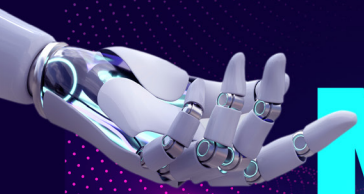
ESIGELEC
SCHOOL OF ENGINEERING
SMART AND CONNECTED SYSTEMS

Muthoot
Institute of Technology & Science

ESIGELEC, France & MITS, India
present



MAKE YOUR ROBOT TICK!

A Robotics Competition

Rulebook

github.com/romainrossi/make_your_robot_tick_2024

www.en.esigelec.fr | www.mgmits.ac.in

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1. CONTEXTE & OBJECTIVE

1.1 Organiser: ESIGELEC

ESIGELEC, a premier French Graduate School of Engineering (Grande École), founded in 1901, with a long history in education and research and significant expertise in Smart Embedded and Connected systems, is situated in Rouen, approximately an hour and half away from Paris, by train. ESIGELEC is fully recognized by the French Ministry of Higher Education and Research. With a personnel and student strength of 2100, including 1700 students and 400 teaching, administrative and support staff, the ESIGELEC group is actively involved in academic training, research, innovation and transfer of technology.

Through its programs across the spectrum – the flagship Diplôme d'ingénieur (the French engineering program), the Masters programs taught entirely in English and PhD programs, the school trains engineers in the following areas: Test and quality software development, Artificial intelligence and big data, Network and IOT cybersecurity, Big data for digital transformation, Business engineering: IT and networks, Digital services engineering, Finance engineering, Digitalisation, automation, robotics and artificial intelligence, Energy and sustainable development, Electronics and transport engineering, Business engineering: energy and signal distribution, Mechatronics and electronics, Embedded systems engineering: autonomous vehicle, Embedded systems engineering: communicating objects, Medical systems engineering, Electronic systems for automobiles and aeronautics, Telecom engineering.

85 partners spread over 40 countries, joint-preparatory cycles offered in 3 African countries and in Sri Lanka, over 50 visiting professors, representative offices in China and in India and more than 35% of its students coming from across the globe, make ESIGELEC one of the most active French graduate schools internationally.

ESIGELEC has an impressive corporate network of over 3000 industrial partners, who offer our students internship and job opportunities. They are also actively involved in teaching, apart from being an integral part of our study and scientific boards. Several seminars, greatly appreciated by our students, are offered throughout the year by industry representatives.

ESIGELEC prides itself in its Institute of Research in Electronic and Embedded Systems (IRSEEM) with a focus on Electronics, Automation, Computer Science/Instrumentation, and Systems. IRSEEM conducts high-end applied research in the automobile, aeronautics and electronics domains.

ESIGELEC Rouen
INGÉNIEUR.E.S GÉNÉRALISTES
SYSTÈMES INTELLIGENTS ET CONNECTÉS

1.2 Host Institute: Muthoot Institute Of Technology and Science

Muthoot Institute of Technology and Science (MITS) is promoted by Muthoot M. George Institute of Technology, a Section 25 Company within the Muthoot Group. The Muthoot Group, with a reputation that has been shaped over decades with high quality practices, total customer satisfaction and steady growth, spanning 130 years in the field of business, is a legacy built on God-given values of trust, truth, transparency and tradition and has become one of the top business houses today by the grace of God.

MITS is a self-financing technical institution offering postgraduate and undergraduate engineering programs, situated in the industrial suburb of Kochi, close to the Smart City and Info Park, approximately 15 kms from Vytilla Junction towards Muvattupuzha on the Kochi Madurai National Highway.

The Institute is approved by All India Council for Technical Education (AICTE) and affiliated to APJ Abdul Kalam Technological University (KTU). MITS is NBA accredited in five programs namely Mechanical Engineering (ME), Electrical and Electronics Engineering (EEE), Electronics and Communication Engineering (ECE), Computer Science and Engineering and Civil Engineering. Additionally the Institute also runs Master Programs in Computer Application, Master of Technology in Cyber Security (CS) and Artificial Intelligence and Data Science (AI-DS).

Muthoot Institute of Technology and Science, Kochi, Kerala is ranked as one of the top Institutes in the state of Kerala with consistent performance and results. It stands number One among all private engineering colleges in the state under APJKTU with over 503 placements with top companies like TCS, Cognizant, Infosys, Wipro, Deloitte, Accenture, IBM, Capgemini, SOTI, Cadence to name a few.

MITS strives to be the centre of excellence for learning and research in engineering and technology, producing intellectually stimulated skilled professionals who are socially responsible and committed to performance possessing an ethical value system. CIDRE, The Research Centre at MITS, in order to achieve its objectives has four sub centres, Centre for Sustainable Innovation,Centre for Entrepreneurship Incubation, Centre for IC&SR (Industrial Consultancy & Sponsored Research) and A TinkerLab for developing creative innovative Ideas.

Muthoot Global Center for Education and Research (MGCER) in association with ESIGELEC has been offering two successful MSc. programs in Automotive Embedded Systems (AES) and Connected Intelligent Embedded Systems (CIES) since 2019. Approximately 50 students have successfully graduated and are working in Schengen countries and India.

Muthoot
Institute of Technology & Science

1.3 Objective & a quick glance

MAKE YOUR ROBOT TICK, organised by ESIGELEC, a premier French Graduate School of Engineering & MITS, a premier engineering college in India, aims to showcase French expertise in technology, French higher education and a very successful Franco-Indian cooperation!

Participants will be required to design, develop and make a robot capable of **collecting energy** from various **sources** and delivering it to a **storage** facility, to score points. The team whose robot collects the maximum energy within the prescribed time will be declared the winner.

Registrations will open between November **15th 2023 and 10th December 2023**. The final competition will be conducted in **May 2024** (exact dates will be communicated to the finalists at a later date).

Eligibility and general rules:

- The competition is open to full time engineering students who are currently studying at the Bachelor's (Under Graduate) level in universities/ colleges in India, Sri Lanka, Bangladesh and Nepal.
- Each team will have four members. All team members must be students of the pre-final or final year of a Bachelor's program in engineering.
- All members of a team must belong to the same college/institution. However team members may belong to different years of study.
- Each student can join only one team.
- All teams will designate one member as the team leader, who will be responsible for all communication with ESIGELEC & MITS.
- Each team member will register with only one email ID.
- Teams will NOT BE PERMITTED to change/replace any team member(s). Teams once registered, will remain unchanged till the end of the competition.
- Failure to comply with any of the rules, terms and conditions of the competition may result in disqualification of the team.
- All participants (implicitly) consent to allow their names and photographs to be used for promotional purposes by ESIGELEC & MITS, during and after the competition.
- ESIGELEC holds intellectual property rights for all materials submitted by the participating teams for the competition.
- ESIGELEC AND/OR MITS will not be responsible for any competition-related material lost in transit.

- All material submitted must be the team's original work. Any kind of plagiarism is strictly prohibited and will lead to disqualification of a team.
- Teams must provide proper citation for the source of any idea or words taken from anyone else and provide references for the material used in their work.
- All competition related decisions, including the results at the various stages of the competition, will be made at the sole discretion of ESIGELEC & MITS. No appeals will be entertained.
- ESIGELEC & MITS reserve the right to modify or amend the prizes, rules, terms and conditions of the competition at any time.
- Teams who are selected for the final at MITS, India, will make their own arrangements to reach the venue. MITS, shall arrange for the stay and food for two nights and three days (arrival on the day prior to the final round of the competition and departure on the next day).

1.1.1 Technical Specifications

Each team will submit a technical specifications document to the Organising Committee of MAKE MY ROBOT TICK. The format and deadlines will be explained to the 12 teams that will participate in the finals, at MITS, India.

This document must provide the overview of the project with a focus on:

- General information
- Team information
- Technical specifications:
    - Strategy
    - Technical choices
    - Hardware architecture and schematics
    - Algorithms

Note: This document must be submitted to the organising committee at least one month prior to the competition.

2. COMPETITION PLATFORM

2.1 Overview

The competition platform is a flat, rectangular surface of approximately 2.44m x 1.22 m, with all four sides bordered with plates 20cm in height (Fig. 1). The surface and the borders are white in colour.

The platform comprises:

- 4 **Energy sources** (charging station):
  - 3 fixed sources:
    - 2 **Regular sources** (Blue)
    - 1 **Fast source** (white), located behind a wall with two gates (one closed, one open). The position of the open gate is chosen randomly, at the beginning of each match
  - 1 **Medium source** (yellow): the position is allotted from among 36 possibilities, by a draw of lots, at the beginning of each match.
  - 0 to 4 **Energy Drains** (Red): These are "fake" sources and they drain energy if the robots connect to them.
- The **Energy Storage Station** consists of an energy counter placed in the centre of the competition platform and a display showing the energy score.

Figure 1 shows the entire competition platform.

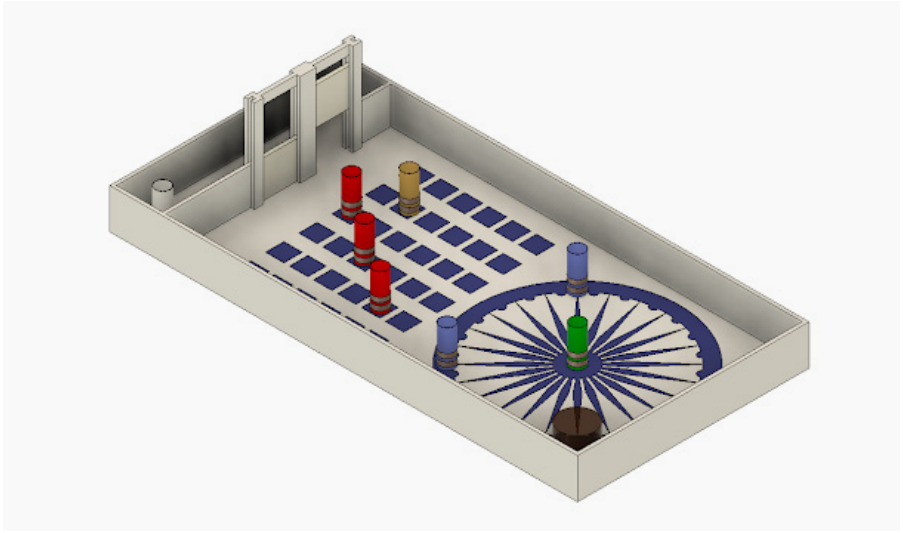
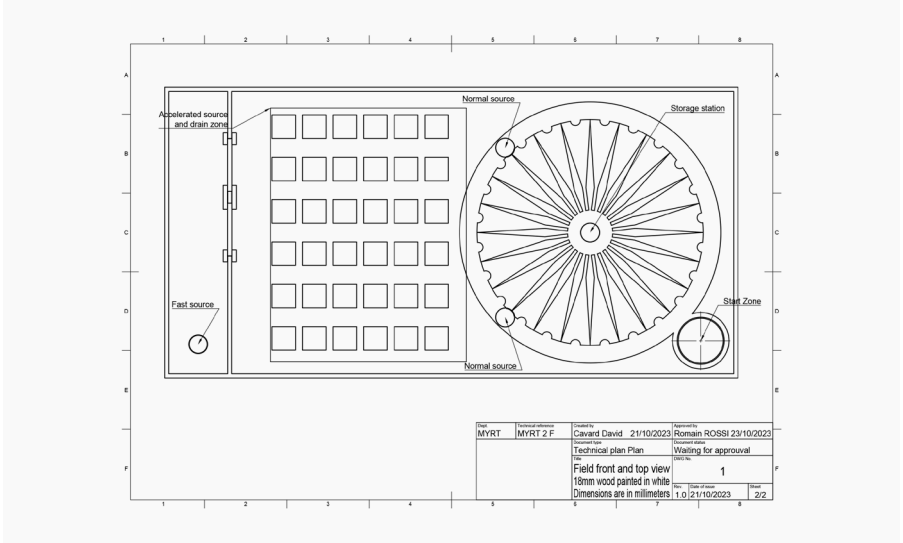


Figure 1
View of the competition platform.

2.2 Architecture of the Competition Platform

Figure 2 illustrates the overall architecture of the competition platform and indicates the surface of the platform, the position of the charging stations and the Energy Storage Station.



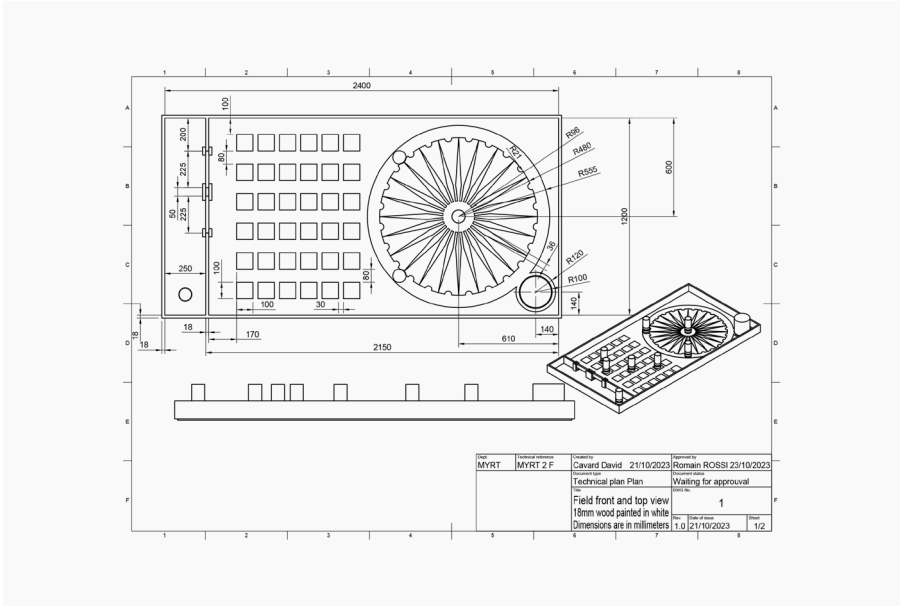


Figure 2
Platform dimensions.

The platform dimensions have a tolerance of +- 10mm.

2.2.1 Platform Surface

The competition platform has a white surface with blue patterns.

2.2.2 Platform Surface

The competition platform has four energy sources:

- 2 regular
- 1 accelerated
- 1 fast

And 0 to 4 energy drains.

The Sources and Drains have identical size and shape, and differ only by colours.

The two Regular Sources and the Fast Source have a fixed position on the competition platform (see position on the platform drawings).

The Medium Source and the Energy Drains are randomly positioned by the referees, at the beginning of each match, by drawing lots. The procedure is as follows: the referee rolls one dice twice, giving the position (first X, and then Y) of the Medium source on the chequered part of the platform. The same procedure is used to place each of the Energy Drains.

The number of drains will vary according to the stage of the competition and the degree of difficulty will increase as the competition progresses.

Competition stage	Number of drains
Qualification / Review	0
Round of 16	1
Quarter finals	2
Semi-finals	3
Finals	4

Figure 3 illustrates the energy sources / energy drains, physical properties and the height of the two electrodes to connect the robot.

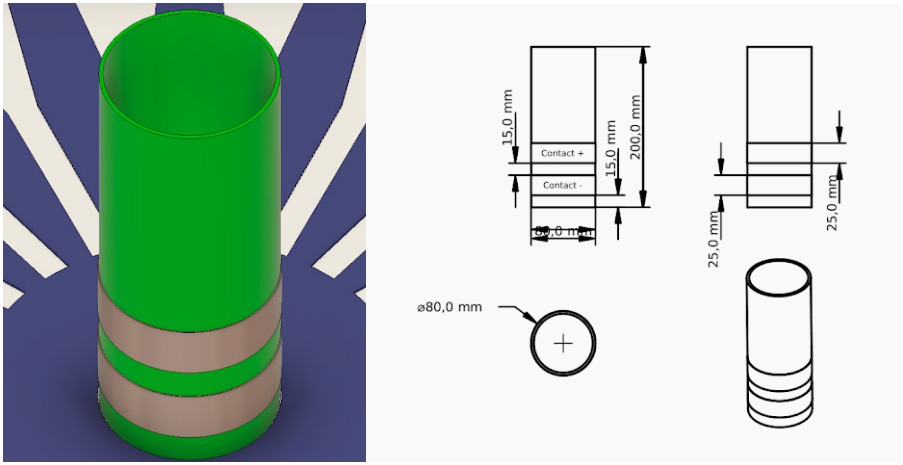


Figure 3
Mechanism and 3D view of energy sources.

Figure 4 shows the location of the energy sources on the competition platform.

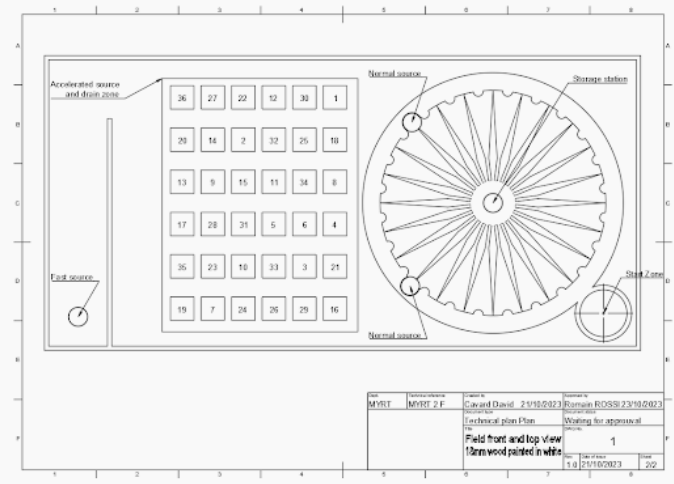


Figure 4
Positions of the Energy Sources and the Energy Storage Station.

During the competition, the Energy Sources are activated and deactivated successively as in figure 5. Energy drains however, remain activated throughout.

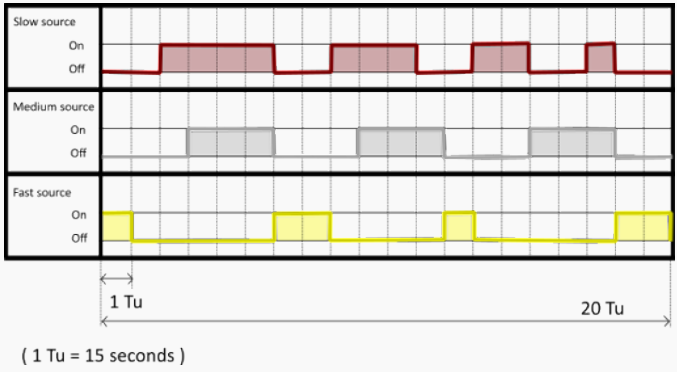


Figure 5
Activation of energy sources.

2.2.3 Energy Storage Station

The Energy Storage Station is in the centre of the wheel. The mobile robot must connect to this facility and inject all the energy that it will have collected from different Energy Sources. The energy delivered by the robot is measured by a meter and will determine the points won by the teams.

2.2.3.1 Gates

The access to the Fast Source is protected by a wall with two gates. One of the gates will be randomly chosen and opened by the referee, at the beginning of each match.

2.2.3.2 Energy Meter

The Energy Storage Station is built with an Arduino card and a display. This system will manage the following:

- Triggering the charging station (On/Off according to the figure 5)
- Measuring the energy delivered by the robot
- Displaying the energy collected

2.2.4 Mobile Robot Starting Area

The starting area of the mobile robot is clearly indicated on the surface of the platform, as shown in Figure 6. This starting area is in the bottom right corner of the field. All robots must start from this area.

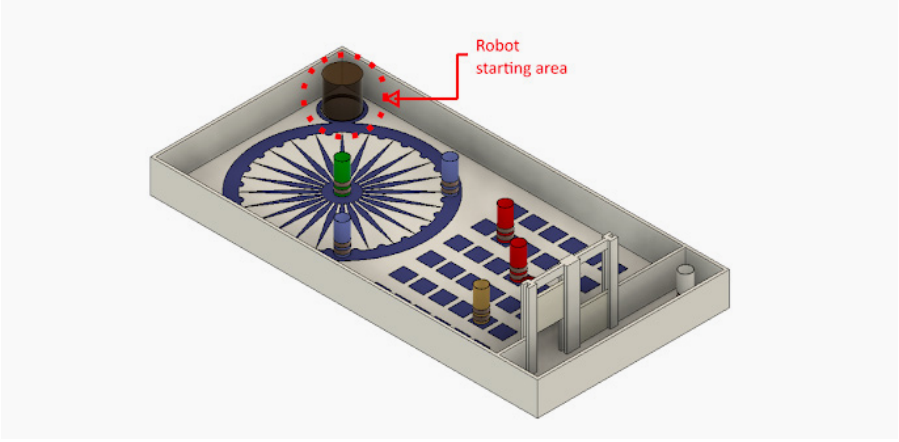


Figure 6
Starting area of the robot on the competition platform.

3. THE ROBOTS

3.1 General Information

Each team has to design, build and program an autonomous mobile robot, in keeping with the following specifications.

- A team must have only one robot during the whole competition. Extra parts may be used only to repair the robot.
- The robot must comply with ALL the following specifications, throughout each match. If a robot does not comply with the specifications, the team will be disqualified and all their subsequent matches declared lost.
- The mobile robot must be fully autonomous and self-contained, all components of the robot must be properly attached to the robot and none of them must come off during the match.
- Any form of remote control or offloading of the computing power is strictly forbidden.
- The use of embedded radio communication systems (including, but not limited to, Bluetooth, Wi-Fi...) is strictly forbidden.
- Light-based communication (IR, Visual coding, Lifi...), sound-based communication (Ultrasound, speech recognition) are also strictly forbidden.

In the event that the jury has a doubt about the purposes for the use of an electronic device in the robot, or is doubtful of any form of remote communication, the team will be allowed to remove this device and submit their robot for review again. If the jury remains unconvinced, the team will be disqualified.

3.2 Mechanical constraints

3.2.1 Maximum Dimensions

The robot must have an external perimeter of less than 90 cm, measured at the largest external perimeter of the system.

The robot must have a maximum height of less than 20 cm, measured from a surface supporting the robot to the topmost part of the robot.

These specifications will remain valid throughout the match. If the robot changes its geometry during the match, it must comply with these specifications at all times, even during an action.

3.3 Architecture

The mobile robot, designed and built by the teams, will comprise multiple subsystems: a mobile base, an embedded controller, sensors, power supply and an energy harvesting system.

Each subsystem in turn, must comply with the specifications explained here below.

3.3.1 Mobile base

- The robot can use any kind of surface transportation system (wheels, tracks, omniwheels, legs, etc.) in any kind of arrangement (two wheels, ten legs…).
- The robot must not elevate above the field surface at any time, at least one part of the robot must stay in contact with the field at all times, therefore, no jumping or flying is allowed.
- The speed of travel of the robot must be limited, to ensure safety in case of uncontrolled behaviour. While no strict limit is prescribed, at team whose robot seems to pose a safety risk because of a high speed, will be asked to limit the speed by the jury. The maximum attainable speed must be demonstrated during the review of the robot.

3.3.2 Embedded computer / processor / microcontroller

There are no restrictions with regard to the choice of embedded processor. However, the use of any form of remote control is not allowed. All data processing must be embedded in the robot. No form of data processing offloading (cloud computing, remote laptop with Wi-Fi …) is allowed.

3.3.3 Power Supply

The robot can use any kind of power supply: dry cell, rechargeable batteries of any chemistry. The power supply must be embedded and must be safe to use.

The maximum voltage across any two points in the robot electrical circuit must remain strictly below 48V at all times.

3.3.4 Energy Harvesting System

The system must collect energy supplied at Energy Sources and deliver it at the Energy Storage Station. The total quantity of energy delivered at the Energy Storage Station will be calculated. The final score in the competition will be calculated from this quantity of energy.

The Energy Harvesting System designed by the teams must be completely independent from the power-supply used for the robot's other subsystems. This system can use any energy storage device, but it is advised to use a form of condenser or super-condenser (see note below).

The Energy Harvesting System must not have any electrical connection with the robot's main power supply. The energy delivered to the Energy Storage Station must come only from the Energy Sources.

Note: The energy harvesting system must be completely empty at the start of each match. This will be verified by the referee using a voltmeter. The energy harvesting system must accept to be short-circuited (this can be performed by the referee to ensure the energy harvesting system is empty). The use of rechargeable batteries is discouraged, as an incident of short-circuit can damage them.

3.4 Security Requirements

3.4.1 Structure of Robot

The robots must not have pointed edges that may cause damage or prove dangerous. All chemical products, pyrotechnics or aerosols are strictly prohibited.

3.4.2 Risk of Electrocution

The embedded voltage must not be greater 48V between any two points in the circuit, throughout the competition.

3.4.3 Emergency Button

For security reasons, all robots must have an emergency button, in red that is easily accessible to the referee. This button must be located on top of the robot. The referee can press this button in case of a major issue and thereby stop the match. If the referee presses this button the robot must come to a halt instantly and disable any moving parts.

The organising committee reserves the right to reject any system it deems dangerous.

4. RULES FOR THE FINAL ROUND OF THE COMPETITION

4.1 Review of Robots

- A review of each robot will be conducted, to ensure that they adhere to the specifications highlighted in the rules (dimensions, security, etc.). Once reviewed and approved, the robots can be used for the competition.
- Failure to comply with any of the rules, terms and conditions of the competition may result in disqualification of a robot or a team. The referee can, at his / her discretion, grant a second review of a disqualified robot or team.
- Once a robot is approved after review, the team is not allowed to make any significant change to it before a match. If the team needs to perform a modification on the robot, a fresh review by the referee must be requested by the team, before the next match.
- A robot will not be allowed to compete in a match before a successful review.

4.2 The Match

The main objective of the robot is to collect energy from various charging stations and to store it in the Energy Storage Station, avoiding the Energy Drains. The robot that delivers the maximum amount of energy will be declared the winner.

4.2.1 Before The Start of The Match

The following points will be verified before the start of the match:

1. The team places the robot at the starting area
2. The referee ensures that the energy collection system is empty
3. The referee resets the energy meter
4. The referee will draw lots to:
    - Decide the location of the medium charging station first and then the drains (if a location is already used, the next position will be retained).
    - Decide which of the two doors will be opened
5. The referee places the medium charging station and the drains
6. The referee flags off the match
7. The team activates the robot by pressing the start button

4.2.2 During The Match

The robot must remain autonomous throughout the competition. The teams cannot intervene at any stage or touch the robot without permission from the referee.

1. The robot must connect to the charging station to collect the energy and deliver it to the Energy Storage Station. Several trips may be necessary between the recharge terminals and the storage facility, to increase the score.

2. At the end of the competition (of a duration of 5 min), the robot must come to a halt on its own. In case the robot does not come to a halt, the referee will press the emergency button.

4.2.3 After the Match

After the match, the following must be ensured:

1. The referee must write down the score obtained on the meter.
2. Once the score is noted, the teams may appeal but this appeal must be made immediately after the referee announces the score. If the referee accepts the appeal, the corrected score will be noted.
3. The team leader then signs the match sheet.

4.3 Qualifying Round

During the qualifying phase, teams that have been authorised can participate in the two qualifying rounds of the competition. A ranking will be maintained on the basis of points scored (the total of the two scores) to determine the teams that will qualify for the final round. Teams that tie, will be required to participate in a third elimination round and the score obtained in this elimination round will be used to decide the team that will go through to the final round.

4.4 The Final Round

At the end of the qualification round, the first eight teams make up the final competition round. This is done on three steps:

- Round 1 : 12 teams
- Quarter finals : 8 teams
- Semi-finals : 4 teams
- Finals : 2 teams

A separate round will also be conducted for the 3rd and 4th places. Figure 10 illustrates the different stages of the match.

Figure 8
Final stage competition table.

5. MATCH SCORE

5.1 Points

Below are the means to obtain points during the match:

1. Energy score: the quantity of energy delivered to the Energy Storage Station (Maximum 100 points).
2. Number of connections to the charging stations (two or more successive connections to the same Energy Source is only counted once):

    - Regular: 5 points
    - Medium: 10 points
    - Fast: 25 points
    - Energy Storage Station: 10 points

3. Leaving the starting area: 5 points.

A connection to the Energy Drains does not fetch points, and will drain energy from the Energy Harvesting System.

5.2 Penalties

The penalties will be as follows:

- The robot must stop automatically at the end of the match time, if not the referee will stop the robot via the emergency stop button and a penalty of 10 points will be applied.
- External intervention during the match: no external intervention will be allowed during the match. In the case of any external intervention, the team will receive a penalty of 25 points each time.
- The referee can award penalties for bad conduct of the team.

6. CONCLUSION

This preliminary document provides the technical specifications of the competition, including the architecture of the platform, the mobile robot and the rules of the competition. An evaluation system based on three criteria has also been explained.

Post the elimination round to be conducted online, on December 16th 2023, an updated, final version of this document, with precise information on all aspects of the competition, will be made available to the twelve successful teams, who will compete in the finals in May 2024.

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Make Your Robot Tick!

1st Prize
₹ 2,00,000
max 4 members
per team

2nd Prize
₹ 1,00,000
max 4 members
per team

3rd Prize
₹ 20,000
max 4 members
per team

github.com/romainrossi/make_your_robot_tick_2024

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