance	10 Sept. 2018
International Competition	1-5 October 2018

Registration (1 March - 1 August 2018):

Early registration will open from 1 Feb to 30 Mar 2018 on www.landminefree.org

Late registration will open from 1 April to 30 May 2018 on www.landminefree.org

Participation in the ACADEMIA class is open to students in four or five year's universities and technical colleges.

School students are eligible to compete in RANGER class only and NOT eligible to compete in the EXPLORER class.

Graduate students are NOT eligible to compete as student team members, but are welcome to serve as team mentors or lead instructors. Graduate students are encouraged to contribute to the team via advice and technical assistance.

For ACADEMIA and RANGER: There are no limitations about the number of participating teams per organization.

Teams must have at least three students with at least one faculty member or adult mentor involved in the process. One student should be designated as the team Leader.

Participation in the RANGER class is open to students in middle and high schools as well as students in home schools, after school programs, clubs, and community organizations of comparable grade levels.

FEES:

250 $ registration fees for ACADIMIA teams.
200 $ registration fees for Junior teams.
500 $ registration fees for Industry teams.
All Teams will be qualified from the regional competitions will Not pay international Registration fees.
Once team registered they must pay their registration fees within a week from their registration date (before the registration deadline).
Payment method details will be sent to team leader after completing the registration form.
Registration or regional fees are not including any accommodation or catering for teams from Minesweepers competition
250 $ registration fees for ACADIMIA teams.
200 $ registration fees for Junior teams.
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Payment method details will be sent to team leader after completing the registration form.
Registration or regional fees are not including any accommodation or catering for teams from Minesweepers competition

Registration steps:

Fill the team data form.
Choose the payment method at the end of the team data form and submit.
Follow the payment instruction received to the team leader email.
Upload the receipt to this form.
Waiting for a confirmation email from the organizing committee.
Note: You may start working on your robot during the registration steps and do not wait to the registration deadline.

Eligibility Round:

It is required from all teams (Academia and Explorer) to submit 3 min video showing their work and their Robot working as a condition to pass this round.
In your video, you must:
Show your Robot body as complete design also as complete Robot basic parts are installed on it.
Prove that your Robot can Navigate and surf with its own power without any help.
Prove that Electronics & control system can run your Robot by record dry test for each.
Prove that you are using ROS to control your robot.

Submission must be on Youtube and sending the link through mail to tech@landminefree.org before 15 July 2018.
The results will be published after 1 week from the deadline and the judges will choose the featured videos to be uploaded on the Competition Youtube channel.

REGIONAL COMPETITION (4-5 Aug 2018, Borg El-Arab, Egypt):

All teams must submit the technical report before 15 July 2018 with committed to all technical conditions in the template and this is a condition to compete in the finals by mail to tech@landminefree.org.
Teams can earn up to 5 points bonus if they made press release or any media outreach in public media like newspapers, TV, radio, news websites and Facebook pages (more than 20000 likes) and send link of it by mail to world@landminefree.org by 1 day before the finals.
Regional finals will contain Field achievement, presentation in addition to the report sent before.
The top two winners in each class of the regional competition will be qualified to compete in the international competition in Madrid.
All participants will receive a participation certificates with other prizes and trophies.

International Competition (1-5 Oct 2018, Madrid):

The 2018 Minesweeper competition will take place Oct at Madrid.

Winning teams' members must finish their passports and send their copies to competition committee 1 week following the regional finals to give them the needed invitation for visas.

There will be 25% discount from any fund coming to the teams through Hadath process.

Judging:

There will be a steering committee for judging.
We will make a training for all judges before the competition.
All teams will run their robots using ROS .

Scores will be presented according following points :

For Field Judging :

1-Detection of Surface Mine | ***5 points***

2-Detection Underground Mine | ***10 points***

3-Completely Scan the field and 80% of Mines Detected (Systematic Motion) | ***30 point***

4-Wrong Detection of a Mine | ***- 5 points***

5-Passover Buried Mine without Detection | ***-10 points***

6-Touching Surface Mine | ***- 10 points***

7-Reset Time ***(-2/1min)***

For Map Judging :

1-A mine map can be presented in vector or graphical format.

2-Must be created automatically by the robot system.

3-presented to the out-field jury committee by the team representative .

4-The Team Must Show and explain Codes and mapping Algorithms .

5-The Team Must Prove That the map created automatically by the robot system

to calculate the following scores:

1-Mine Map True Positive for Surface Mines (a minefield cell contaminated by surface mine is labeled in the map as a cell with surface mine) | ***5 points***.

2-Mine Map True Positive for Buried Mines (a minefield cell contaminated by buried mine is labeled in the map as a cell with buried mine) | ***10 points***.

Presentation:

1-Teamwork/Presentation | *5 points.*

2-Overall Mechanical Design and Locomotion System | *5 points*.

3-Sensors and landmine detection mechanism | *8 points*.

4-Systems Design and Operation | *5 points*.

5-Control and Electrical System | *5 points*.

6-Mapping and Localization System | *7 points*.

7-Arena Navigation Plan | *5 points*.

8-Rough Environment and High Heat Facing | *5 points*.

9-Budget / Working Plan | *5 points*.

10-Design Evaluation | *7 points*.

MINESWEEPERS FIELD:

Minesweepers Academia

Competition Rules [Metallic Surface/ Buried Object Detection + Minefield Mapping]

Minesweepers is an international competition for humanitarian demining. Each participating team (Max. 10 members) will construct a teleoperated or an autonomous robot that should be able to search for underground and aboveground anti-personnel mines and produce automatically a map of the detected mines. The robot has to able to navigate through rough environment that mimics a real minefield.

1. Minefield

The competition environment will be an open wood area with a size of 20 x 20 m, delimited by 4 GPS coordinates. The competition area will be marked by plastic tape for visualization purposes, there will also be a virtual fence to stop the robots from going outside the competition area. There will be no mines in a stripe of 0.5 m of terrain along the borders of the competition area. Most of the arena will be covered by low grass with a few trees, some steep inclines, ditches and culverts. Some photos of the minefield are shown below.

2. The Mines

Two different kinds of artificial mines are used in this competition:

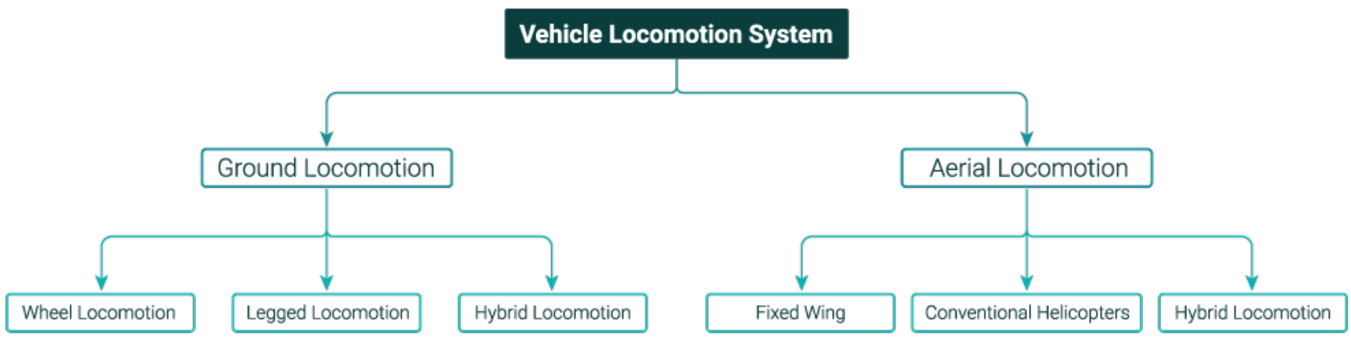
Buried Mines: These mines are made from metallic cubes, with approximate dimensions of 10x10x10 (LxWxD). These mines are completely buried underground with maximum depth 10 cm. These buried metallic cubes mimic real anti-personnel (AP) blast mines. Real AP blast mines are deliberately designed to be small (typically 6-14 cm in diameter): this makes them cheaper and easier to store, carry and deploy. AP blast mines rely on the effect of explosive blast to damage the victim, and are designed to detonate when the victim steps on them. These mines are often buried in order to camouflage their presence.

Surface Mines: These mines are made from metallic cubes, with approximate dimensions of 10x10x10 (LxWxH) and labeled in black color. These mines are visible and are located on the surface of the competition area. Any contact with them will be penalized. These black metallic cubes are used to simulate aboveground mines and unexploded ordnance (UXOs). Unexploded Ordnance is a piece of explosive ordnance or ammunition that has failed to function as intended. Although they have failed to function as intended, UXO can sometimes require only the slightest disturbance to detonate. UXOs vary greatly in size from hand grenades the size of an apple to large aircraft bombs.

Some landmines will be organized in a pattern for easier removal and accountability and others will be scattered randomly. Locations of each landmine will be known for the jury committee.

3. The Robots

Each team must use a teleoperated or an autonomous robot per game. The robot has to be made by team members. Teleoperated robot must be operated under ROS remotely from a base station located outside the minefield. Wireless controller based on ZigBee for example would be recommended to communicate the base station with the robot due to the large size of the field. In case of autonomous robots, all the actions of the robot must be completely autonomous without human intervention. Autonomous robot will be rewarded a 40% bonus over teleoperated robots. Careful attention must be paid to the robot locomotion systems as the roughness of the terrain is very high. Both unmanned ground vehicles (UGVs) and unmanned aerial vehicles (UAVs) are allowed as illustrated in the figure below.



Unmanned ground vehicles can be wheeled, legged or hybrid. Wheeled robots include but are not limited to differential drive, tricycle drive, Ackerman steering, synchro drive, omnidirectional drive, Multi-Degree-of-Freedom (MDOF) vehicles, MDOF vehicle with compliant linkage or tracked vehicles. Legged robot can be uniped, biped, tripod, pentapod, quadruped or hexapod robot. Any types of hybrid locomotion can also be used. Examples of hybrid locomotion include a vehicle equipped with tracks for fast locomotion, and legs for more difficult terrain or flippers with self-cleaning tracks or legged vehicles with driving wheels attached to the end of each leg. UAV can be an alternative for the locomotion systems. As shown in above figure, UAVs can be classified into fixed wing, conventional helicopters and multi-rotor helicopters. Fix wind UAVs are naturally stable platforms capable of long flight times and extreme range. However, they are difficult to coordinate with slower ground systems. Conventional helicopters are common collective pitch model helicopters known for their excellent maneuverability and scalability. However they suffer from high level of complexity. Quad-rotors have the ability to hover and there are naturally stable and durable. However, they have limited pay-load. Ball-bots or UAVs that can land on a roving platform are also allowed.

Robot can also be an unmanned aerial vehicle or a quad-rotor. Robot can be actuated using electric, pneumatic or hydraulic actuation system, Diesel/Petrol engine or using solar energy.

4. Sensors

Each team can select their own set of sensors for localization of mines. Although teams can install cameras on robot or install them on the sides of the field, no camera or sensors is allowed to hangover the competition area.

5. Mine Detection

When a robot detects a mine, it has to autonomously report this event using a light blinking signal and a warning siren for at least 2 seconds. Teams have to correctly position the alarm device on their robot.

6. Mine Map

Each deminer robot has to provide map of the detected mines when it's competition time slot finishes. The map represents a 19x19 meter area divided to 100x100 cm squares based on the common reference frame of the arena. The X coordinate of the map is shown by letters A to S and the Y coordinate of the map consists of numbers 1 to 19. So a position (x,y) where the mine is detected has to be reported for example by B2. This map can be simply a text file or text shown on the display of the robot. The sequence of the positions has to be the same as the detected mines. This mine map can be represented graphically or using vector format as shown in Fig. 1 and 2 respectively

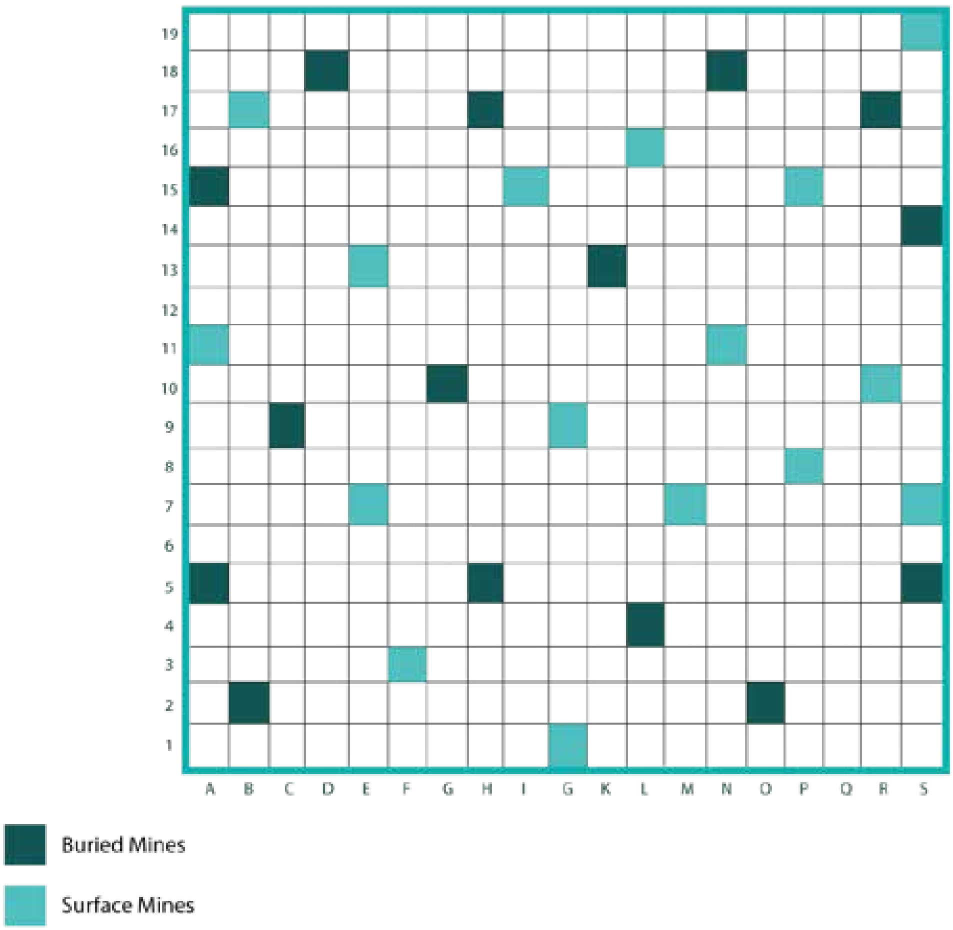


Fig. 1 Graphical Representation of the Mine Map [Dark: buried mine, Light: Surface Mine]

Buried mines found at:	
A	5
A	15
B	2
C	9
D	18
G	10
H	5
H	17
K	13
L	4
N	18
O	2
P	8
R	17
S	5
S	14

Surface mines found at:	
A	11
B	17
E	7
E	13
F	3
I	15
J	1
J	9
L	16
M	7
M	11
P	15
R	2
R	10
S	7
S	19

Fig. 2 Vector Representation of the Mine Map

Each deminer robot has to provide map of the detected mines when it's competition time slot finishes. The map represents a 19x19 meter area divided to 100x100 cm squares based on the common reference frame of the arena. The X coordinate of the map is shown by letters A to S and the Y coordinate of the map consists of numbers 1 to 19. So a position (x,y) where the mine is detected has to be reported for example by B2. This map can be simply a text file or text shown on the display of the robot. The sequence of the positions has to be the same as the detected mines. This mine map can be represented graphically or using vector format as shown in Fig. 1 and 2 respectively

7. Procedure

Each robot starts the game from one of the corners of the competition arena such as A1 (Fig. 1). Team members will bring the teleoperated or the autonomous robot to this location. Then the robot has to search the field to find buried mines or the mines scattered on surface. When the robot detects any kinds of mine it should register the location of the mine in the map and produce a light signal and siren and also report the mine location to update the mine map. All the detected mines will be removed from the field before a new team enters the arena.

Robot has to able to navigate through rough environment of the minefield and avoid obstacles. Robots must avoid surface mines else the team will be penalized.

During competitions only one of team members can attend the field. He/she can request a “Reset Time” which means he/she can stop the game and take out robot for repair or adjustment. The time spends for this repair will be included within the competition time and there would be a penalty for each resent time. The competition time allowed for each team is 20 minutes including the reset time. Jury committee will calculate the team's score and prepare the field for the next team during another 10 minutes.

The competition will end with one of the following conditions:

The dedicated time finishes,

Team dismiss the game,

Any cheating happens,

Robot touches a surface mine.

8. ROS

The main requirement to participate in this category is to build the software system of the robot using Robot Operating System (ROS). ROS is an open source platform that provides a set of software libraries and tools to help you build robot applications. It provides hardware abstraction, device drivers, libraries, visualizers, message-passing, package management, and more. Building the robot based on ROS allows you to make use of interesting software module and the high fidelity simulator developed by the participants of the different editions of Humanitarian Robotics and Automation Technology Challenge (HRATC) organized by IEEE Robotics & Automation Society – Special Interest Group on Humanitarian Technology (RAS–SIGHT). Minesweepers is also organised under the auspices of IEEE RAS SIGHT. ROS-based robots can participate in any of other four categories of the competition. Team with ROS-based robots can be awarded the prize of any of the other four categories plus a special award for this special category.
Hardware: You can build your own robot and make it ROS-enabled or you can use low-cost ROS-enabled robotic starter kits.
Software: You can write your own ROS code or you can download and use ROS Open Source Modules for Humanitarian Demining: SIGHT - Special Interest Group on Humanitarian Technology Open Repositories

ROS Tutorials:

What is ROS?
ROS (Robot Operating System) is a flexible framework for writing robot software provides libraries and tools to help software developers create robot applications. It provides hardware abstraction, device drivers, libraries, visualizers, message-passing, package management, and more. ROS is completely open source (BSD) and free for others to use, change and commercialize. It aims to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms and enable software developers to build more capable robot applications quickly and easily on a common platform.

ROS Tutorials
Video Tutorial
ROS books

Minesweepers Juniors

Competition Rules [Metallic Surface/ Buried Object Detection ONLY]

Minesweepers-Junior is an international outdoor robotic competition on humanitarian demining for primary and secondary school students. Each participating team (Max. 10 members) will construct a teleoperated or an autonomous robot that should be able to search for underground and aboveground anti-personnel mines. The robot has to able to navigate through rough environment that mimics a real minefield.

1. Minefield

The competition environment will be an open wood area with a size of 20 x 20 m, delimited by 4 GPS coordinates. The competition area will be marked by plastic tape for visualization purposes, there will also be a virtual fence to stop the robots from going outside the competition area. There will be no mines in a stripe of 0.5 m of terrain along the borders of the competition area. Most of the arena will be covered by low grass with a few trees, some steep inclines, ditches and culverts. Some photos of the minefield are shown below.

2. The Mines

Two different kinds of artificial mines are used in this competition:

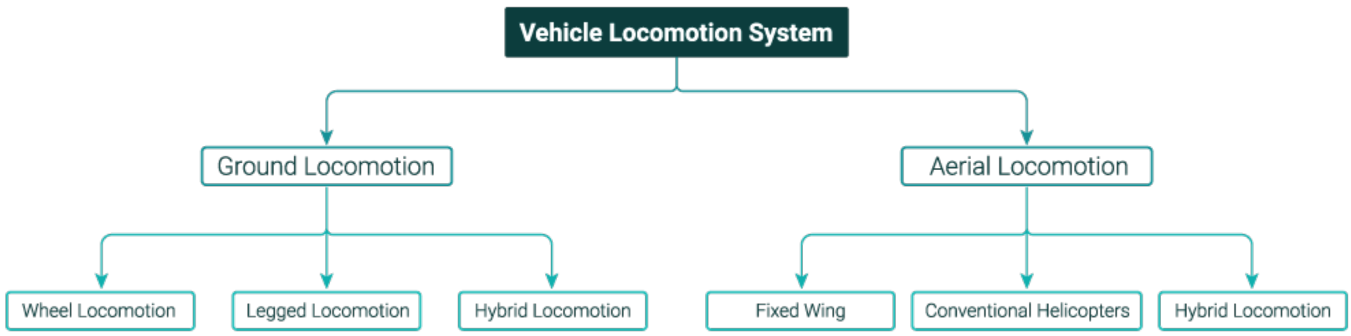
Buried Mines: These mines are made from metallic cubes, with approximate dimensions of 10x10x10 (LxWxD). These mines are completely buried underground with maximum depth 10 cm. These buried metallic cubes mimic real anti-personnel (AP) blast mines. Real AP blast mines are deliberately designed to be small (typically 6-14 cm in diameter): this makes them cheaper and easier to store, carry and deploy. AP blast mines rely on the effect of explosive blast to damage the victim, and are designed to detonate when the victim steps on them. These mines are often buried in order to camouflage their presence.

Surface Mines: These mines are made from metallic cubes, with approximate dimensions of 10x10x10 (LxWxH) and labeled in black color. These mines are visible and are located on the surface of the competition area. Any contact with them will be penalized. These black metallic cubes are used to simulate aboveground mines and unexploded ordnance (UXOs). Unexploded Ordnance is a piece of explosive ordnance or ammunition that has failed to function as intended. Although they have failed to function as intended, UXO can sometimes require only the slightest disturbance to detonate. UXOs vary greatly in size from hand grenades the size of an apple to large aircraft bombs.

Some landmines will be organized in a pattern for easier removal and accountability and others will be scattered randomly. Locations of each landmine will be known for the jury committee.

3. The Robots

Each team must use a teleoperated or an autonomous robot per game. The robot has to be made by team members. Teleoperated robot must be operated remotely from a base station located outside the mine-field. Wireless controller based on ZigBee for example would be recommended to communicate the base station with the robot due to the large size of the field. In case of autonomous robots, all the actions of the robot must be completely autonomous without human intervention. Autonomous robot will be rewarded a 40% bonus over teleoperated robots. Careful attention must be paid to the robot locomotion systems as the roughness of the terrain is very high. Both unmanned ground vehicles (UGVs) and unmanned aerial vehicles (UAVs) are allowed as illustrated in the figure below.



Unmanned ground vehicles can be wheeled, legged or hybrid. Wheeled robots include but are not limited to differential drive, tricycle drive, Ackerman steering, synchro drive, omnidirectional drive, Multi-Degree-of-Freedom (MDOF) vehicles, MDOF vehicle with compliant linkage or tracked vehicles. Legged robot can be uniped, biped, tripod, pentapod, quadruped or hexapod robot. Any types of hybrid locomotion can also be used. Examples of hybrid locomotion include a vehicle equipped with tracks for fast locomotion, and legs for more difficult terrain or flippers with self-cleaning tracks or legged vehicles with driving wheels attached to the end of each leg. UAV can be an alternative for the locomotion systems. As shown in above figure, UAVs can be classified into fixed wing, conventional helicopters and multi-rotor helicopters. Fix wind UAVs are naturally stable platforms capable of long flight times and extreme range. However, they are difficult to coordinate with slower ground systems. Conventional helicopters are common collective pitch model helicopters known for their excellent maneuverability and scalability. However they suffer from high level of complexity. Quad-rotors have the ability to hover and there are naturally stable and durable. However, they have limited pay-load. Ball-bots or UAVs that can land on a roving platform are also allowed.

Robot can also be an unmanned aerial vehicle or a quad-rotor. Robot can be actuated using electric, pneumatic or hydraulic actuation system, Diesel/Petrol engine or using solar energy.

4. Sensors

Each team can select their own set of sensors for localization of mines. Although teams can install cameras on robot or install them on the sides of the field, no camera or sensors is allowed to hangover the competition area.

5. Mine Detection

When a robot detects a mine, it has to autonomously report this event using a light blinking signal and a warning siren for at least 2 seconds. Teams have to correctly position the alarm device on their robot.

6. Procedure

Each robot starts the game from one of the corners of the competition arena. Team members will bring the teleoperated or the autonomous robot to this location. Then robot has to search the field to find buried mines or the mines scattered on surface. When the robot detects any kinds of mine it should produce a light signal and siren. All the detected mines will be removed from the field before a new team enters the arena.

Robot has to able to navigate through rough environment of the minefield and avoid obstacles. Robots must avoid surface mines else the team will be penalized. During competitions only one of team members can attend the field. He/she can request a “Reset Time” which means he/she can stop the game and take out robot for repair or adjustment. The time spends for this repair will be included within the competition time and there would be a penalty for each resent time. The competition time allowed for each team is 20 minutes including the reset time. Jury committee will calculate the team's score and prepare the field for the next team during another 10 minutes.

The competition will end with one of the following conditions:

The dedicated time finishes,

Team dismiss the game,

Any cheating happens,

Robot touches a surface mine.

Minesweepers Industry

[Metallic/Non-metallic Surface/Buried Object Detection + Imaging + Minefield Mapping]

Minesweepers-Industry is a special category of the Minesweepers: Towards a Landmine-Free World competition. Companies are invited to participate in this competition and demonstrate their state-of-the-art solutions and technologies in the area of humanitarian demining.

In this competition, each participating team will construct a teleoperated or an autonomous vehicle that should be able to search for surface and buried metallic and minimum metal objects of different dimensions and shapes that mimic the anti-personnel landmines and unexploded ordnances. The vehicle must be able to automatically produce a high-precision map of the detected objects without human intervention. The vehicle has to able to navigate through rough environment that mimics a real minefield.

1. Minefield

The competition environment will be an open wood area with a size of 20 x 20 m, delimited by 4 GPS coordinates. The competition area will be marked by plastic tape for visualization purposes, there will also be a virtual fence to stop the robots from going outside the competition area. There will be no mines in a stripe of 0.5 m of terrain along the borders of the competition area. Most of the arena will be covered by low grass with a few trees, some steep inclines, ditches and culverts. Some photos of the minefield are shown below.

2. The Mines

The competition environment will be an open wood area with a size of 20 x 20 m, delimited by 4 GPS coordinates. The competition area will be marked by plastic tape for visualization purposes, there will also be a virtual fence to stop the robots from going outside the competition area. There will be no mines in a stripe of 0.5 m of terrain along the borders of the competition area. Most of the arena will be covered by low grass with a few trees, some steep inclines, ditches and culverts. Some photos of the minefield are shown below.

The metallic objects will be made of steel while the minimum metal objects will be made of different materials such as plastic and wood. The minimum metal objects will contain few small metallic parts that real landmine's spring, striker tip, or shear wire. These objects are completely buried underground with maximum depth 10 cm. They mimic real anti-personnel (AP) blast mines. Real AP blast mines are deliberately designed to be small (typically 6-14 cm in diameter): this makes them cheaper and easier to store, carry and deploy. AP blast mines rely on the effect of explosive blast to damage the victim, and are designed to detonate when the victim steps on them. These mines are often buried in order to camouflage their presence.

Surface Mines: These objects are similar to the buried objects described and are labeled in black color to facilitate vision-based detection and localization. These objects are visible and are located on the surface of the competition area. Any contact with them will be penalized. These black objects are used to simulate aboveground mines and unexploded ordnance (UXOs). Unexploded Ordnance is a piece of explosive ordnance or ammunition that has failed to function as intended. Although they have failed to function as intended, UXO can sometimes require only the slightest disturbance to detonate. UXOs vary greatly in size from hand grenades the size of an apple to large aircraft bombs.

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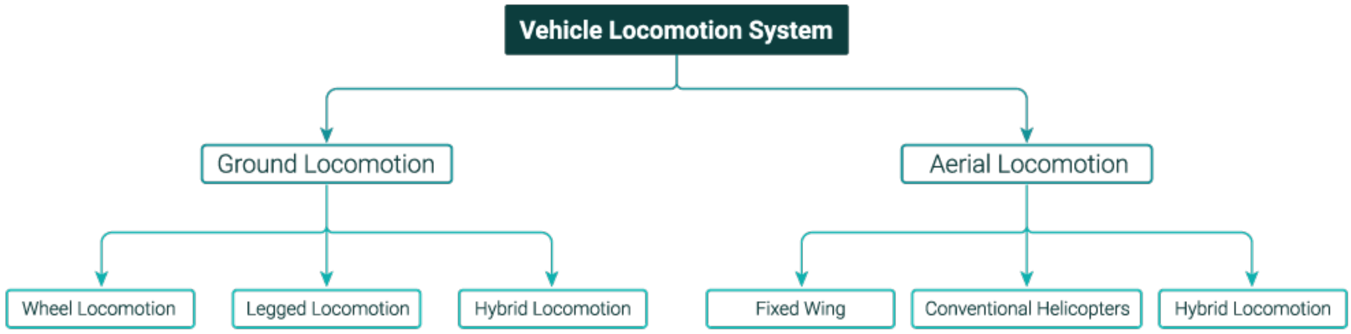

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6. Mine Map

Each deminer robot has to provide map of the detected mines when it's competition time slot finishes. The map represents a 19x19 meter area divided to 100x100 cm squares based on the common reference frame of the arena. The X coordinate of the map is shown by letters A to S and the Y coordinate of the map consists of numbers 1 to 19. So a position (x,y) where the mine is detected has to be reported for example by B2. This map can be simply a text file or text shown on the display of the robot. The sequence of the positions has to be the same as the detected mines. This mine map can be represented graphically or using vector format as shown in Fig. 1 and 2 respectively

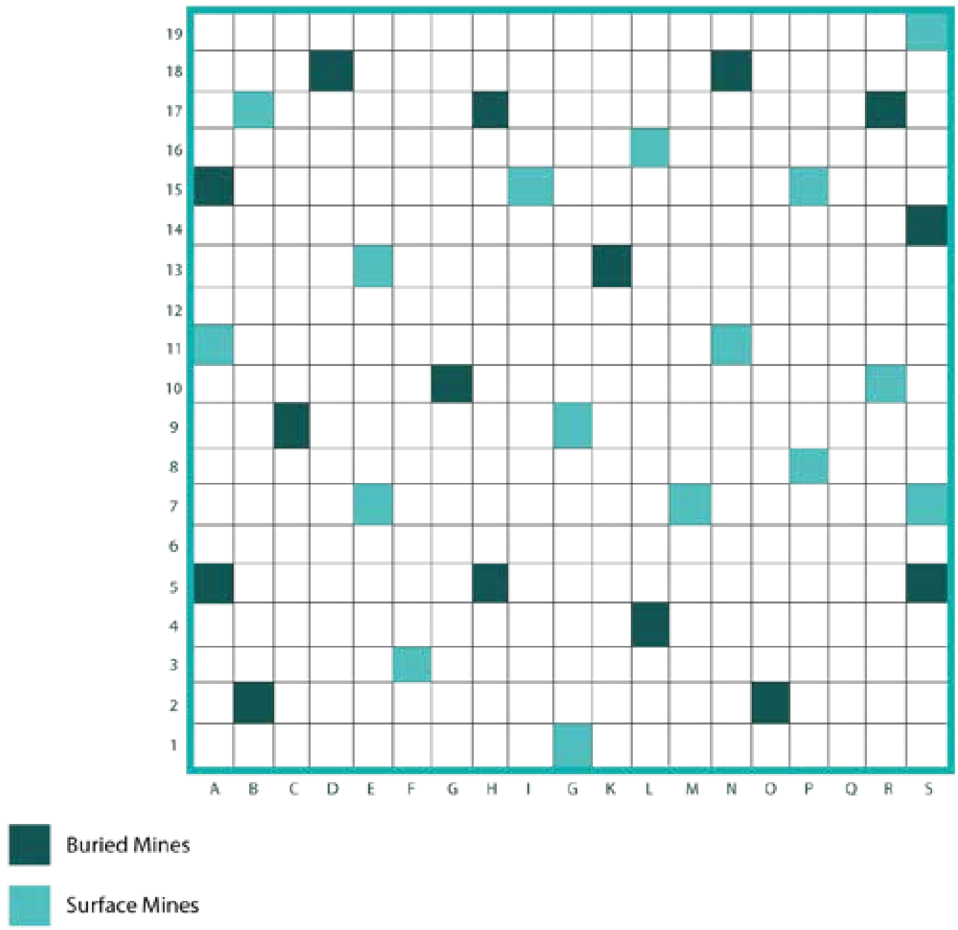

Fig. 1 Graphical Representation of the Mine Map [Dark: buried mine, Light: Surface Mine]

Buried mines found at:	
A	5
A	15
B	2
C	9
D	18
G	10
H	5
H	17
K	13
L	4
N	18
O	2
P	8
R	17
S	5
S	14

Surface mines found at:	
A	11
B	17
E	7
E	13
F	3
I	15
J	1
J	9
L	16
M	7
M	11
P	15
R	2
R	10
S	7
S	19

Fig. 2 Vector Representation of the Mine Map

The scoring points will be calculated from the map. If the map is not created automatically by the robot without operator intervention and submitted to the jury committee, the judge won't be able to complete the scoring sheet. There will be two judges: one in the arena and one outside. The judge in the field will take care of observing the touching with the surface mines and control the time and the resets. But the judge outside the arena will calculate the points based on the provided map taking into consideration the observations of the in-field judge in terms of number of touches and time. If no map is provided (in raw or graphic format as shown below), no points will be obtained.

7. Procedure

Each robot starts the game from one of the corners of the competition arena such as A1 (Fig. 1). Team members will bring the teleoperated or the autonomous robot to this location. Then the robot has to search the field to find buried mines or the mines scattered on surface. When the robot detects any kinds of mine it should register the location of the mine in the map and produce a light signal and siren and also report the mine location to update the mine map. All the detected mines will be removed from the field before a new team enters the arena.

Robot has to able to navigate through rough environment of the minefield and avoid obstacles. Robots must avoid surface mines else the team will be penalized.

During competitions only one of team members can attend the field. He/she can request a “Reset Time” which means he/she can stop the game and take out robot for repair or adjustment. The time spends for this repair will be included within the competition time and there would be a penalty for each resent time.

The competition time allowed for each team is 20 minutes including the reset time. Jury committee will calculate the team's score and prepare the field for the next team during another 10 minutes.

The competition will end with one of the following conditions:

The dedicated time finishes,

Team dismiss the game,

Any cheating happens,

Robot touches a surface mine.

Extra bonus!

By using following robot systems you will get 20% extra score :

1. Robot operating system (ROS).
2. Multi robot system
3. Autonomous robotic system

8. ROS

The main requirement to participate in this category is to build the software system of the robot using Robot Operating System (ROS). ROS is an open source platform that provides a set of software libraries and tools to help you build robot applications. It provides hardware abstraction, device drivers, libraries, visualizers, message-passing, package management, and more. Building the robot based on ROS allows you to make use of interesting software module and the high fidelity simulator developed by the participants of the different editions of Humanitarian Robotics and Automation Technology Challenge (HRATC) organized by IEEE Robotics & Automation Society – Special Interest Group on Humanitarian Technology (RAS–SIGHT). Minesweepers is also organised under the auspices of IEEE RAS SIGHT. ROS-based robots can participate in any of other four categories of the competition. Team with ROS-based robots can be awarded the prize of any of the other four categories plus a special award for this special category.
Hardware: You can build your own robot and make it ROS-enabled or you can use low-cost ROS-enabled robotic starter kits.
Software: You can write your own ROS code or you can download and use ROS Open Source Modules for Humanitarian Demining: SIGHT - Special Interest Group on Humanitarian Technology Open Repositories

ROS Tutorials:

What is ROS?
ROS (Robot Operating System) is a flexible framework for writing robot software provides libraries and tools to help software developers create robot applications. It provides hardware abstraction, device drivers, libraries, visualizers, message-passing, package management, and more. ROS is completely open source (BSD) and free for others to use, change and commercialize. It aims to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms and enable software developers to build more capable robot applications quickly and easily on a common platform.

ROS Tutorials
Video Tutorial
ROS books

9. Multi-Robot Systems (MRS)

Multi-robot systems (MRS) are a group of robots that are designed aiming to perform some collective behavior. By this collective behavior, some goals that are impossible for a single robot to achieve become feasible and attainable. There are various foreseen benefits of MRS compared to single robot systems. These benefits include, but are not limited to the following [Khamis 2014]:

Resolving task complexity: some tasks may be quite complex for a single robot to do or even it might be impossible. This complexity may be also due to the distributed nature of the tasks and/or the diversity of the tasks in terms of different requirements. Examples of these tasks include reconnaissance, surveillance, search and rescue.

Increasing the performance: performance measures are application-dependent. However, and as an example, task completion time can be dramatically decreased if many robots cooperate to do the tasks in parallel. Spatial and/or temporal area/object coverage can be improved using multiple robots. Moreover, in some applications, these robots can cooperate to establish ad hoc communication relay network to improve radio coverage.

Increasing reliability: increasing the system reliability through redundancy because having only one robot may work as a bottleneck for the whole system especially in critical times. But when having multiple robots doing a task and one fails, others could still do the job.
Simplicity in design: having small, simple robots will be easier and cheaper to implement than having only single powerful complex robot.

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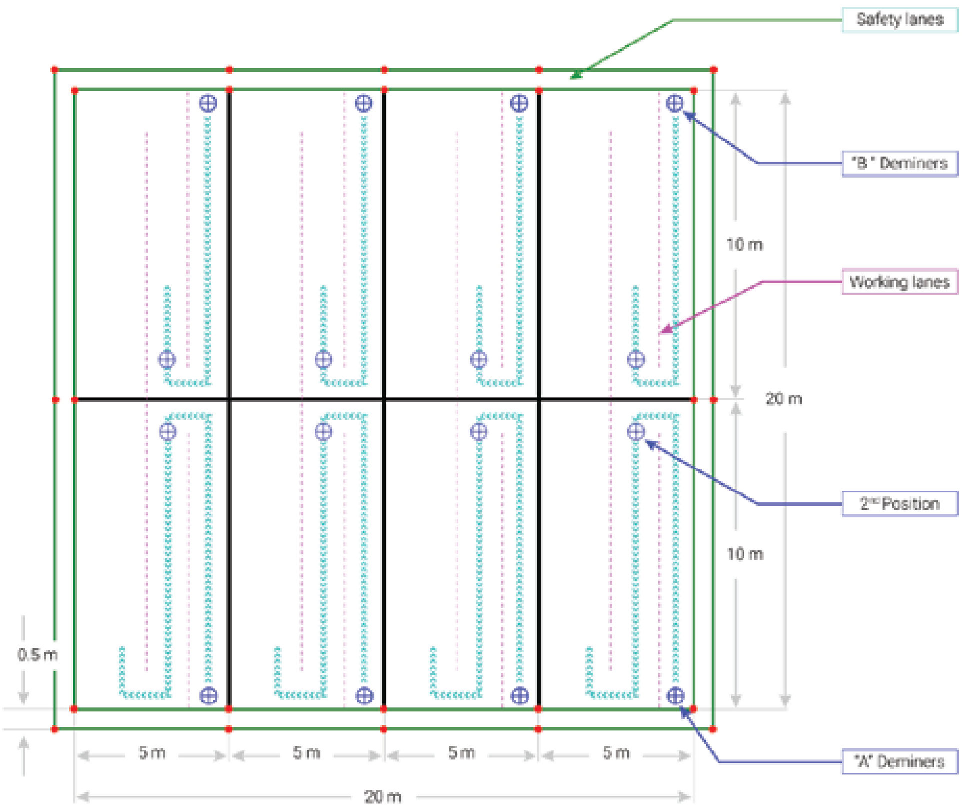
MRS can play a crucial role in humanitarian demining. According to the Standard Operating Procedures (SOPs) for humanitarian demining, human deminers use metal detectors to identify targets, which are then flagged for subsequent digging by a supervisor. The objective of this category is to mimic the conventional mag-and-flag approach or SOP using multiple unmanned teleoperated and autonomous vehicles. The arena of the competition is shown in the following figure. Teleoperated vehicles play the role of human deminers while an autonomous vehicle is used to mimic the supervisor/team leader's role. The team leader has to be equipped with a gripper or a marking mechanism to mark the location of the landmine detected by the deminers. More than one deminer can be integrated into the team but only one supervisor or team leader is allowed.



If two deminers are used, these unmanned vehicles "A" and "B" are assigned to each lane as shown in the figure. Vehicle "B" starts to work after vehicle "A". If a deminer detected a surface-laid or a buried mine in its assigned lane, it has to produce a warning siren for at least 2 seconds and inform the team leader about the position of the detected mine. All the deminers have to stop and wait while the autonomous vehicle (the team leader) comes forward marks the detected mines with a red mark or flag and the scanning procedure continues until all the arena is scanned.

General rules for scoring are as following.

But the exact scores will be decided during the competition.

10 Positive score for detecting every buried metallic mine by the deminers,

5 Positive score for detecting every surface metallic mine by the deminers,

30 Positive score for complete surf of field if 80% of mines are detected correctly by the robot team,

5 Negative score for wrong detection by the deminers,

10 Negative score for passing over a buried mine without detecting it by the deminers.

5 Negative score for touching a surface mine by the deminers.

3 Negative score failure in producing a light signal and/or a siren by the deminers for a detected mine.

5 Negative score per deminer for failure of pausing the movement of the deminer after detecting the landmine and failure in waiting the supervisor.

10 Negative score for failure of correct marking by the supervisor.

2 Negative score for every minute reset time.

10. Scoring sheet

Action	Count	Score / Unit	Subtotal
Arena Score: The following score will be based on the performance of the robot in the competition arena and will be observed and calculated by the in-field judge.			
Detected Surface Mines		5	
Detected Underground Mines		10	
Completely Scan the field and 80% of Mines Detected (Systematic Motion)	Yes No	30 0	
Wrong Detection of a Mine		-5	
Passover Buried Mine without Detection		-10	
Touching Surface Mine		-5	
No light signal and/or a siren	Yes No	-3 0	
Reset Time (-2/1min)		-2	
Mine Map Score: A mine map (in vector or graphical format) must be created automatically by the robot system and presented to the out-field jury committee by the team representative to calculate the following scores:			
Mine Map True Positive for Surface Mines (a minefield cell contaminated by surface mine is labeled in the map as a cell with surface mine)		5	

Mine Map True Positive for Buried Mines (a minefield cell contaminated by buried mine is labeled in the map as a cell with buried mine)		10	
Mine Map False Negative for Surface or Buried Mines (a minefield cell contaminated by surface or buried mine is labeled in the map as a clean cell)		-5	
Mine Map False Positive for Surface or Buried Mines (a clean cell in the minefield is labeled as contaminated by surface or buried mine is the mine map)		-5	
Total Score:			
Autonomous Robot	YES (Multiply by 1.2)		No
Running Using ROS	YES (Multiply by 1.2)		No
Multi Robot System	YES (Multiply by 1.2)		No
Final Score:			

Thank You