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

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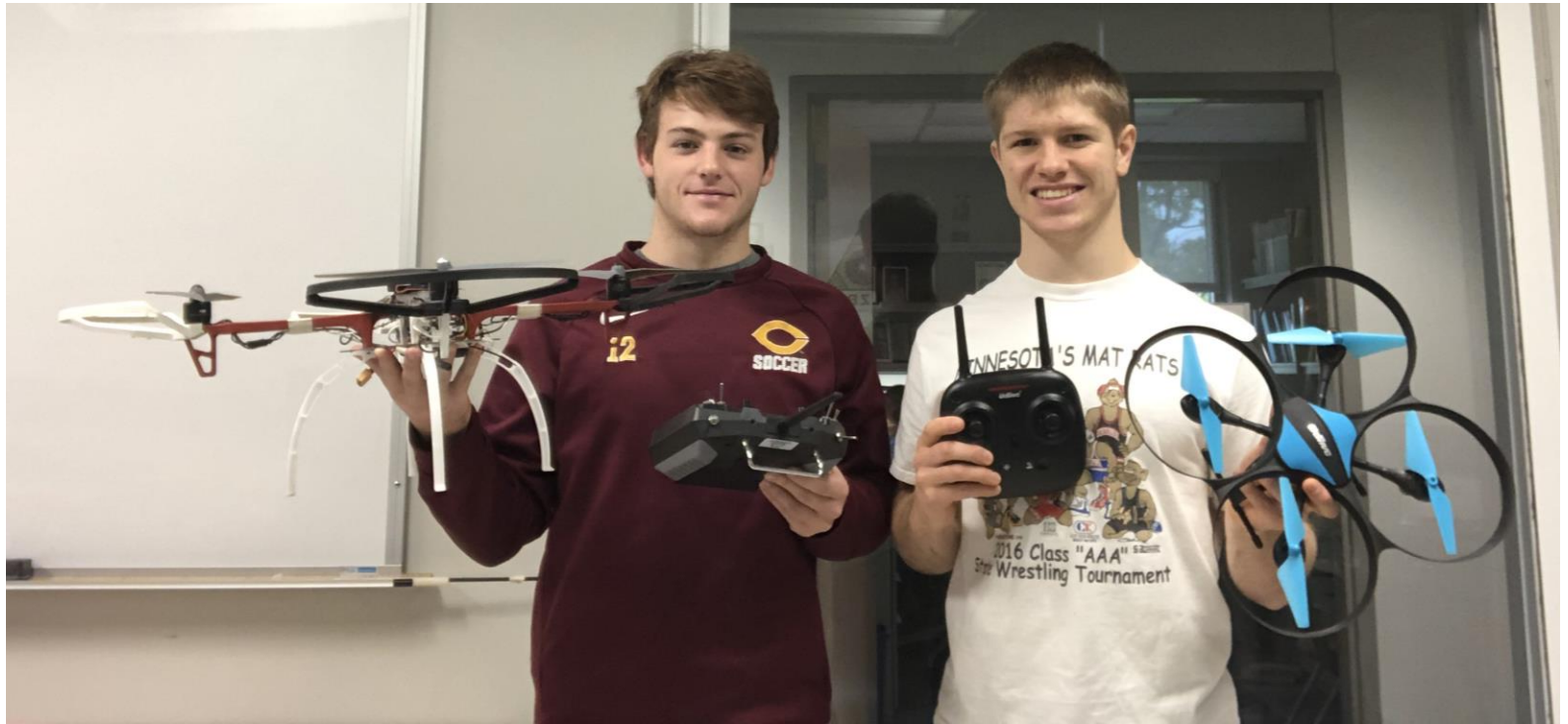

NASA's MN Space Grant Consortium (MnSGC)
2019-2020 Intercollegiate Quadcopter Challenge

Agenda for student team kick-off

Introductions (to MnSGC, to teams, and to the quadcopter challenge)
Blue Heron (commercial) drone
Looking over the provided parts (mostly for the drone kit)
Comments about building the kit, including soldering
Comments about CAD
Comments about Arduino microcontroller programming and sensor suite wiring
Comments about reports: written, oral, video
Comments about the in-person fly-off
Logistics for team check-in videocons with TAs

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Underlying goals of this program (Note: STEM stands for Science, Technology, Engineering, and Mathematics)

- Provide opportunities for 2-year college / 4-year college / university students (and faculty) in Minnesota to engage in more aerospace-related activities, either curricular or extra-curricular
- Increase the number of 2-year college / 4-year college / university students that graduate with STEM degrees and get jobs in STEM areas and/or pursue additional studies in STEM (2-year-school to 4-year-school transfers; 4-year-school to graduate school)
- Enhance the diversity (gender, race, ethnicity) of higher education students in MN studying in STEM areas
- Increase the ability of college faculty members in Minnesota to deliver/support aerospace-related content in areas of interest to NASA
- Enhance the number of higher education students and faculty in Minnesota engaged in UAV (un-crewed aerial vehicle) activities, including RC multi-rotor "drones"
- Hone skills useful in aerospace build projects (and beyond!) including flying/building/tuning drones, CAD (for design, documentation, and, fabrication), microcontroller programming, wiring/soldering sensor suites, and more
- Bottom Line: Learn lots, have fun, be even more motivated to stay in STEM!

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Participating Institutions (and faculty advisers to student teams)

Century (Community) College, Mahtomedi	Megan Jaunich <Megan.Jaunich@century.edu>
Concordia College, Moorhead	Matthew ArchMiller <marchmil@cord.edu>
Gustavus Adolphus College, St. Peter	Charles Niederriter <chuck@gustavus.edu>
Hamline University, St. Paul	Kevin Stanley <mstanley01@hamline.edu>
Leech Lake Tribal College, Cass Lake	Eric Kuha <eric.kuha@lltc.edu>
Minnesota State University Moorhead, Moorhead	Linda Winkler <winklerl@mnstate.edu>
Normandale Community College, Bloomington	Susan Kasahara <Susan.Kasahara@normandale.edu>
University of Minnesota – Crookston, Crookston	Christine Bakke <cbakke@crk.umn.edu>
University of Minnesota – Twin Cities, Minneapolis	James Flaten <flate001@umn.edu>

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Aspects to the challenge

Learn to fly a commercial drone
Build a larger drone (from a kit) then fly/tune it
Plan for "exploration challenge" including photography, microcontroller-logger sensors, sample collection
Preliminary Design Report (PDR)
Build accessories for the drone – practice flying them (indoors)
Make a promotional video talking about learning and progress (in advance of the in-person fly-off event)
Walk-through of a sample exploration area (to collect "back-up" data) at the in-person fly-off event
Oral Report (to a panel of judges) at the in-person fly-off event
Exploration flying: photography (horizontal, vertical, and hidden surfaces), environmental sensing, sample return
Data analysis, including generating 3D maps of exploration region
Post-Challenge video to present results from in-person fly-off event

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Dates

Oct. 13, 2019: faculty adviser training (in person) and distribution of materials
Oct. 27, 2019: student team kick-off (by videocon)
Rest of fall, continue in spring: check-in videocons with TAs about every 2 weeks
Jan. 27, 2020: due date for written PDR report – progress, plans for challenge build/operations
Mar. 20, 2020: promotion video due (posted)
Mar. 27 - 28, 2020: walk-through on Friday evening 6 to ~9 p.m.
oral presentations then fly-off on Saturday, 9 a.m. to ~3 p.m.
also submit flight code for microcontroller sensor suite system
Apr. 17, 2020: final video with fly-off results due (posted)
also submit written copies of maps, graphs, photos, etc. (i.e. items discussed in video)

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Website (repository for documents – not interactive)

https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2019_2020/

Websites (historical) for two years of the MnSGC's Community College Quadcopter Challenge

https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2015_2016/

https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Competition_2014_2015/

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Agenda for student team kick-off

Introductions (to MnSGC, to teams, and to the quadcopter challenge)
Blue Heron (commercial) drone
Looking over the provided parts (mostly for the drone kit)
Comments about building the kit, including soldering
Comments about CAD
Comments about Arduino microcontroller programming and sensor suite wiring
Comments about safety (LiPo batteries, spinning props, soldering irons, etc).
Comments about outdoor flying (note – this challenge only expects in-door flying)
Comments about reports: written, oral, video
Comments about the in-person fly-off
Logistics for team check-in videocons with TAs

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Provided-parts list

1	MN Space Grant Intercollegiate Quadcopter Challenge - 2019-2020 - parts provided		sum	872.581	
2					
3	description	cost ea	number	total cost	notes
4	DIY drone book	17.42	1	17.42	Kindle version also available
5	commercial drone - Blue Heron from Force1	104	1	104	Use discount code "UWAPOLLO"
6	Generic - Flame Wheel Landing Gear (4)	8.69	1	8.69	
7	SummitLink - F450 Prop Guard (4)	17.99	1	17.99	
8	Flame Wheel F450 frame, 960KV motors, 30A ESCs, 9450 props (3 pair)	198.9	1	198.9	
9	even lower current rating option (same weight): ZIPPY Compact 3700mAh 4S 25C (35C burst), 343 grams	30.57	1	30.57	
10	Adapter between HXT 4mm and XT-60 plugs	1.7	0.5	0.85	will need this with the ZIPPY battery
11	Taranis QX7 lower-cost 16 channel transmitter (price with battery pack)	113.99	1	113.99	
12	Taranis Q X7/S OpenTX User Manual (sold separately)	14.5	0	0	not provided - purchase if desired
13	FrSky R-XSR (rc receiver)	19.7	1	19.7	
14	mRo PixRacer $15 Autopilot kit (included GPS module uBlox M8N GPS)	240.7	1	240.7	
15	iMAX B6AC V2 Balance Charger and Discharger	54.95	1	54.95	
16	extra USB for programming quadcopter 3-foot, 3-pack	7	0.333	2.331	
17	XT60 Female to XT30 Male adapter for charging QX7 battery pack	3.9	1	3.9	ordered - never came in
18	Arduino Uno	23.38	1	23.38	
19	battery jack	2.95	1	2.95	
20	tiny breadboard	3.95	1	3.95	
21	microSD card breakout (but not SD cards)	4.5	1	4.5	
22	1 Gig microSD card	4.95	1	4.95	
23	Dallas one-wire digital temperature sensor	2.84	1	2.84	
24	servo micro-size	5.95	1	5.95	
25	jumper wires kit 140 pc	6.2	1	6.2	
26	USB A male to B male programming cable 6 ft	2.37	1	2.37	
27	TMP36 analog temperature sensor	1.5	1	1.5	

You will also need: soldering iron, laptop, CAD account, Arduino IDE, additional sensors, some basic tools (see TA notes for which ones they used), safety goggles (to use whenever propellers are spinning)
You might also want/use: different camera(s), 3D printer, laser-cutter, extra drone batteries

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Link to TA notes (about building drone kit, tuning it, and more) – watch these notes – they will evolve

https://docs.google.com/document/d/1SgcNd4dhYuZK56H-KQk4vkFfbZR0HSBnaGGZdTkXJbs/edit?usp=sharing

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Arduino microcontroller training links

Integrated Development Environment (IDE) – a free download
https://www.arduino.cc/en/main/software

Training slides for included parts
https://docs.google.com/presentation/d/1AVQmmOjnsAqBF6LHIkpAUVgMlFVTAjBmr9QdE6ch0lk/edit?usp=sharinghttps://docs.google.com/presentation/d/1AVQmmOjnsAqBF6LHIkpAUVgMlFVTAjBmr9QdE6ch0lk/edit?usp=sharing

A more-thorough set of slides (which calls for part that might be useful but are not provided)
https://docs.google.com/presentation/d/1eIsCDgpDu-nCz0vGucmX006oPLuZxcmLnavc_X0pgl8/edit?usp=sharing

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Judged Aspects of the Quadcopter Challenge (relative weights TBA)

1. Written PDR (a template will be provided listing topics to cover; page limit TBA)
   - Progress on building/tuning/flying drone from kit, plans for accessories/operations for fly-off event
2. Promotional/educational video
   - 1-2 minutes long, posted to YouTube, voted on at fly-off event
3. Oral report (a template will be provided listing topics to cover)
   - 10 minutes before panel of judges followed by Q & A
   - Also submit copy of code for in-flight microcontroller-logged sensor suite, actuators, etc.
4. Fly-off event (see next page for more details)
5. Final video with fly-off results (no template provided)
   - 10 minutes max – use the time wisely!
   - Include video footage from the fly-off event (video/photos take by drone and video watching drone)
   - Analysis of data collected during fly-off or, if that didn't go well, data collected during the walk-through
   - Also submit written copies of maps, graphs, photos, etc. (i.e. the items discussed in video)

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Judged Aspects of the Quadcopter Challenge (relative weights TBA) continued

4. Fly-off event
   - 20 min (running time) for general characterization and mapping of an indoor "exploration region": take general photos and/or video, log environmental conditions using microcontroller-logged sensors (at least measure temperature, pressure, relative humidity, and magnetic field – additional sensors optional), then generate 3-D map(s) (i.e. include elevation variation) with real units
   - Take high-quality images of specific targets on horizontal, vertical, and hidden surfaces
   - Probe (temperature and magnetic field at least) and sample return material (at least 1 cubic cm) from fluid targets (e.g. water) plus dry or wet granular targets (e.g. sand, soil, gravel)
   - Allowed to swap out camera(s), sensors, etc, but practice being very efficient if planning to do so
   - Camera and sensor data must be logged (for post-flight processing) – telemetry of data in real-time by radio is optional, but might be helpful in using the exploration time most effectively

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What the "exploration area" might look like
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2015_2016/Sample_Exploration_Area_Photos.pptx

What a map of that "exploration area" might look like
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2015_2016/Sample_Exploration_Area_Map.pdf

Some photos from a past MnSGC Quadcopter Challenge walk-through and fly-off event
https://www.flickr.com/photos/141506412@N06/sets/72157667608958096/