KFUPM

ROBONEXUS

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RoboNexus Capture the Flag Guidelines

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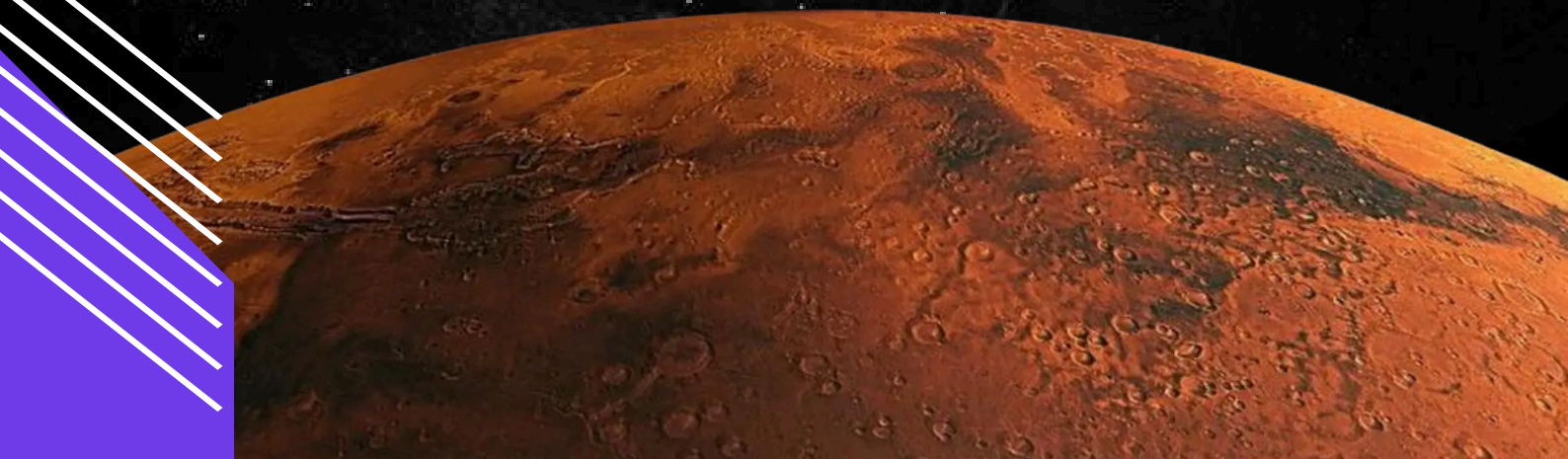

1. Overview and Objectives:

The Capture the Flag challenge features two alliances, each consisting of **two robots**, competing to collect flags from around the field and bring them back to their own flag zone. At the start of every match, **five flags** are placed across the field in fixed positions, encouraging strategic movement, route planning, and active competition for control. Each match begins with a **45-second autonomous period**, during which robots must operate without human input. Once this phase ends, human drivers assume control for the remainder of the match.

Throughout the match, robots may:

- Collect neutral flags from the field
- Capture flags by placing them in their alliance's flag zone
- Steal flags from the opponent's flag zone
- Defend their own zone from opposing robots
- Reclaim flags that were previously captured or stolen.

The objective of each match is for an alliance to secure as many flags as possible before time expires. During autonomous mode, robots attempt to reach and secure nearby flags without driver assistance. Once drivers take control, alliances focus on transporting flags to their own flag zone while also preventing opponents from doing the same.

2. System Requirements:

Option 1 – DJI RoboMaster EP (Advanced Ready-to-Use Platform)

System Requirements:

1. **Base Robot:**
   - DJI RoboMaster EP
2. **Power & Control**:
   - Built-in battery and safety system
   - Controlled via DJI EP App or Python SDK
3. **Movement:**
   - 4 Mecanum wheels for omni-directional control (optional)
   - Speed and movement are controlled via software
4. **Sensors:**
   - Built-in vision module + depth camera
   - Supports object recognition and AprilTag detection
5. **Flag Pickup System**:
   - Attach a small controllable electromagnet or gripper to the arm
6. **Control Modes:**
   - Manual control via app or joystick
7. **Programming:**
   - Python or Blocks using the Robomaster app

Option 2 – Built by user (General System Requirement)

Robot Design and Build

1. The robot must fit within a maximum of 350 × 350 × 500 mm (Length × Width × Height).
2. To start the match, all sharp edges must be covered for safety.
3. The robot may have a camera.
4. The design must prevent damage to the arena.
5. The user must be able to move the robot forward, backward, left, and right to reach and pick up the flag.

Magnetic Pickup System

1. The robot shall have a controllable magnet mounted at the front or bottom to attract and hold a metallic-based flag.
2. The magnet can be permanent or powered (electromagnet), depending on availability and ease of construction.

Simple Power and Structure Design

1. The robot shall use a basic power source such as a rechargeable battery (e.g., 9V or Li-ion).
2. The chassis shall be made from lightweight materials (plastic, wood, or aluminum) and equipped with simple DC motors for movement.
3. The maximum total weight of the robot shall not exceed 7.0 kg, including all components

Control System

1. The robot shall be manually controlled using a simple remote control, joystick, or mobile app.
2. Control must be wireless. (ensuring a stable signal is the team's responsibility)
3. An active live video from the robot's camera is optional.
4. Max Speed should be 3.5 m/s

Electrical Requirements

1. All wiring must be insulated — no exposed copper or damaged wires.
2. A fuse or circuit breaker is required to prevent an electrical fire.
3. Battery must be secured with straps or brackets (no loose batteries).
4. The robot must not emit electrical noise, jamming signals, or wireless interference that affects other robots' control systems.

3. Arena & Environment

3.1 Arena Layout:

The arena consists of a rectangular area 3 × 3 m wide with clear boundary markings. Each team has a designated home zone used for flag collection. All five flags are placed across the arena in fixed locations that are spaced far apart to support efficient route planning and obstacle navigation. The arena has clearly marked boundary lines, and the robot must remain inside them at all times. Crossing the boundary line at any moment during the match is considered a violation.

3.2 Flag:

Five neutral flags are placed in predetermined locations before the start of the round. These locations are spaced far apart to encourage movement across the entire field. Each flag is attached to a stand, allowing robots to lift or grip it using a variety of mechanisms

3.3 Obstacles:

The arena contains a set of physical and dynamic obstacles designed to challenge robot mobility, stability, and navigation skills:

- Static Barriers: Fixed walls or blocks that create narrow pathways and require precise steering.
- Ramps and Uneven Terrain: Sloped or raised areas that test wheel traction, balance, and speed control.
- Moving Elements: Rotating or shifting components that periodically block routes, requiring timing and adaptive movement.
- Restricted Zones: Marked areas that robots must avoid; entering them results in time or point penalties.
- Magnetic Interference: If a robot's magnet unintentionally attaches to an opposing robot made of metal, the affected alliance may safely immobilize the opposing robot for up to 15 seconds before both robots must disengage and resume normal play.

All obstacles are evenly distributed across the arena to ensure both teams face equal difficulty and competitive fairness.

4. Rules of Play

4.1 Match Duration

Each match lasts a total of three minutes.The timer begins as soon as the referee signals the start of the round, and all scoring ends the moment the timer reaches zero.

4.2 Autonomous Period (First 45 Seconds)

During the first thirty seconds of the match, robots must operate without any human players. Robots must attempt to reach nearby flags, position themselves advantageously, or begin moving toward the center of the field. Teams may earn points during this period, and robots must remain fully autonomous until the referee announces the transition to driver control.

4.3 Driver-Control Period

After the autonomous period, drivers take control of their robots for the remainder of the match. During this time, robots may retrieve flags from the field, steal flags from the opponent's flag zone, defend their own zone, or disrupt opposing strategies within the limits of the rules.

4.4 Flag Capture Rules

1. A flag is considered captured when it is brought into a team's flag zone and released by the robot.
2. If a robot finishes the match holding a flag inside its zone, that flag does not count.
3. A flag does not score if it is outside the zone when time expires, even if the robot is holding it near the boundary.
4. Teams may steal flags from the opponent's flag zone at any time during the match.
5. Once a robot releases a flag in its own zone, the opposing team may take it again.
6. This back-and-forth exchange can happen many times, and alliances must balance attack and defense to maintain control.
7. Robots may move flags by pushing or grabbing them with a gripper or magnetic attachment.
8. If a robot is pushing a flag without holding it, opponents may grab the flag.
9. A flag that tips over during the match remains playable, but it does not count for scoring at the end, even if it's inside the zone. (For a flag to count, it must be upright at the end of the match.)
10. Teams may try to stand tipped flags upright before time expires.

4.5 End-of-Match Conditions

When the timer reaches zero, all robots must stop immediately. Referees will then check each flag's position. A flag counts as a scoring flag if:

- The flag is upright.
- Any part of its stand is inside the alliance's flag zone.
- The flag is not being held by a robot.

Flags outside all zones, or any flag that has tipped over inside the zone, do not count for either alliance.
Case of DRAW: GoldenFlag

5. Match Procedure & Technical Inspection

5.1 Safety and Fair Play

1. Intentional damage attempts are strictly prohibited.
2. Teams must follow referee instructions at all times
3. Cheating, arguing, or interfering with matches is not allowed.
4. Unsportsmanlike behavior results in penalties.
5. No flames, liquids, or dangerous materials.
6. No sharp edges, exposed wires, or loose batteries

5.2 Testing & Inspection

Before every match, each robot must successfully pass a pre-match safety and readiness inspection.

Inspection Checklist:

1. Robot Dimensions: Fits within a maximum of 350 × 350 × 500 mm (Length × Width × Height)
2. Battery check: (secure, undamaged, properly mounted)
3. Wiring: No exposed copper, no loose connections
4. Safety Switch: Accessible and operational
5. Pickup Mechanism: Safe for field, flags, and other robots
6. Camera Feed (if used): Must be functioning before the match

5.3 Documentation Requirements

Each team must maintain and present the following documents when requested:

- A basic wiring diagram must be provided.
- Simple mechanical layout drawing.
- List of materials used (BOM).

5.4 Pre-Match Setup

Once inspections are complete:

1. Robots are placed on their designated starting positions.
2. Drivers and team members must stand behind the driver's line.
3. Flags and obstacles are confirmed to be in the correct starting positions.
4. The field crew ensures all electronics and timers are functioning.

5.5 Match Start Procedure

1. The referee confirms both alliances are ready.
2. A simple countdown system ("3-2-1-Start!") is used.
3. A start buzzer or sound plays to begin the autonomous period.
4. Robots must remain stationary until the start signal.

If a team is not ready, a single delay of up to 60 seconds may be granted.

5.6 Post-Match Procedure

1. When the stop signal plays:
2. All robots must freeze immediately.
3. Referees examine the final position of each flag.
4. Scores, penalties, and violations are recorded.
5. Teams may inspect the field to verify scoring.

Before leaving the arena, both alliances must sign the final score sheet. Signing indicates that the teams accept all scoring decisions, penalties, and events that occurred during the match. Once signed, the score becomes final and cannot be changed.

6. Scoring System

Teams are scored based on speed, control, and accuracy in retrieving and delivering flags.

1. **+3 points** for each upright flag in an alliance's flag zone at the end of the match.
2. **+6 points** for the **first flag captured** and delivered into a flag zone (double points).
3. **+6 points** for delivering a flag into the zone during autonomous (double points).
4. A flag counts if **any part of its stand** is inside the flag zone boundary.
5. A flag held by a robot **inside the flag zone** at the end of the match **does not count** if it is upright.
6. Flags **held outside** the flag zone do **not** score.
7. **Tipped flags do not score**, even if located inside the flag zone.
8. Flags outside both zones at the end of the match score zero points.

The highest total score wins the match.

7. Penalties & Violations

1. **Robots may not intentionally damage, crush, or break a flag or flag stand.**
   - Penalty: Opposing alliance receives +2 points.
2. **Robots may not intentionally knock over any flag (regardless of location)**:
   - Penalty: +1 point to the opposing alliance.
3. **Robots may not intentionally knock over a flag inside the opponent's flag zone:**
   - Penalty: +2 points to the opposing alliance.