MN Space Grant 2014 – 2015

Community College Quadcopter Competition

Critical Design Review

Team Name

[Insert a Meaningful Photo or Figure (like a logo)]

Written by: (full names of all students)

Advisor:

Institution:

Report Date:

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1. **Introduction** *(Remove all explanatory text before submission; start with the text from your PDR and improve/expand on it as need be)*

Introduce the overall project with a general description of what you are trying to accomplish and why you are doing it. Also introduce your team members and include a team photo with individuals identified, either on the photo or in a caption. Team roles will be described in the organizational chart later but a brief description about who has been working on what part of the project might be helpful here.

1. **ELEV-8 Build/Fly Progress (Including Rotor Protection)**

Report, using both text and photos (note: every photo, diagram, and graph needs a number and a caption), on the overall build of the ELEV-8 kit. Comment about as how build went, especially what was challenging, and any deviations you made from the instruction manual (such as installing a different flight controller board, and why). Describe your rotor protection. Include CAD diagrams with key dimensions – at least one at an oblique (angled) view. Include comments on how and why the design was chosen, designs that didn’t make the final cut and why (maybe), the material(s) used, price, how it was fabricated (does not have to be using laser cutting or 3D printing), and the finished weight. Include photos of the rotor protection on (and possibly off) the quadcopter. Discuss the process of learning to fly the ELEV-8, including your experiences with toy quadcopters, flight simulators, etc.

1. **Progress and Plans for Competition Challenges**

Items you will want to include in this section:

- Plans and progress on the team’s promotional/educational video.

- Discuss competition plans regarding rotor protection – especially, will it be always on, always off, or some of each? If not “always on” include notes about ease of removal.

- Talk about continuing to improve flying capabilities, especially with respect to the “multi-pilot” challenge (basic flying (with a toy is OK), 3 team members minimum) and “competition/precision” flying (at least 1 team member, preferably more, ready to fly the ELEV-8 through its competition paces). What piloting benchmarks remain?

- Document progress on the “camera mount” challenge: Include at least one (conceptual) sketch plus the final CAD design from which the camera mount was printed, complete with dimensions and at least one oblique view. Include photos of the camera mount with and without the camera in place, in both the “down-view” and “out-view” configurations. Discuss fabricating the camera mount – remember this must utilize 3D printing and/or laser cutting. Discuss the camera(s) selected. Discuss and illustrate your out-view and down-view solutions. Explain when you will use which view in competition and describe how you will switch between the two views – manually swap mounts, manually tilt the camera in a single mount, remotely tilt a single mount in flight, etc.

- Describe progress on the “close-up imaging” challenge: Will this be the same camera that is being used for general exploration and mapping? (Remember that only one non-FPV camera may fly at a time). Discuss ideas about how to focus and steady the camera, maximize/optimize resolution, and image targets on both horizontal and vertical surfaces. Include test photos taken of detailed targets on both horizontal and vertical surfaces.

- Describe progress regarding the “exploration” challenge: What sensors will you carry? Why were they selected? How often will they be logged? How will they be mounted? (Note – the running quad might mess up the readings on some types of sensors.) How will you identify an “anomaly” in temperature, magnetic field, etc? Will the quad notify the team in real time if it finds an anomaly and, if so, how? Describe plans (here or in the following sections) for generating maps that include elevation and real units. Discuss the Arduino microcontroller programming that was done including issues you had, if any. Include figures/photos of hardware and discuss flight operations associated with sample return (e.g. collecting a fluid sample or granular sample from the exploration area).

- Discussion (briefly) the main candidates considered for your “unique capability” and explain which one was selected and how it was implemented. Include figures, photos, and/or data relating to the unique capability. Discuss removability, if you plan to remove this feature during the competition itself.

1. **Plans for Competition Flight Day Operations**

This section describes plans for operations and roles during the competition flight day, which should be quite well-developed by now. Items to be considered are (a) equipment needing to be switched out during exploration (if any), (b) how (and when) the camera(s) will switch between out-view and down-view, (c) how to get real units on maps (e.g. how to establish horizontal and vertical scales), (d) who will play what roles during flights (e.g. if you have live video but don’t want the pilot to see it, since then you may not use it for data analysis, who will watch the video and how will they communicate with the pilot about what they see and what they want him/her to do next?), (e) how will you fly to collect sample(s) and how will you check if the sample return is large enough (1 cc, min.), etc. Be specific and thorough – the more you think out (and practice!) in advance, the more efficient and effective your team is likely to be.

1. **Progress Preparing for Post-Competition Data Analysis**

After the competition is over you will have 2 weeks to prepare your maps and data for the final report. Discuss your plans for doing that data analysis, including what you explicitly expect to practice doing (hopefully everything!) in advance of the competition – this exercise will inform you how best to handle your quadcopter during the exploration phase to ensure that you collect adequate data and video so that you can produce high-quality maps and data plots after the competition. Thinking about (and practicing!) post-competition data analysis in advance might also motivate you to collect “extra” data, such as filming the entire flight of the quadcopter during the exploration with a fixed camera mounted near the pilot station. This section should include at least some figures and/or sample video-stills to indicate the types of photographs you plan to take in competition and discussion about how you will proceed from them to generate maps. Talk also about your plans to connect logged data points with specific locations on the map. For example, if data point #297 indicates a hot spot, how will you know exactly where that hot spot is physically?

1. **Organizational Chart (and perhaps description of roles)**

Create an organizational chart (an “Org chart” – look up examples on the internet to see what this might look like) stating team roles and listing who is fulfilling each. Describe here (or else in the Introduction) who is involved in each part of the project and explain (briefly) what each part entails.

1. **Budget and Parts List**

List all parts (use an Excel spreadsheet format). Include vendor, cost, and any other details that may be relevant (such as weight). In this report it is OK to skip listing travel costs, scholarships, stipends to advisors, and institutional indirect (if any), but someone needs to be watching over those as well, as part of the overall budget. Describe or list (separately) your planned future purchases, if any.

1. **Schedule**

This will include past as well as future dates, sort of like a journal. Detail how the past semesters went (what you got done, how long it took, etc.). Lay out a timeline for the upcoming final weeks and what you are planning to accomplish and by when. Look up “Gantt chart” to see one way in which this might be laid out.

1. **References**

Cite web links and any other references you have used. This will definitely include the ELEV-8 instruction manual and might include links to instructional videos, Arduino teaching materials, data sheets for sensors, etc.

1. **Appendices**

This section is for other supporting documents. For example, include the full list of challenges handed out at the kick-off as Appendix A. Include the Arduino flight code for logging sensor data and possibly other functions like controlling servos, flashing warning LEDs, etc. Include other supporting calculations, if any.

1. **Acknowledgements and Words of Wisdom**

Explicitly list specific people and institutions you’d like to thank including (at least) NASA’s MN Space Grant Consortium (MnSGC) for funded this competition, your adviser(s), your institution (for agreeing to field your team in this competition), and people at the U of MN who have helped out. Conclude your CDR with 3-5 “Words of Wisdom” you’d like to share with potential future quadcopter competition participants. These might be pithy comments or bullet points listing some things that you found particularly useful or things you wish you’d known earlier or things you want them to try (or to avoid). One of mine, to motivate your thinking, is **“Learn from the mistakes of others – you cannot possibly live long enough to make them all yourself!”**