Definition of **Air Challenge** Guidelines

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--	Original	J. Searle	09/11/2014	
A	Added Payload mounting	J. Searle	12/16/2014	
B	Updated number of drop zones	J. Searle	01/05/2015	
C	Added dimension to payload mounting	J. Searle	02/16/2015	
D	Update to be a multi-rotor platform	J. Searle	09/10/2015	
E	Update new logo	P. Ward	11/01/2016	
F	Modify size of drop zones and AOI	S. Zingaro	02/08/2017	
G	Max. cost of robotic system added	S. Zingaro	02/27/2017	
H	Clarifications including max. time	S. Zingaro	06/19/2017	
I	Updated definition of drone size	S. Zingaro	06/28/2018	
J	Changed dimensions to metric	S. Zingaro	02/22/2019	
K	Added drop zone detail and clarifications. Updated cover.	S. Zingaro	06/27/2019	
L	Updated mission scenario and added use of sensors	S. Zingaro	08/27/2020	
M	Added DTRA/IIRM logos and acknowledgement	S. Zingaro	12/18/2020	
N	Updated challenge (use of QR codes)	S. Zingaro	08/26/2021	

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1 Introduction

1.1 Purpose

The purpose of this document is to define the Air Challenge and air competition course for the Sea, Air and Land Challenge.

1.2 Scenario

An explosion has occurred in a downtown metropolitan area. There is a concern that the explosion may have released radioactive elements into the air, jeopardizing the health and safety of all citizens in the surrounding area. In order to safely determine whether or not the explosion is a radioactive threat, an Unmanned Aerial Vehicle (UAV) with radiation detection capabilities is being sent to the scene. With cameras, sensors and automated image processing, the UAV will fly over the region and determine if any radiative matter is present. A live relay of this information will be sent to the first responders, allowing them to remain protected at a safe distance until the best method of response is determined. In addition, the UAV will be able to drop markers on "hot spots" to indicate a radiation danger zone and serve as a warning to the ground crews.

Using sensors that will recognize differences in radiation concentration can increase the safety for the responders and local civilians. Without a fully developed UAV equipped with radiation detection, first responders would have no indication as to whether the explosion site is safe, nor will the surrounding areas know if radiation is heading their way. This Air Challenge explores building and using sensors that could one day be used on UAVs.

1.3 Definitions

Tele-Operated (or remote controlled) – References a type of robot that has an operator making decisions about the operation of the robot. Sensory data from the robot or other device (video, telemetry, etc.) is delivered in near real time to the robot operator, and the operator makes decisions about what the robot is supposed to do (e.g. turn left/right, speed up/down, deposit a payload etc.). This is the type of operation used by hobbyists and may also be called operator in the loop. This can either be accomplished by wireless or wired communications, although most (including the Air Challenge) applications dictate wireless communication.

Autonomous - The robot has a sensor package that collects data, and based on computer processing, makes decisions without an operator on how it is to operate and what it is to do. The general rules of an autonomous robot are:

- Gain information about the environment (Rule #1)

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- Work for an extended period without human intervention (Rule #2)
- Move either all or part of itself throughout its operating environment without human assistance (Rule #3)
- Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications (Rule #4)[i]

QR Code - A Quick Response code is a type of matrix (two-dimensional) barcode that can be read easily by a digital device. QR codes:

- Store information as a series of pixels in a square-shaped grid
- Are frequently used to track information about products in a supply chain, are used in marketing and advertising campaigns, and can even determine an object's position within augmented reality.

2 Challenge

For this challenge, the combination of a QR code reader system and a payload will be developed to provide QR code reading and drop capabilities for a hobby sized multirotor. The multirotor, which is controlled by an experienced pilot or a team member who passes a qualification test, will fly a pattern searching for "radiation hot spots" that have been randomly placed. As the multirotor performs its flight pattern, it must detect the QR code, which links to a situation which may be a "radiation hot spot" or "safe area", using a camera or QR code reader. Once the operators determine that a "hot spot" has been located, the multirotor must be able to drop a marker on the "hot spot" (target) to indicate a "radiation danger zone". Obviously, efficiency and accuracy are important aspects of this challenge.

The team is responsible for building/selecting a multirotor platform that can:

- Safely carry the sensor/payload package
- Fly for the duration necessary to complete the challenge

The team is also responsible for designing a tele-operated (or autonomous) payload package and reader that can:

- Be safely secured and carried by the multirotor
- Find potential locations (camera or pilot view)
- Identify and relay information to the operators regarding radiation hot spots. This is to be achieved using a QR code reader system
- Drop the markers onto the targets at the hot spots

Notes:

- The pilot will be required to always be in visual contact of the multirotor or have a spotter who is always in visual contact of the multirotor
- The teams that are not actively flying will be restricted in location to be behind the flight line and the operating pilot and team. The course may be changed between team runs, so that knowledge of one course is no advantage to second runs or other teams.
- A proficiency test will be executed (either by video or in-person at the team's

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school/facility) by a member of Sea, Air, and Land staff or other qualified personnel, using the team's multirotor prior to Challenge Day.
- If a team pilot cannot pass the flying proficiency test, a pilot may be provided for Challenge Day. Please verify availability prior to Challenge Day.
- On Challenge Day, a brief flight worthiness test will be given to ensure the multirotor and payload are safe for flight.

2.1 Requirements

To receive maximum score on the air course the vehicle must complete the following

- Multirotor must fit with in a 533 mm x 533 mm (21" x 21") box. This does not include propellers or propeller guards.
- No limits are put on height.
- Airframe must be capable of being flown indoors
- Total cost of the system must not exceed $500
- Pilot or spotter must visually see the airframe at all times during challenge run
- Payload, including sensor or camera and drop mechanism, must be secured to Airframe
- Pilot must pass "Sea, Air and Land" qualification flight
- Airframe and payload must pass challenge day safety exam
- Be able to find and identify two areas of "high radiation" via QR code
- Be able to drop "radiation hazard" markers in the two "high radiation" zones (a target will be provided within the zone). Markers are of the team's choosing.
- A maximum of 10 minutes will be allowed to identify two high radiation areas and drop markers at these two zones to "warn others of high radiation".
- Prior to the run, team will introduce themselves and their design concept in a short "elevator speech" (untimed)
- Optional Tip: The pilot may consider becoming an Academy of Model Aeronautics member. AMA youth membership is $15 for those under age 19.

2.2 Coded Areas/Drop Zone

Outdoor courtyards or indoors areas: Coded areas/drop zones will have the following characteristics:

- Will be marked by a rectangle
- Drop zone will be at least 30 cm x 30 cm (1'x1')
- Each zone will have a QR code, with a minimum size of 15 cm x 15 cm (6" square). These QR codes will show a situation which the operators must read and determine if the location is a radiation hot spot or a safe area
- Drop zones will be scored on proximity to target within zone

Note: Teams may ask the judges to add unique marking to the drop points BUT this must be approved by the Challenge Coordinator prior to Challenge Day.

2.3 Key Design Points

The following bullets are some key design points that will be instrumental to the success of your vehicle.

- Have a field of regard of 180 degrees

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- Be able to look ahead in direction of flight
- Be able to have a system that is able to read a QR code. The complete system does not need to be attached to the multirotor.
- Be able to determine optimal height and timing to read QR code (or take a photo of the code) or drop payload

2.4 Course Layout

- The course will have up to eight coded areas/ drop zones
- The course will NOT have a specific pattern of for the flight

Figure 1 is a possible course layout derived from the above given description. This is a template for the air course and not meant to be an implementation diagram. Color is not an indicator of QR code but may be used to aid in navigation.

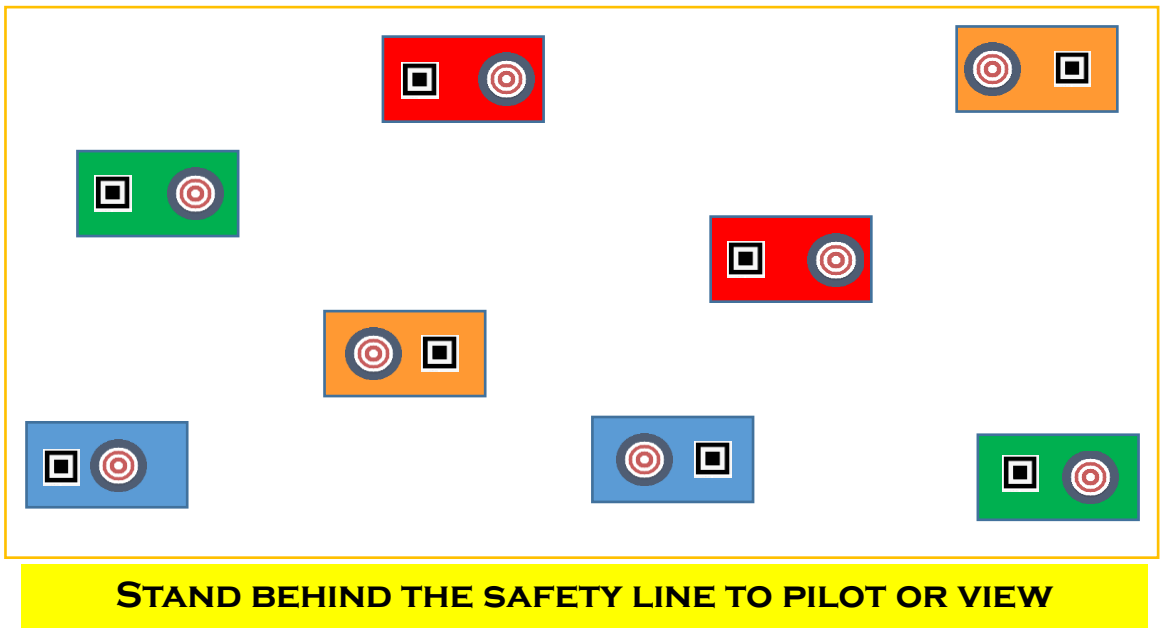

Figure 1 Sample Course Layout

[i] http://en.wikipedia.org/wiki/Autonomous_robot

IIRM | INTERACTION OF IONIZING RADIATION WITH MATTER

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