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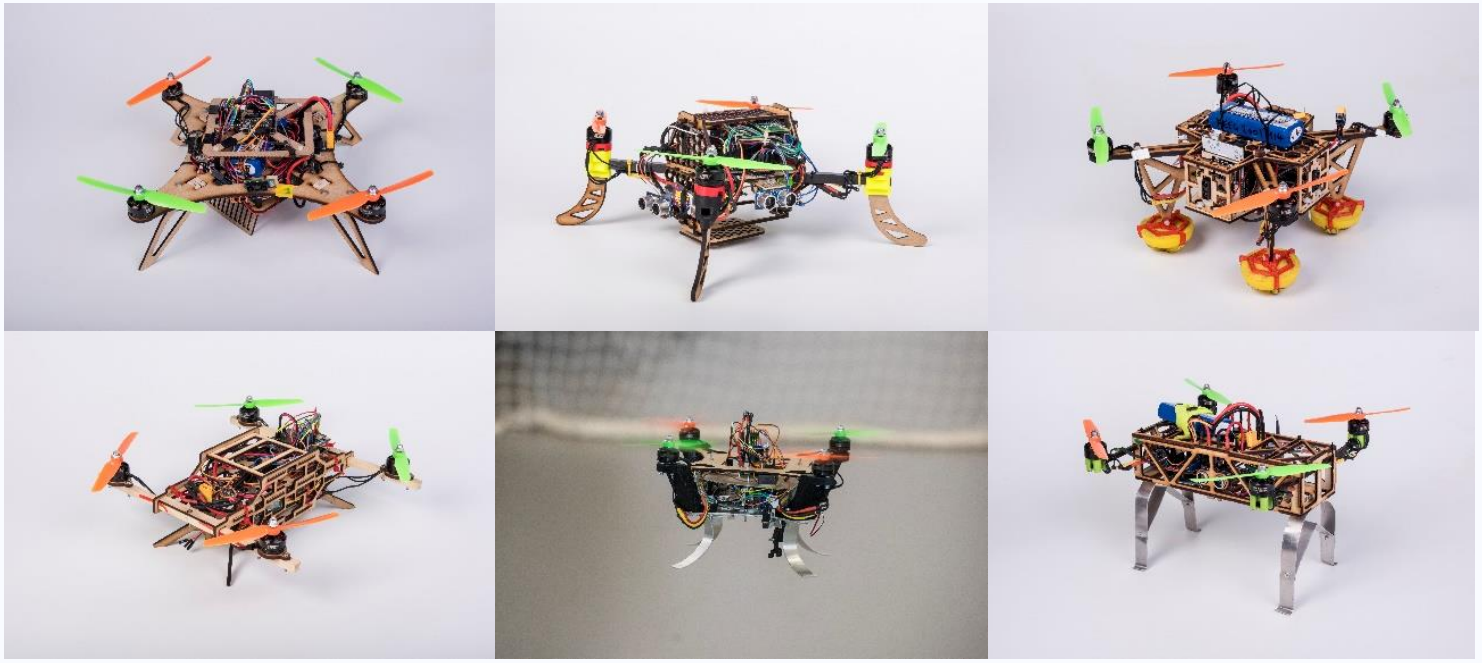
FEEG2001 – Multirotor Design Challenge

2023-2024

Dr David Toal

Welcome

- Welcome to the FEEG 2001: Multirotor Design Challenge!
- Over the next 11 weeks you will combine all of the things you have learnt already in FEEG 2001 and other courses to design, build and (hopefully) fly a quadcopter



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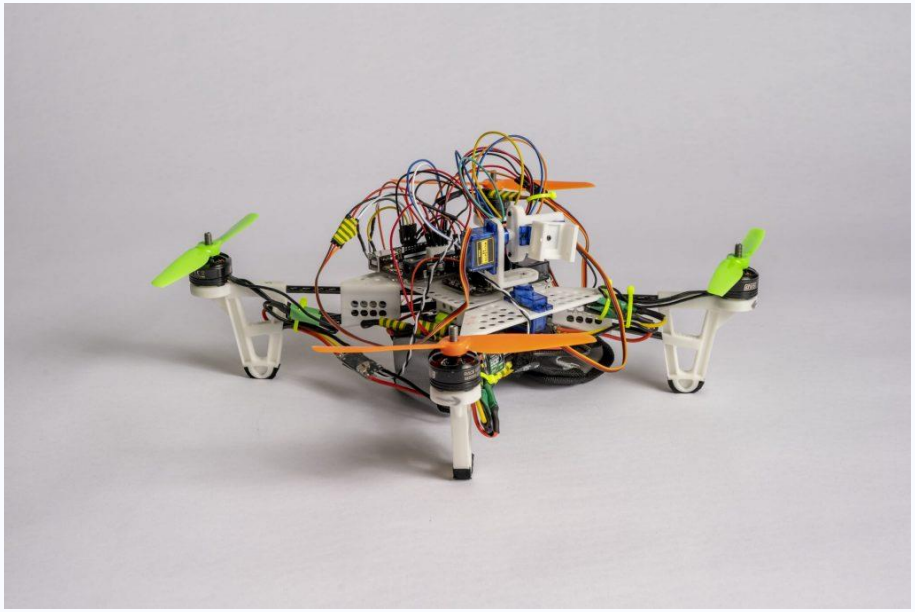
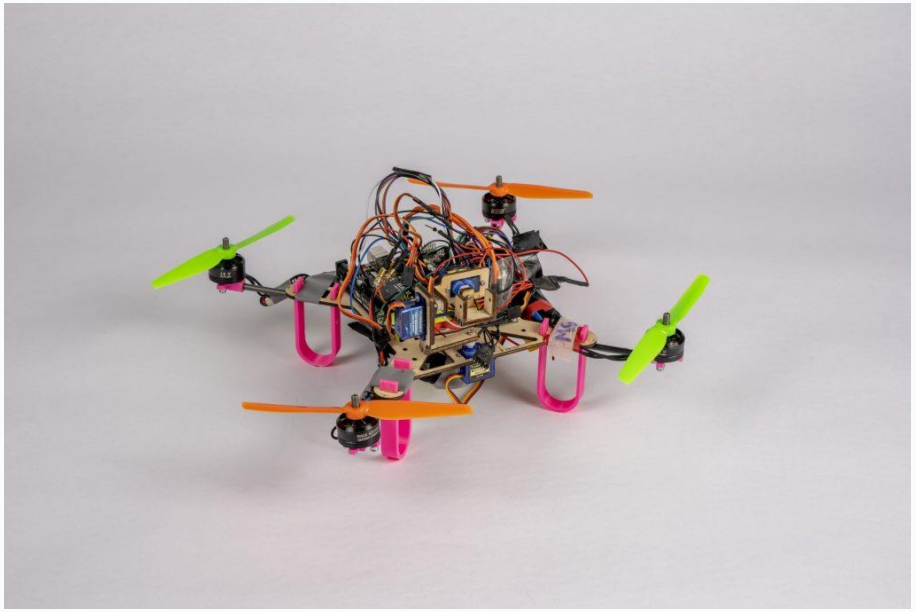
Multirotor Project

Project Overview

- To design, build & fly a quadcopter with a self-levelling camera gimbal and flight recorder
  - Please read the detailed design brief on Blackboard





Structural Design

- Design and build the main structure for your aircraft e.g. frame & landing gear

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Structural Design

- Arms and motor connectors should be capable of resisting all torque and bending loads
- The landing gear should be capable of surviving hard landings
- Structural analysis should form part of an iterative design process
  - Start with simple hand calculations – try not to reach for FEA when at the concept stage

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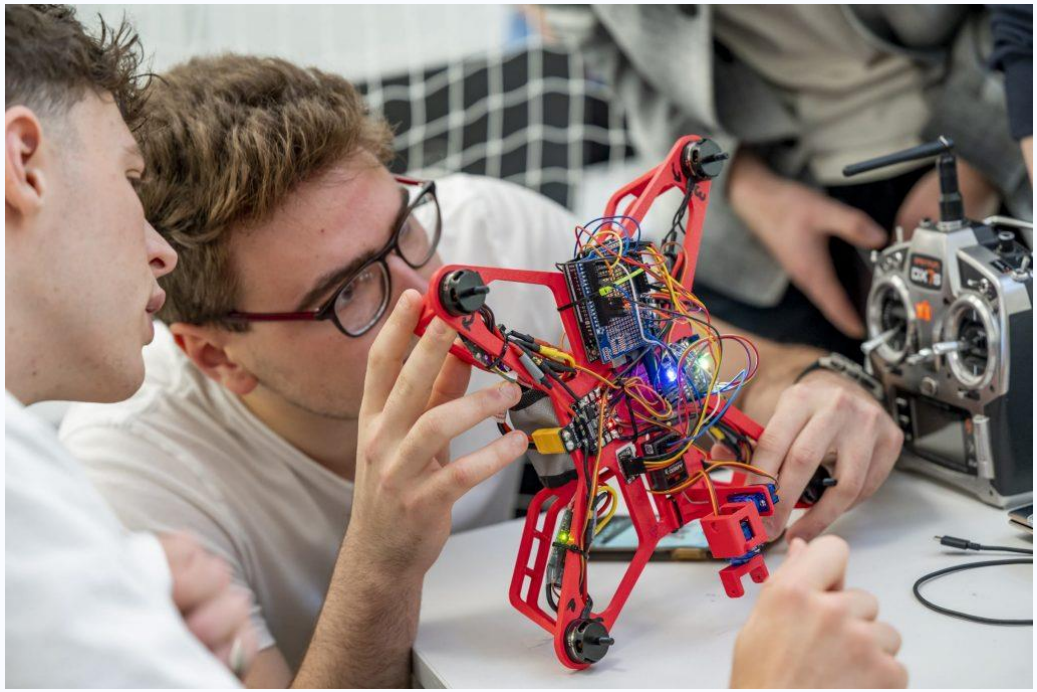
Gimbal Mechanism

- Design a camera gimbal mechanism:
  - At least two axis of movement (pitch & roll)
  - Remotely switch between locked and self-levelling modes
  - Housing a mini HD FPV camera

Arduino Flight Computer

- Develop and implement an Arduino-based system to
  - Control the gimbal mechanism as per the design requirements
  - Record flight data to a SD card from any sensors on board the aircraft



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General Design Constraints

- The quadcopter motors should be placed 235.0mm square
- Motors along the diagonals should spin in the same direction
- One set of motors should spin clockwise, the other anticlockwise
- Only the provided flight systems may be used (batteries, flight controller, motors, propellers etc.)
- Arduino components can be used in any configuration or combination
- Only an Arduino UNO may be used (multiple boards are permitted)

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Additional Design Constraints

- Total aircraft mass <0.65kg
- Landing footprint of 275mm square
- Camera should be placed above the plane of the rotors
- The flight controller should be capable of remotely being armed/disarmed
- The aircraft should be ready to fly within 5 minutes
- The battery should be housed within the provided li-po bag and secured with the provided Velcro strap

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Assessment

- The general scheme is as follows:
  - 10% - From Semester 1 Activities
  - 0% - Design Context Overview
  - 0% - Design Presentation
  - 0% - System Review
  - 50% - Performance Test
  - 40% - Final Report

Formative Assessment

- See the provided documentation on Blackboard

Design Context Overview (Week 3)

- Formative team presentation
- 10 mins including Q&A
- 5 PowerPoint slide (excluding title slide)
- Covering:
  - A list of group members and their roles
  - Design concepts, presented as annotated drawings/diagrams
  - An initial design specification
  - Preferred design concept to develop further inc justification
  - Technical description of the current working design in development
  - A project plan in the form of a simplified Gannt chart – showing what will be done when and by whom.

Design Presentation (Week 5)

- Formative team presentation
- 10 mins & 5 mins Q&A
- 8 PowerPoint slides (excluding title slide)
- Covering:
  - Overview of your chosen concept & detailed design specification
  - Technical description of the current design in development
  - Design evaluation and analysis to identify areas of assured performance and potential technical risks
  - A more detailed Gannt chart – showing progress and the critical path
  - Key questions the group must resolve
- Engineering drawing review

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System Review (Week 9)

- Carried out during the timetabled session on **22nd April** in the design studio
- It's recommended that during this review each group:
  - Present their aircraft for inspection along with any other materials under construction
  - Present a working prototype of their flight computer
  - Prepare to answer questions on any tasks still to be completed
- Each review will last 5-10 minutes

Demonstration for Performance Assessment (Weeks 10 & 11)

- Summative test of your aircraft & gimbal

- Design innovation – 15%
- Adherence to design brief – 15%
- Prototype build quality – 20%
- Flight & bench test performance – 50%

Design Report (16th May)

- Template provided on Blackboard
  - Only one member of your team submits the report
- The report template should be populated as you go through the project - report sections align with the stages of your project.
- You should try and include any testing data obtained in your demonstration sessions.
- You should be editing your report in the week before your submission.

Project Completion incl. Disassembly (Week 12)

- The project concludes in week 12 after your prototype demonstration and report submission
- At this point you will be asked to:
  - Disassemble or remove project builds not selected for display at the Design Show,
  - Return all salvageable electronic and mechanical components to the project leads, and,
  - Empty storage boxes of all contents.
- NOTE: Please design for disassembly & re-use

Design Project Teamwork and Logbooks

- Hopefully you are already aware of which team you are in – this is published on Blackboard
- We recommend that you:
- Agree a team leader
  - Someone responsible for overall coordination and management
  - Do this early in the project before research or design work
- Assign roles to all team members, including the team leader
  - Discuss your individual interests, skills you'd like to develop
  - Develop sub-groups
  - Remember you Belbin roles from part 1 these may help balance the team

Design Project Teamwork and Logbooks

- Roles including a team leader can be changed by consensus or the majority consent of the team
- Support each other in developing your skills
- Practice sharing information - any member should be able to explain all aspects of the team's design
- Keep shared records of design information and actions
- Maintain an individual logbook/journal
  - A template will be provided and you may be asked to show your logbook/journal to members of staff
- Your logbook/journal will provide evidence of your individual contribution and will inform your preparation of assessed items such as the report.

Team Issues

- It is common for teams to experience issues e.g. a lack of engagement, a breakdown in communication etc.
- The team leader can be replaced at any time by the majority consent of the team, or at the request of the Project Leader
- It is the team leader's responsibility to manage and address these issues in the first instance by calling a team meeting or speaking to the individual team members in question
- It is important that persisting issues are communicated first to your project leads and potentially to your module lead

Provisions

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Design Provisions?

- Every team will be provided with a number of provisions:
  1. Transmitter/receiver binding instructions
  2. Manuals for provided components
  3. Basic wiring loom schematics
  4. Flight controller guide
  5. FAQ document

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Blackboard

- All of the provided data files can be found on Blackboard

  FEEG 2001 > Sem 2 Design Projects > Multirotor Project

- If any additional files are uploaded I will send out an email alert to each group

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Project FAQ

- A document with frequently asked questions has been provided
  - Compiled from questions/issues raised in previous years
  - This will be updated periodically throughout the year
  - If you have a question check here first, chances are it's been asked before
- Please check your emails for updates and general advice

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Provided Components

- One flight controller
- Four speed controllers
- Four motors
- A 6 channel receiver
- One power distribution board
- One 6DOF sensor
- One SD card breakout board
- Other bits and bobs
- You already have an Arduino kit with servos etc.

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Provided Components

- **All provided components should be returned at the end of the semester**
- **If you do not need a component return it!**

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Materials & Manufacturing

- The FEEG2001 Projects Guide and Design Briefs document contains a full description of materials and facilities that are available

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Studio & Workshop Sessions

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Design Workshop & Studio Sessions

- Every week you will have a 3 hour session timetabled in the design studio (177/3011)
  - Quadcopter, Monday mornings (9:00-12:00)
- I will be present at the majority of timetabled sessions
  - Except weeks 3 & 5 due to the presentations
- There will also be some postgrad assistants present to answer questions
- Remember that the design studio will be used by other projects throughout the semester

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Clashes?

- Some of you may have clashes with labs for other modules
- If so these **other labs take priority!**
- Your attendance is typically a mandatory part of these modules **do not miss them!**
- While you are attending another lab your group can still meet in the design workshop and continue with the project
- If you discover your whole group will miss a session please tell me in advance

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What Are These Sessions For?

- These sessions give each group:
  - Dedicated design time
  - Dedicated time to ask questions and raise any issues
  - Dedicated build & testing time
  - Dedicated build and storage space

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What Are These Sessions For?

- These sessions are:
  - Not formal lectures – you are free to work as you see fit
  - Not to be missed – other than these sessions you may not have much access to the workshops, **use this time wisely!**
  - Not the only time you should be working on your designs – group meetings and computer based work can, and should, also be done outside of these sessions
    - It may help to plan what you will do during the workshop sessions in advance

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Weekly Supervision

- I will attempt to spend time with every group during each session
- Keep a record of what each group member has been doing over the previous week
  - Create a set of PowerPoint slides which are continually appended as the project progresses
  - 1-2 slides per student with images and a few bullet points will suffice
  - Put each students name against the relevant slide
  - I will ask you to take me through these each week

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Safety

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Batteries

- If you need a Li-Po battery to test out your design ask the technician, you will be asked to sign for it and it should be returned at the end of each session
- Students are **NOT** permitted to charge any Li-Po battery
- Students are **NOT** permitted to remove Li-Pos from the labs
- Students are **NOT** permitted to use any other Li-Po batteries
- All batteries should be housed within a Li-Po bag on board your aircraft

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Batteries

- This may seem like a rather draconian measure but…

- We don't want this happening to any of you

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Additional Safety Measures

- **DO NOT** take/remove batteries from the labs
- **DO NOT** connect up the speed controller to the motors with the battery connected
- **DO NOT** install the propellers without a staff member or postgrad present
- **DO NOT** let the speed controller wires touch and short when connecting the battery
- **ALWAYS** unbind the transmitter after testing
- If in doubt about connecting up the battery to your Arduino please ask instead of risking a blown board
- Students are **NOT** permitted to test fly their aircraft

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Questions?


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