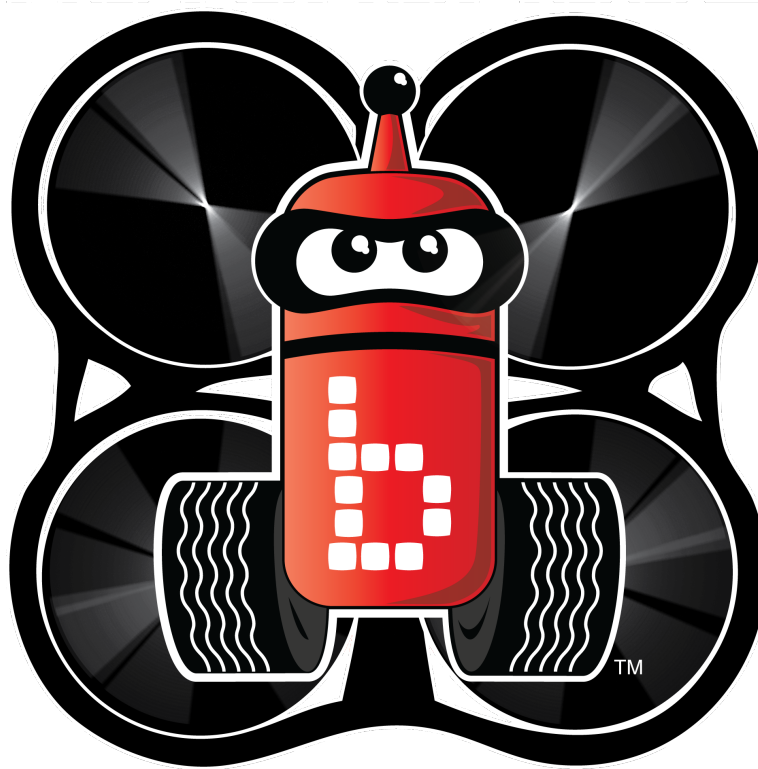


2016

Autonomous Aerial Robot Tournament

KISS Institute for Practical Robotics



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Table of Contents

KIPR / Botball / GCER Sponsors	3
KIPR Autonomous Aerial Robot Tournament	4
KIPR Autonomous Aerial Robot Tournament Game	4
This Year's Game: Search and Rescue	4
The Board	5
Zones	6
Game Rules	6
Randomization	6
Time	7
Movable Walls	7
Drone Navigation	7
UGV Navigation	8
Botguy	8
Zones	8
Penalties	8
Team Membership	9
Wall Visual Identifiers	9
Competition Rounds	10
Notable Changes from 2015 Game	10
Scoring	11
Tie Breaking	12
Robot Construction Rules	13
Tournament Logistics	14
Game Materials	15
Game Board Setup	15
Advice for Tournament Participants	15

KIPR / Botball / GCER Sponsors



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 <http://www.kipr.org/aerial-robot>.

For information on KIPR's Botball Educational Robotics Program for students in middle school and high school visit <http://www.botball.org>.

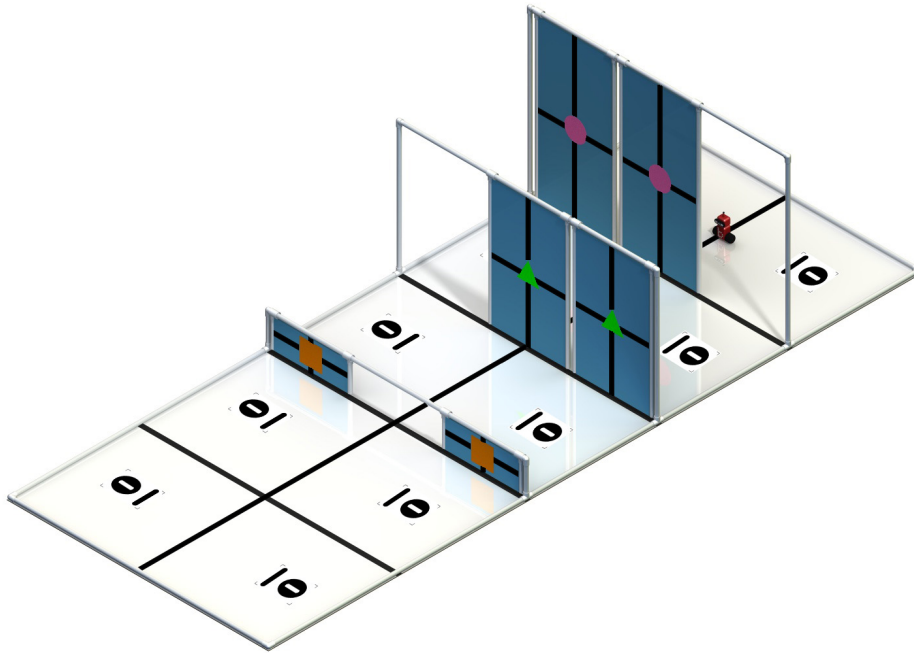
This Year's Game: Search and Rescue

The mission for this year's KIPR Aerial Challenge is to send an Autonomous Drone and Unmanned Ground Vehicle (UGV) through a structure, static environment, to recover Botguy. Your base station must map the environment and then direct the drone to fly safely through to scout ahead. An Unmanned Ground Vehicle can be deployed to recover Botguy and bring him back to the base station. Through the combination of Drones and UGVs, you can accomplish your mission to retrieve Botguy.

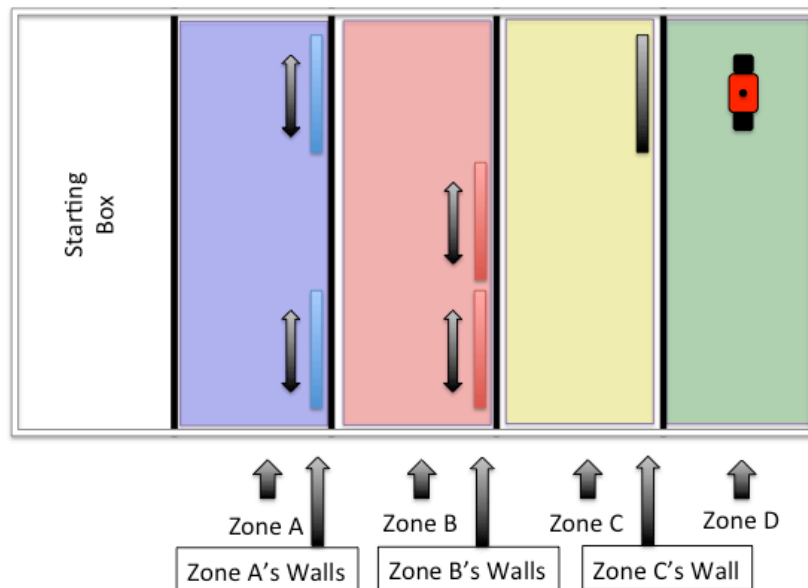
Three sets of movable walls will be placed at random locations before the start of the game. Your Drone must successfully fly to the other side and land next to Botguy. Being unable to reach Botguy with the Drone will hurt the mission. An UGV can be deployed to recover Botguy to bring him back to the base. A successful mission is defined as recovering Botguy, as well as all mission assets.

The Board

The KIPR Aerial Challenge Game Board is 8 feet by 20 feet. It is divided into 5 equal size zones as marked by black tape.

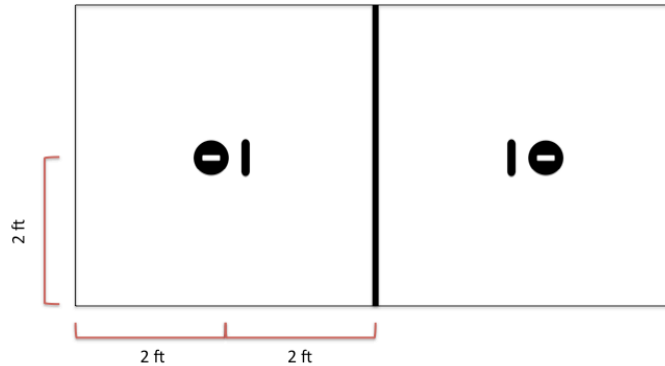


Note that the diagrams in this documents are meant for illustrative and descriptive purposes, rather than for accuracy. Please consult individual seconds for details on construction.



Zones

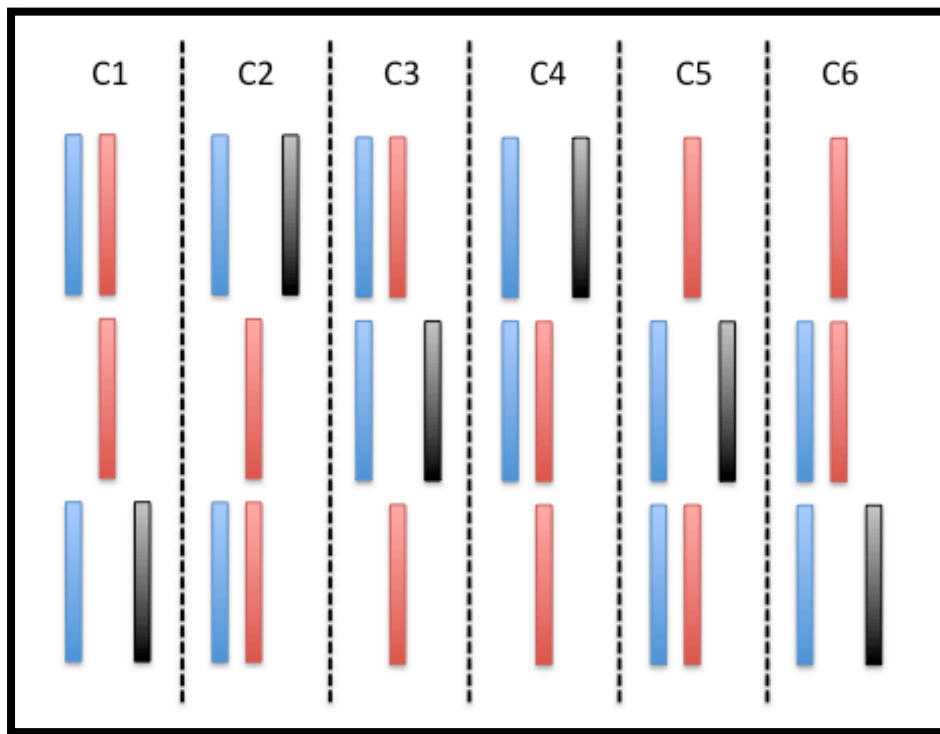
All Zones will have the [AR Drone navigational markers](#) and a black line running down the middle. The line will be composed of 1.875-inch Duck Brand Duct Tape. These markers will aid both robots for navigational purposes.



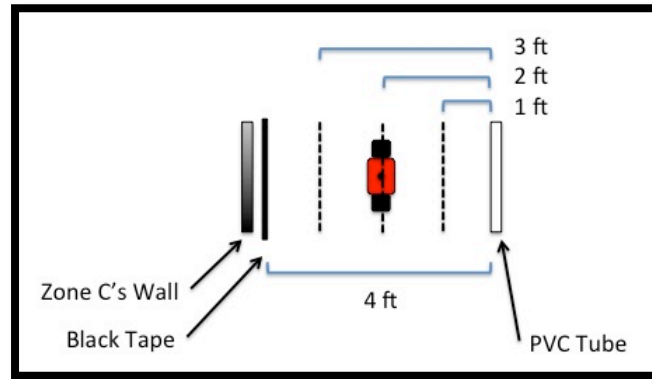
Game Rules

Randomization

On the game board, there are three sets of moveable walls that will be placed at random, but in only 6 possible configurations. These walls are located in Zone's A, B, and C. Wall positions are illustrated in the following diagram.



Botguy will be randomly placed within Zone D, behind Zone C's wall. He will be placed at one of three locations behind the wall. Botguy's possible positions are illustrated in the following diagram.



Once teams are set on the board, judges will activate a program on a KIPR Robot Controller that will instruct them where to place the walls and Botguy.

Time

Teams will have 180 seconds to complete their mission. The time will begin when the starting light turns on. Robots running after the 180 seconds will result in mission failure (disqualification).

Movable Walls

Each wall is of varying height so that the base station can distinctly map out their locations. The walls are 2.5 feet wide and have varying height described below.

Zone C's wall is not labeled as random since it will always be in the missing gap of Zone B's walls.

	# Walls	Random	Height (ft)
Zone A	2	Yes	1
Zone B	2	Yes	4
Zone C	1	No	6

Drone Navigation

The objective for the drone is to navigate to Botguy and land in Zone D. Flying over the Zone A's walls is permissible, however the drone must fly through Zone B's walls (in between and under wall height). A penalty will be assessed for flying over Zone B's Walls, and it is highly ranked in terms of tiebreakers. The Drone may not fly over Zone C's Wall. Doing so will also result in a penalty. Hitting any of these walls during the mission will result in penalties. All penalties apply when going to and from Zone D.

UGV Navigation

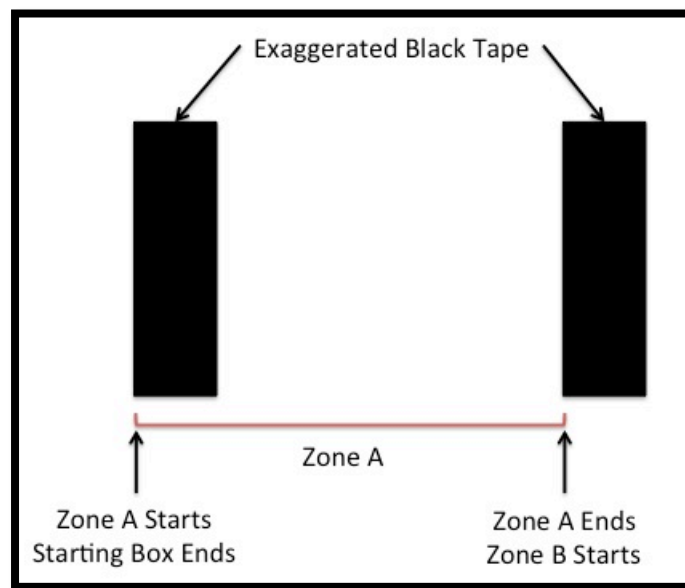
The unmanned ground vehicle must safely navigate through the walls to reach Botguy. Bumping the walls will result in a penalty. Your UGV may execute its mission as soon as the starting light turns on. It is recommended that the landing zone for the drone and the pick up zone for the UGV be coordinated appropriately to eliminate any accidental collisions. All penalties apply when going to and from Zone D.

Botguy

In order to score Botguy, he must be brought back to the starting box. He will only score if he is entirely within the starting box, as defined by the vertical projection of the inside edge of the PVC and black tape.

Zones

Reaching a zone is defined as the vertical projection of the black tape, as shown in the below diagram. Being within a zone, or the starting box, is defined by the robot being completely within the vertical projection of the zone. The following diagram illustrates how zone delineation is done.



Penalties

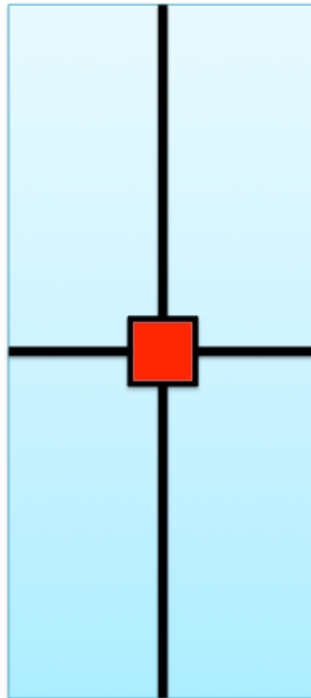
For violating fundamental aspects of this year's game, various penalties can be assessed at the judge's discretion. The robots should be within the game board at all times. For the drone, the objective for the game is to navigate through obstacles, not over them or around them. For the UGV, the objective is to navigate through the obstacles, not around them via outside of the game board.

Team Membership

Teams can be comprised of Middle and/or High School aged students (must be also competing in the International Botball Tournament), college students, professional engineers, hobbyists, poets, and anyone else fulfilling the criteria above are all encouraged to participate.

Wall Visual Identifiers

Distinct colored markers will be placed on the Zone B's and C's walls. The markers will be placed at the center of the walls, in the middle width-wise and in the middle height-wise. Each color marker will be 6 inches wide. In reference to facing outwards towards the opposite end of the board from the starting box, of Zone B's walls, the left wall will have a square shape marker, and the other will have a circular shaped marker. Zone C's walls will have a similar scheme, but a different color. Colors will be determined at the conference. In addition, a black border made of electrical tape will be placed around the marker to provide some contrast against the wall material. A vertical and horizontal line will be added to the panel using the black Duct Tape for visual purposes. In the past, blue foam core has been used as the material for the wall. An example of a 6-foot wall panel is as follows.



Competition Rounds

1. The robots 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 robots leave the start 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 robots must power down their mobility system within 180 seconds of the start lights turning on (ground robots should come to a halt and aerial robots should be on the ground).
6. Each team will have at least three competition rounds (the judges may increase the number for all teams, if they feel it is warranted and time is available).

Notable Changes from 2015 Game

- Addition of lines to the wall dividers for navigational purposes.
- Addition of border around marker on wall divider for navigational purposes.
- Addition of markers on ground panels for navigational purposes.
- Higher penalties for flying outside or over walls.

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. If there is a tie, then refer to the Tie Breaker list.

2016 AAV Scoring Sheet
JUDGES' CHECKLIST
☐ Table Reset
☐ Team Verified
☐ Robot Size Check
☐ Calibration
☐ Hands Off

Phase 1: Aerial Drone Identification

Task	Pts	Complete
Zone B Reached	20	
Zone C Reached	30	
Zone D Reached	40	
Landed in Zone D	100	
Landed in Zone D not on Botguy	50	

Total

Phase 2: UGV Rescue

Task	Pts	Complete
Zone B Reached	5	
Zone C Reached	5	
Zone D Reached	5	
Drone Present on Recovery	100	
No Drone Collision	10	
Botguy in starting box	50	
UGV in starting box with Botguy	5	

Total

Phase 3: Drone Recovery

Task	Pts	Complete
Landed partially in starting box	50	
Landed completely within starting box	100	
Landed not on Botguy or UGV	30	

Total

Sum of Mistake %

100% - Sum of Mistake %

Sum of Points Earned

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.

11

Tie Breaking

Scouting Ahead will be referenced as Phase 1.

Rescue Mission will be referenced as Phase 2.

Vehicle Recovery will be referenced as Phase 3.

1. Drone reached Botguy without hitting any walls.
2. Drone returned to starting box without hitting any walls.
3. UGV reached Botguy without hitting any walls.
4. UGV returned to starting box without hitting any walls.
5. Flawless Phase 1 (perfect score, no mistakes)
6. Flawless Phase 2 (perfect score, no mistakes)
7. Flawless Phase 3 (perfect score, no mistakes)
8. Higher Phase 1 Score = $(\text{Phase 1 points}) \times (100\% - \text{Phase 1 Mistakes})$
9. Higher Phase 2 Score = $(\text{Phase 2 points}) \times (100\% - \text{Phase 2 Mistakes})$
10. Higher Phase 3 Score = $(\text{Phase 3 points}) \times (100\% - \text{Phase 3 Mistakes})$
11. If Botguy is out of Zone D, then team with Botguy closest to the starting box.

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, an aerial robot is any self-powered aerial vehicle that is under autonomous computer control. The control computer can be on the aerial robot, or elsewhere on the team's entry. An aerial robot is not permitted to have a physical tethered connection to a ground robot.
2. Ballistic entries are not allowed -- nor are others which use high pressure or chemical rocket propellant (as per standard KIPR Open construction rules).
3. A team's entry (all materials placed on the game-board) must mass less than 10kg (22 pounds).
4. 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).
5. The team's entry may not contain or release pressurized materials at greater than 7 bar (100 psi).
6. 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.
7. 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 0oC (32oF) or above 50oC (122oF).
8. 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 should be shielded so as to be unlikely to damage the hoops.
9. Robots must operate autonomously (no external power or control from outside of the game board area will be allowed).
10. Each team may only have a maximum of five independent structures on the game board at a time.
11. Each robot must have a name suitable for broadcast over a PA system.
12. A team's entry may be made out of any materials or parts (including Botball and non-Botball kits) as long as the entry conforms to the construction rules above.

Tournament Logistics

1. If the judges determine that a robot violates the construction rules, whether or not a challenge 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 have a 10-ft by 20-ft ground footprint, prepare accordingly.
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 two minutes or less.
9. For each minute or fraction thereof in excess of 2 minutes the team's score will be reduced by 20%.
10. Game duration is 180 seconds or until team completes the challenge.
11. Lights will remain on for 175 seconds, and flash the last 5 seconds unless the judges stop the game because a robot has reached the opposite end zone
12. Once the starting lights are turned on, the round counts unless a judge rules outside interference
13. Robots must cut power to their motors and turn off or stop issuing motion commands to servos after 180 seconds or risk forfeiting the round
14. Mistakes are added at judge's discretion.
15. There are no instant replays, and attempts to use videos to question a decision will be ignored.
16. If a team is unhappy with the judges' decision, they should challenge it then and there. Once the score sheet is signed, there is no further challenging.
17. Challenges to scoring after the teams have left the table will not be considered.
18. Teams cannot touch, borrow equipment, modify robots or computers, or beam commands to another team's stuff (including their pit table) without the permission and presence of a member of that team
19. 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 Materials

The game surface is 8' x 20'

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

Game Board Setup

- A team's entry must be completely within their starting box (45.5" wide and 93" 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 Zone A and B walls at random locations.
- 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. Deal with it.

Advice for Tournament Participants

Test your robots from start to end:

1. Go through the entire starting sequence
2. Make sure you can calibrate to the starting light
3. Make sure the robots stop when they are supposed to: verify with a stopwatch!
4. Does the starting sequence work with very bright or uncertain overhead lights? (tournament will be held in a net containment on open flooring)
5. Test the shielding of your sensors!

Check <http://www.kipr.org/aerial-robot> regularly for rules updates.

Check out the KIPR Open and Aerial Robot Tournament discussion and FAQ at <http://community.botball.org>

Good Luck!