2019-2020 MN Space Grant Consortium (MnSGC) Intercollegiate Quadcopter Challenge

The Minnesota Space Grant Consortium (MnSGC), led from the Aerospace Engineering and Mechanics (AEM) Department at the University of Minnesota - Twin Cities (UMTC) (Director, Professor Demoz Gebre, and Associate Director, Professor James Flaten) is funding the 2019-2020 MnSGC Intercollegiate Quadcopter Challenge. This program is designed to enhance student and faculty capability at colleges and universities in Minnesota in STEM areas of interest to NASA - in this particular case, for un-crewed RC multi-rotor drones (AKA quadcopters). Oversight of this challenge is being organized by Professor Thelma Berquo and two undergraduate student teaching assistants at Concordia College, Moorhead.

Quadcopters are being used for this challenge because quadcopter kits are readily available. Compared to fixed-wing, radio-controlled airplanes, students can quickly learn to pilot quadcopters and they can be operated in small spaces (including indoors) with limited infrastructure (which is not the case with fixed-wing, radio-controlled airplanes). Each student team will start by building and learning to fly a basic quadcopter from a commercially-available kit (each team will use the same brand of kit, for uniformity). Students will then significantly modify their kits in order to mount sensors, actuators, and electronics necessary for the "exploration challenge." This will also involve some mechanical design and fabrication, giving the students experience with computer-aided design (CAD) software for design, documentation, and (potentially) fabrication with 3-D printing and laser cutting. In addition, the students will have to learn microcontroller programming and integration of electronics, sensors, actuators, and data-logging to ensure that their modifications function properly.

Challenge website:
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2019_2020/
Overview slides:
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2019_2020/Quadcopter_Kickoff_Slides_2019-2020.pdf

Photo showing learn-to-fly (toy) drone (at right) and larger kit drone (at left).

Synopsis of the 2019-2020 MnSGC Quadcopter Challenge.

In this challenge (AKA "competition", though without prizes) teams of college/university students will do the following:

1. Learn to fly a toy "Blue Heron" drone (at right in earlier photo).
2. Assemble a Flamewheel 450 drone using a Pixracer flight controller (at left in earlier photo) then learn to fly it (and tune it as need be).
3. Plan for "exploration" flying in an indoor area. The student teams don't know exactly what this will look like, but the photo below shows one possibility: a room with (a) various horizontal, vertical, and hidden surfaces (such as on a table or on a column) plus (b) various "targets" including things to take photos of for close-up examination and also mapping (with units) plus (c) things to characterize (might be hot, might be magnetic, etc.) plus (d) things like sand and water to try to retrieve at least 1 cubic cm samples. Teams will be allowed to fly their drone in and out of the exploration area and swap what it carries for various flights, but may not enter the exploration area themselves.
4. Outfit the drone with camera(s) (live video telemetry optional), a sample return device, and microcontroller-logged sensors (use an Arduino microcontroller (or something even better); measure <u>at least</u> temperature, pressure, relative humidity, magnetic field; additional sensors optional (but no guarantee that the basic sensors will be able to characterize all the oddities of the environment); live data telemetry optional)
5. Write one mid-project Preliminary Design Report talking about progress as of late January and plans for the remainder of the project – see posted PDR template and rubric
6. Practice flying, data collection (including sample return), and data processing
7. Make a 2-3 minute educational/promotional video about their experience in the project (due 1 week before the fly-off)
8. Do a (blindfolded) walk-through (carrying the drone, collecting actual data) of a sample exploration area the night before the fly-off to at least collect some sample data that could be analyzed if actual flying doesn't go well.
9. Do a 10-minute oral presentation before a panel of judges talking about what they have built and how they plan to use it for exploration flying.
10. Do a 20-minute (running time) fly-off on an indoor exploration course, monitored by judges. See posted "Overall distribution of points" document. Notice that 5 out of the 25 points for fly-off performance are "supplementary" – basically, "impress the judges by doing things particularly well and/or above and beyond the required elements."
11. Submit a 10-minute final oral report (in video format) talking about results – especially discussing graphs of sensor data, maps, photos/videos taken, etc. The materials discussed in this report will also be submitted electronically, if judges want to take a closer look.

Key dates:

- October 2019 – kick-off with faculty advisers (in person) then student teams (remotely) TAs hold videocons with teams every 2 weeks to discuss progress and handle questions.
- January 27, 2020 – PDR (written report) is due
- March 20, 2020 – promotional video is due
- March 27 & 28, 2020 – walk-through (evening, not judged), oral presentations (morning), fly-off (mid-day into the afternoon)
- April 17, 2020 – final video (and supplementary materials) is due

Photo showing a potential exploration area. Note table, column, bucket (of water), pile of sand (on table), photography targets on top and back side of column (not directly visible to the team from their “home base”), two other “interesting” targets (both white, near right side of the area).