



مسابفة محمد بن زايد العالمية للروبوت
Mohamed Bin Zayed International Robotics Challenge

مباغة مستقبل الروبوتات Inspiring the future of Robotics

Organized by



جامعة خليفة
KHALIFA UNIVERSITY

MBZIRC 2019

Call for Intention to Participate
Preliminary Challenge Description

Introduction

The Mohamed Bin Zayed International Robotics Challenge (MBZIRC) is a biennial international robotics competition. MBZIRC provides an ambitious and technologically demanding set of challenges, and is open to all teams from all countries. MBZIRC aims to inspire future robotics through innovative solutions and technological excellence.

Robotics is poised to have a transformative impact in a variety of new markets and on various human social aspects. These include robot applications in disaster response, healthcare, domestic tasks, transport. However, there is a gap between current reality in robotic capabilities and the requirements of future applications. Enabling technologies for such applications include robots working more autonomously in dynamic, unstructured environments, while collaborating and interacting with other robots. MBZIRC aims to focus on some of these enabling technologies, by providing a demanding set of benchmark robotics challenges to attract the best international teams. Similar to other major competitions, the MBZIRC aims to provide an environment that fosters innovation and technical excellence, while encouraging spectacular performance with robotics technology.

More information about MBZIRC can be found at the website : <http://www.mbzirc.com>

The inaugural MBZIRC took place at the YAS Marina Circuit in Abu Dhabi, UAE, in March 2017. It was a successful event with 27 international teams consisting of 275 team members competing over 3 days. Building on MBZIRC 2017, the next edition of MBZIRC is scheduled for Fall 2019.

This document describes the preliminary version of the main Challenges of MBZIRC 2019, and the call for Intention to Participate. The document also includes important dates, deadlines, and the application process for the call for Intention to Participate. It is noted that this document provides only a broad overview of the MBZIRC 2019 Challenges; a more detailed version of the MBZIRC 2019 Challenges will be released with the main Call for Proposals in November 2017. Through this Call for Intention to Participate we are also soliciting feedback from the robotics community on the MBZIRC 2019 Challenges. The MBZIRC Organizers reserves the right to continue to fine tune the MBZIRC 2019 Challenge Description and Rules, leading up to the competition in Fall 2019, based on feedback from the robotics community, participants, and the MBZIRC International Technical Advisory Committee.

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Competition Overview

MBZIRC 2019 will be based on autonomous aerial and ground robots, carrying out navigation and manipulation tasks, in unstructured, outdoor and indoor environments.

MBZIRC 2019 will consist of three challenges and a triathlon type Grand Challenge

Challenge 1 is based on UAV dynamic aerial tracking and interventions in 3D.

It requires a team of UAVs to autonomously locate, track and interact with a set of objects moving in space.

Challenge 2 is based on UAV and UGV picking and placing of objects in an indoor-outdoor environment.

It requires a team of robots (UAVs and UGVs) to collaborate to autonomously locate, track, pick, and deliver multiple static and dynamic objects in an outdoor-indoor environment.

Challenge 3 is based on UGV and UAV mobile manipulations in an urban fire search and rescue scenario.

It requires a team of UAVs and a UGV to collaborate to carry out a series of complex manipulations in an outdoor-indoor fire related USAR environment.

The Grand Challenge requires a team of robots (UAVs and UGVs) to compete in a triathlon type event that combines Challenges 1, 2 and 3.

MBZIRC 2019 will take place in an outdoor, open, arena(s) approximately the size of a football pitch. The arena(s) will contain various obstacles. The arenas for Challenges 2 and 3 will also contain an indoor structure. The exact nature of the obstacles and the indoor structure will be specified in due time.

The challenges are motivated by pushing technological and application boundaries in robotics. The technological challenges addressed in the competition include autonomy in semi-structured (uncertain), dynamic, outdoor-indoor environments with sense and avoid, GPS denied navigation, fast speeds, complex maneuvers, air-surface collaboration, physical interactions, and complex manipulations. It is noted that each challenge will consist of a series of sub-tasks focusing on one or more of the above aspects.

Competitors may participate in one or more of these challenges, using un-tethered, autonomous robots. More details about the scoring scheme will be provided in the MBZIRC 2019 'Scoring Scheme' Document, in due time.

For safety reasons, the dimensions and speeds of the UAVs and the UGV will be constrained. More details about the safety protocols that must be followed by all participating teams will be provided in due time.

2.1 Challenge 1 – UAV Dynamic Aerial Tracking and Interactions

Challenge 1 requires multiple UAVs to autonomously locate, track and interact with a set of objects moving in space. It also involves fast speeds, sense and avoid, complex aerial maneuvers, and robust autonomy in unstructured environments (e.g. wind, lighting conditions etc).

Task Specification

Challenge 1 sub-tasks will include

- UAVs take off autonomously and will maneuver through complex passages to reach targets.
- UAVs will maneuver through obstacles, sensing and avoiding collisions.
- UAVs will track objects moving in 3D.
The objects could be other UAVs in random flight and/or a randomly moving platform with 5 degrees of freedom (x,y,z, roll and pitch). The exact nature of these objects will be specified in due time.
- UAVs will interact with objects moving in space.

The interactions could be physical or virtual contact with the flying objects and/or precise landing and taking off on the randomly moving platform. The exact nature of the required interactions will be specified in due time.

Scoring

The Challenge 1 score will be based on the number of tasks completed, and the speed of completion. More details about the scoring scheme will be provided in the MBZIRC ‘Scoring Scheme’ Document in due time.

Challenge duration

This challenge duration will be 20 minutes.

2.2 Challenge 2 – UAV-UGV Object Delivery in Outdoor-Indoor Environment

Challenge 2 will be based on autonomous UAV-UGV object delivery in an outdoor-indoor environment.

Challenge 2 requires multiple UAVs and a UGV to autonomously locate, track, pick and deliver multiple static and dynamic targets in a complex outdoor-indoor environment. Challenge 2 will also require collaborative task execution, indoor-outdoor transition navigation, GPS denied autonomous navigation, sense and avoid, and fast and complex aerial maneuvers.

Tasks Specifications

Challenge 2 sub-tasks will include

- UAVs-UGV will pick static/moving objects from outdoor and indoor. The exact nature of the static/moving objects will be specified in due time.
- UAVs-UGV will deliver objects to pre-specified locations indoor and outdoor.
- UAVs-UGV will navigate through narrow windows/doors/gaps to reach and pick objects. This could also involve UAVs navigating (and picking/placing objects) from inside a tunnel.
- UAVs-UGV will maneuver through obstacles, sensing and avoiding collisions
- UAVs-UGV will collaborate to pick and deliver objects in a predefined sequence

Scoring

The Challenge 2 score will be based on the number of tasks completed, and the speed of completion. More details about the scoring scheme will be provided in the MBZIRC 'Scoring Scheme' Document in due time.

Challenge duration

This challenge duration will be 20 minutes.

2.3 Challenge 3 – UGV-UAV Manipulations in Urban Fire Fighting

Challenge 3 will simulate an urban environment firefighting scenario using autonomous ground and aerial robots.

Challenge 3 requires multiple UAVs and a UGV to carry out a series of complex manipulation tasks in an outdoor-indoor environment, to extinguish fire. Challenge 3 will also require collaborative aerial manipulations with disturbance rejection, UGV-UAV (surface-air) collaborative task execution, indoor-outdoor transition navigation, GPS denied autonomous navigation, sense and avoid, and fast and complex aerial maneuvers.

Fires will be simulated at various locations in the arena, and at different heights of the building to simulate fire in a high-rise building. The exact nature of the obstacles and the indoor structure will be specified in due time.

Tasks Specifications

Challenge 3 sub-tasks will include

○ UGV to Extinguish Fire

- UGV to navigate from outdoor into a building with simulated fire.
- UGV to collaborate with UAVs to locate fire extinguishers and fire locations.
- UGV to operate the extinguisher(s) to extinguish the fire(s).

○ UAV to Extinguish Fire

- UAV(s) to move from outdoor into a building with simulated fires.
- UAV(s) to locate fire extinguisher(s).
- UAV(s) to pick and operates the fire extinguisher(s) to extinguish the fires. The fires will be at differing heights (to simulate fire in a high-rise building).

○ Opening-closing doors/windows and air-surface collaboration

- UAVs and UGV to open/close doors/windows to gain access to fire locations.
- UAVs to locate internal and external fire sources and communicate to other UAVs and UGV.
- UGV and UAVs collaborate to extinguish fire.

Scoring

The Challenge 2 score will be based on the number of tasks completed, and the speed of completion. More details about the scoring scheme will be provided in the MBZIRC 'Scoring Scheme' Document in due time.

Challenge duration

This challenge duration will be 20 minutes.

2.4 Grand Challenge – Triathlon

The Grand Challenge will consist of a triathlon type event, combining Challenges 1, 2 and 3.

Tasks Specifications

- USAR – Firefighting and rescue
- USAR – Aid delivery and victim rescue

Scoring

The challenge score will be based on the number of tasks completed, and the speed of completion. More details about the scoring scheme will be provided in the MBZIRC ‘Scoring Scheme’ Document in due time.

Challenge duration

This challenge duration will be 25 minutes.

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Prizes and Sponsorship

Funding of US \$5 million will be allocated for prizes and team sponsorship.

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Call for Intention to Participate

Teams who intend to participate in MBZIRC 2019 are requested to register their interest by submitting an online application by visiting (**The deadline is October 15, 2017**):

www.mbzirc.com/xxxx (to be updated)

The application form also provides teams the opportunity to give feedback on the MBZIRC 2019 Challenges outlined in this document.

Appendix 1

Table 1 - MBZIRC Important Dates

The following is a list of important dates and deadlines leading up to the main event in Fall 2019.

| | |
|--------------------------------|----------------|
| Call for Intent to Participate | September 2017 |
| Call for Proposals | November 2017 |
| Submission of Proposals | February 2018 |
| Selection of Finalists | April 2018 |
| MBZIRC 2019 | November 2019 |

| Versions | Date | Descriptions |
|----------|-------------------|--------------------------------------|
| V1 | 20 September 2017 | Initial MBZIRC Challenge Description |