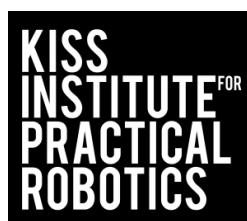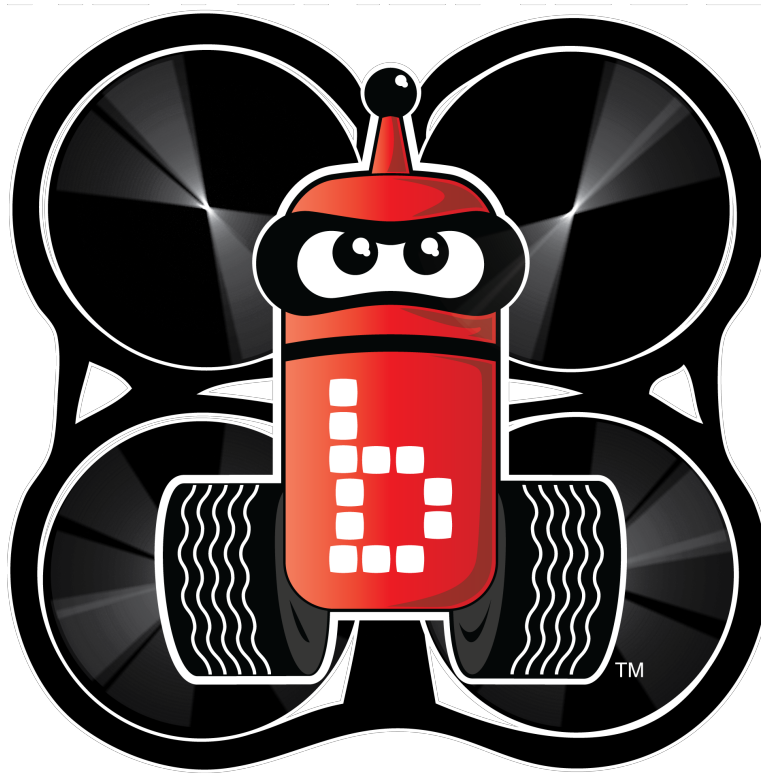# Autonomous Aerial Robot Tournament

KISS Institute for Practical Robotics

## Table of Contents

# KIPR / Botball / GCER Sponsors

## Change Log

| Ver | Date | Description |
|-----|------|-------------|
| **1.0** | Jan 15th, 2019 | Initial draft of 2019 game. |
| **1.1** | Feb 10th, 2019 | Clarifications to rules (Robot Construction Rules #2 and #11), how supplies score, score sheet clarification, and Botguy location. |

# KIPR Autonomous Aerial Robot Tournament

KIPR produces the KIPR Autonomous Aerial Robot Tournament each year at the Global Conference on Educational Robotics. The current game will continue to be revised and used until a team is able to successfully complete all challenges repeatedly.

## KIPR Autonomous Aerial Robot Tournament Game

The KIPR Autonomous Aerial Robot Tournament Game is an autonomous robotics challenge designed and distributed each year by the KISS Institute for Practical Robotics (KIPR) to encourage autonomous robotics education. This document presents the official game rules for the KIPR Autonomous Aerial Robot Tournament Game. These game rules are free for educational use and are used in college courses and robotics events throughout the country. For the latest information on the KIPR Autonomous Aerial Robot Tournament, please visit https://www.kipr.org/global-conference-on-educational-robotics/events/kipr-autonomous-aerial-robot-tournament.

## This Year's Game

In this year's game, you need to conduct a Search and Rescue mission to rescue Botguy. Botopia is on the other side of the mountains and you must fly over there to make contact with him. You will have some supplies to bring to him that are located in your starting box or air field. Teams will have to deal with the recent seismic activity that has reconfigured the landscape, but luckily ground teams have put markers to identify the peak. Teams will have to make the hazardous trip over or through the mountains to reach Botguy. He has placed some indicator markings around him to help identify his location. Teams will be able to see a bright red ring around him.
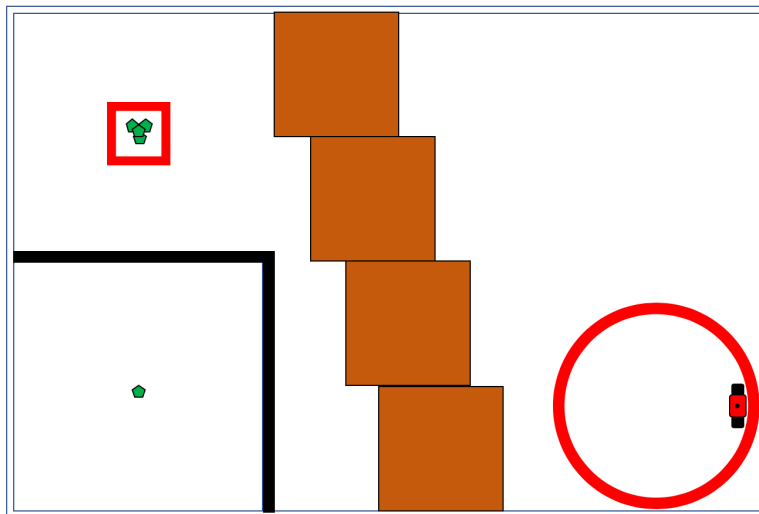
## The Game Board

The Game Board is 8 feet by 12 feet.  1-inch PVC pipe surrounds the entire board.  In the middle of the board there is a mountain.  On one side will be the starting box and supplies.  On the other side Botguy will be waiting to be rescued.

### Mountains

Each part of the mountain will be a 22"x22"x22" cardboard box.  On top of the peak box will be a Velcro X-shaped pattern (hook side) that a *Target Marker* can attach to.  The base of the mountain is comprised of four boxes, staggered by ~6".  On top, the remaining three boxes, set up in a triangle formation, will be randomly placed in one of five different positions.  The below diagram illustrates the five different positions if directly facing the mountain.
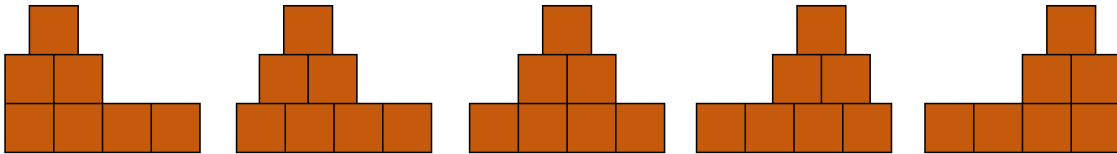


### Supplies

The supplies are simply hacky sacks. They weigh approximately 1 oz. (28 g).  Your team may start off with four in the starting box at the beginning of the game.  Only one is permitted to be in contact with your robot at the start of the game.  There will also be more available in the *Supply Depot*, indicated by the *Supply Marker*.

### Supply Depot

The *Supply Depot* has four supplies available.  They are configured with three on the bottom in a triangle formation, and one sitting on top in the center of the three.

### Supply Marker

This will be red duct tape in a square configuration, outside edge being 12", around the supplies.

### Botguy Marker

Botguy will have a 39" hula hoop around him that is red with black strips breaking up the solid red.  Botguy will be in one of two positions, where the hula hoop is touching the back edge of the PVC and the side.  This is illustrated below.
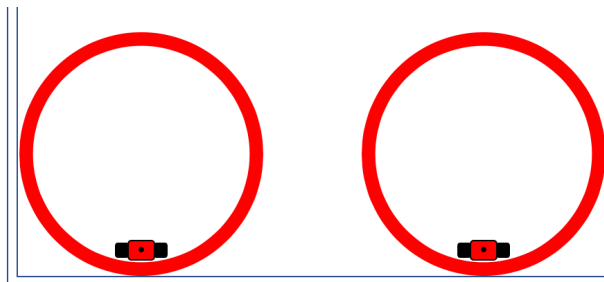
## Target Marker

The Target Marker may contain electronics that involve the use of LEDs to passively emit a light, visible or invisible to humans.  This mainly pertains to the use of infrared LEDs to provide navigation points to a drone.  Microcontrollers, microprocessors, motors, servos, or any other similar device, may not be used.  The Target Marker does not count against your independent structure count.   If unsure if something is permitted, then please email aerial@kipr.org.

The thickness of the Target Marker may not exceed 1-inch and may not extend outside of the target surface.  The weight of the marker may not exceed 3 pounds.

A Target Marker that fails these requirements is not permitted to be used during the competition.  Judges reserve the right to thoroughly inspect the marker at any point during the competition.

## Gameboard Surface

In order to provide the game board some visual texture for aerial platforms, there will be a camouflage material on the surface with the following pattern.

# Game Rules

## Mountains

Teams must land on peak, wait for at least 5 seconds, and then take off again to score full points. If a robot brushes or does not fully wait the 5 seconds, then teams will earn points for touching the top surface of the peak.

If the robot passes the mountains to reach the far side, as defined by all motors being past the mountain, then the team will earn some points. If the robot passes the mountains by flying underneath the peak, but within the game board surface, then they will earn points. Example is shown below.
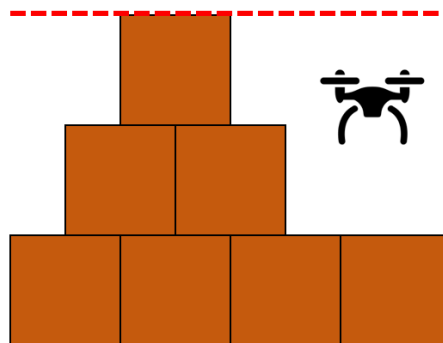
## Botguy

You can score with Botguy by landing on or inside the ring. Teams must land and wait for at least 5 seconds before taking back off. Landing inside the ring is determined by the motor positions. All motors must be inside the ring for maximum points.

## Supplies

These items score by moving them outside of the *Starting Box* and *Supply Depot*. You can put them on your side of the mountain, on the other side of the mountain, inside Botguy's ring, or on top of the mountain. Supplies in the vertical projection of the far side of the mountain or Botguy's ring will earn points.

## Team Membership

Teams can be comprised of K-12 aged students, college students, professional engineers, hobbyists, poets, and anyone else interested in participating.

## Spirit of the Game

If your team has come up with a creative technique to take advantage of a loophole in the rules, then ask aerial@kipr.org. Teams that show up to the competition that take advantage of the rules in a way that defeats the spirit of the game may result in their runs not being awarded points.

## Competition Rounds

1. The aerial robot(s) may not leave the starting box until the starting light has turned on.
2. The light will turn on at the judge's command (at a time of their choosing) and the game timer will start at that point – the robots must be able to autonomously sense when the game has started.
3. Teams whose aerial robots leave the *Starting Box* after the team indicates that they are ready but before the lights turn on will receive a fault.
4. Two faults in a row will cause the team to receive a score of 0 for that round.
5. All aerial robots must power down their mobility system within 90 seconds of the start lights turning on.  It is recommended that the aerial robots be on the ground, as it'd be unfortunate for the robot to cut power and come crashing to the ground.  Drones must land within the time limit or receive a zero for the round.
6. Each team will have a minimum of two competition rounds.  Time permitting, judges will increase the number of rounds for all teams.

## Practice

Based upon team registration sign up, teams will have a specific time slot to practice on the game board.  Teams may trade their timeslot as desired.  Teams are advised to be prepared for their practice rounds.

As KIPR staff might not be available to monitor the practice area, KIPR may appoint a volunteer to act on their behalf to monitor the area.  These volunteers cannot dictate new rules, but are able to enforce the rules of practice.

## Scoring

The following is what judges will be using for scoring at the tournament.  Teams will have their two highest runs averaged together.  This will determine the standings.

**2019 AAV Scoring Sheet**   JUDGES' CHECKLIST  ☐ Field Reset  ☐ Team Verified  ☐ Robot Size Check  ☐ Calibration  ☐ Hands Off

| Task | Pts | Qty | Subtotal |
|------|-----|-----|----------|
| Supply on near side of Mtn<br><span style="font-size:small">Not in Starting Box or Supply Depot</span> | 5 | x_____ | |
| Supply on far side of Mtn | 10 | x_____ | |
| Supply on peak of Mtn | 15 | x_____ | |
| Supply touching or inside of ring | 30 | x_____ | |
| Robot landed partially in ring<br><span style="font-size:small">Any part of drone breaking the inside vertical projection</span>  **OR** | 30 | | |
| Robot landed fully in ring<br><span style="font-size:small">All four motors inside of the ring</span> | 45 | | |
| Brushed peak of Mtn   **OR** | 15 | | |
| Landed on peak of Mtn | 45 | | |
| Drone traveled to far side of Mtn | 5 | | |
| Drone traveled under the peak of Mtn | 10 | | |

**Team Score**

Once the sheet is signed, TEAM SCORE cannot be challenged. Teams, ask to see Head Judge before initialing if there are any questions.

_____

## Tie Breaking

There is no tie breaking in this game.  If multiple teams tie, then they will share that ranking position.

## Robot Construction Rules

The following rules apply to all robots to be entered in the KIPR Autonomous Aerial Robot Tournament Game:

1. For purposes of this competition, a robot is any self-powered aerial vehicle that is under autonomous <u>computer</u> control. The control computer can be on the aerial robot, or elsewhere on the team's entry. If teams are using laptops to control the drone, then they are permitted to have it outside of the *Starting Box*, but within the netting. Teams may run a single cable, or cable bundle, to the starting box to sense the starting light, communicate with the robot, etc.

2. No ground-based robots that locomote across the top of the game surface are permitted. The objective of the game is to have drones moving the supplies to the other side of the mountain, not ground-based robots flinging the supplies over the mountain.

3. Ballistic entries are not allowed -- nor are others which use high pressure or chemical rocket propellant.

4. A team's entry (all materials placed on the game-board) must mass less than 10kg (22 pounds).

5. A team's entry (all materials placed on the game-board) must fit within their (virtual) starting boxes without restraint (other than pressing against interior edge of any game board PVC bordering the starting box).

6. The team's entry may not contain or release pressurized materials at greater than 7 bar (100 psi).

7. The team's entry may not release any liquids during the game, or before, during, or after the game while the team is at the game table.

8. The team's entry may not release any gasses while at the game table that are considered hazardous by the judges, or are at a temperature below 0°C (32°F) or above 50°C (122°F).

9. Robots may not contain features (manipulators, protrusions, or materials) that are designed to, or are deemed by the judges likely to, cause damage or destruction to the game board, or to game pieces. Propellers <u>should be shielded</u> so as to be unlikely to damage the game materials.

10. Robots must operate autonomously. No external power or control from outside of the game board area will be allowed.

11. Each team may only have a maximum of five independent structures on the game board at a time. An independent structure is defined as any structure that is fixed and does not move from its starting location under its own power or means. A fixed navigational marker is an example of an independent structure.

12. A team's entry may be made out of any materials or parts as long as the entry conforms to the construction rules above.

13. If your robot has a name, then it must have a name suitable for broadcast over a public address system.

## Tournament Logistics

1. If the judges determine that a robot violates the construction rules, whether or not a challenge from another team has been made, that robot will not be allowed to run until it has been modified to meet the rules.
2. All competition rounds will take place inside a netted arena. The netting will, at a minimum, have a 10-ft by 14-ft ground footprint. Robots should not plan on drifting more than a foot outside the game surface, so prepare accordingly. Depending the number of teams that sign up, there might be two game surfaces inside the netting.
3. Construction rules apply only to what is brought to the Game Table.
4. During setup teams may adjust starting lights.
5. Starting lights must be attached to the PVC pipe for a starting box.
6. Starting lights may not be in physical contact with any robot.
7. During setup, teams may perform any necessary calibrations needed by their robots.
8. Setup time should be three minutes or less. Try to keep to it. Teams that exceed four minutes will be assessed a 50% penalty on their overall score.
9. Game duration is 90 seconds or until team completes the challenge.
10. Lights will remain on for 85 seconds and flash the last 5 seconds unless the judges stop the game.
11. Once the starting lights are turned on, the round counts unless a judge rules outside interference.
12. Robots must cut power to their motors and turn off or stop issuing motion commands to servos after 90 seconds or risk forfeiting the round.
13. There are no instant replays, and attempts to use videos to question a decision will not be considered.
14. If a team is unhappy with the judges' decision, then they should discuss it then and there. Once the score sheet is signed, there is no further discussion. The head judge may sign the score sheet if necessary to move forward in the rounds.
15. Challenges to scoring after the teams have left the table will not be considered.
16. Teams cannot touch, borrow equipment, modify robots or computers, or transmit commands to another team's equipment (including their pit table) without the permission and presence of a member of that team.
17. The visual properties and RF properties around the arena are unknown. The judges will attempt to remove any issues, but might be limited by resources and building rules. Please plan accordingly.

## Game Board Materials
The game surface is 8' x 12'

- 3 pieces of 4x8' MDF (122cm x 244cm) or some other underlay to screw into
- 3 pieces of 4x8' white 1/8" FRP (122cm x 244cm)
- 40' of Schedule 40 1" PVC pipe


## Game Board Setup
- A team's entry must be completely within their starting box (45.5" wide and 45.5" long) at game start.
- The base of each starting box is defined by the boundaries given by the interior edge of the PVC and tape delineating it.
- The (virtual) height of the starting box is 15" (38 cm).
- After teams have set up and are ready to start, the judges will place the mountain.
- All measurements on official boards, whose uncertainty is not otherwise specified will be as specified within +/- 1/2  inch (12mm) or 1%, whichever is greater.

## Robot and Human Safety

Only approved drones are allowed to fly in the competition. Appendix A has a list of already approved drones.

Drones that are not listed are required to submit the information found in Appendix B to aerial@kipr.org. KIPR has up to 5 business days to review the robot to approve or deny with justification.

Prior to the competition, teams must demonstrate to the Head Judge, or their representative, that the robot is safe to land by demonstrating the kill switch feature. Teams unable to do so will be unable to run. This demonstration can take place at any point during practice.

All teams must have a button switch attached to the computer that will safely land the drone. Without this switch, drones will not be permitted to operate. Teams will not be allowed to access their computer to get the robot to land. This kill switch must be located outside the netting, so plan on having at least 6' of cable.

## Interference

KIPR will be monitoring the airwaves. Our objective is to detect when teams maliciously interfere with the Wi-Fi communication link. If this is detected, then the Head Judge reserves the right to act swiftly and disqualify the offending team. If someone in the audience is detected as interfering, then the team they are affiliated with will be disqualified. Teams might be asked to provide a MAC address of a device associated with their team. Failure to comply may result in disqualification. Any other disruption, or the perception of disruption, may result in your team being disqualified.

Teams should embrace the Spirit of Botball. Teams choosing to intentionally interfere will be banned from ever participating in another KIPR aerial event.

Simply put, don't cheat. It won't be tolerated.

Please email questions to aerial@kipr.org.

# Good Luck!

## Appendix A – Approved Drones

- Parrot AR Drone 2.0
- Parrot Bebop 1
- Parrot Bebop 2
- Parrot Mambo
- Intel Aero RTF

## Appendix B – Application Information

Watch on the KIPR website for registration to open up for the KIPR aerial competition. If you have any questions feel free to email aerial@kipr.org. You will need the items below for registration.

- Team Name
- Web link to drone
- Rough dimensions of the drone
- Any safety features of the drone

If you already own the drone, then please provide clear photos (minimum 2) of the drone.

## Appendix C – Game Board Materials

| Material | Link |
|---|---|
| 22" Cube Cardboard Boxes | https://www.amazon.com/dp/B00BT4LWDA/ |
| Hula Hoop | https://www.amazon.com/dp/B079ZS9LCN/ |
| Hacky Sacks | https://www.amazon.com/dp/B000LL3WE4/ |
| Camouflage Material | https://bit.ly/2Qw9y3Y |