Electronic, Computer, and Avionics Hardware for Robotic Applications

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Overview

Real-world experiments supporting aerospace engineering research makes use of electronics, computers, and avionics hardware. Examples of robotic platforms supporting aerospace engineering research include consumer-sized drones (e.g., with 10-inch diameter propellers), nano-drones, and robotic arms. This project builds these robotic platforms in order to support real-world experiments supporting aerospace engineering research. After these platforms have been built, they are used to perform experiments that evaluate new concepts for controlling aerospace vehicles.

Preliminary Schedule

Week	Date	Tasks due
1	May 27	Initial meeting; review summer schedule ✓
1	May 28	Demonstrate 10-in drone build progress; place purchase requests ✓
2	Jun 2	Demonstrate fully-built 10-in drone ✓
2	Jun 4	Demonstrate 10-in drone flight tracking in department motion chamber
3	Jun 9	Demonstrate leader arm build progress ✓
3	Jun 11	Present fully-built leader arm
4	Jun 16	Demonstrate follower arm build progress ✓
4	Jun 19	Present fully-built follower arm
5	Jun 23	Operate both robot arms in department motion chamber simultaneously
5	Jun 25	Present motion capture chamber results
6	Jun 30	Support LeRobot policy training with robot arms
6	Jul 2	Support LeRobot extension with robot arms
7	Jul 7	Present fully-built Crazyflie 2.1+ drone
7	Jul 9	Demonstrate 10-in drone and Crazyflie drone in motion chamber
8	Jul 14	Support drone integration with Jetson
8	Jul 16	Support demonstration of Jetson drone integration
9	Jul 21	Support edge VLM drone maneuver experiment design
9	Jul 23	Support edge VLM drone maneuver experiment results
10	Jul 28	Support edge VLM drone audio instruction experiment design
10	Jul 30	Support edge VLM drone audio instruction experiment results
11	Aug 4	Support edge VLM drone visual instruction experiment design
11	Aug 6	Support edge VLM drone visual instruction experiment results
12	Aug 11	Present final report
12	Aug 13	Submit revised final report

Schedule Details

Week 1

Goal 1: Demonstrate 10" drone build progress; place purchase requests.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://www.youtube.com/watch?v=myyC8T7Jbsw

Deliverable: Report the status of the build and any blocking issues that might delay a completed build.

Week 2

Goal 1: Demonstrate fully-built 10" drone.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://www.youtube.com/watch?v=myyC8T7Jbsw

Deliverable: Fly the fully-built drone in the department motion capture chamber.

Goal 2: Demonstrate 10" drone flight tracking in department motion chamber.
Approach: Familiarize yourself with the department motion capture chamber.
Deliverable: Position and velocity of the drone during flight.

Week 3

Goal 1: Demonstrate leader arm build progress.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://github.com/jess-moss/koch-v1-1

Deliverable: Report the status of the build and any blocking issues that might delay a completed build.

Goal 2: Present fully-built leader arm.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://github.com/jess-moss/koch-v1-1

Deliverable: Operate the fully-built leader arm in the department motion capture chamber.

Week 4

Goal 1: Demonstrate follower arm build progress.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://github.com/jess-moss/koch-v1-1

Deliverable: Report the status of the build and any blocking issues that might delay a completed build.

Goal 2: Present fully-built follower arm.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://github.com/jess-moss/koch-v1-1

Deliverable: A final report and presentation for Milestone 1 of summer research that summarizes the builds of the 10" drone, leader arm, and follower arm.

Week 5

Goal 1: Operate both robot arms in department motion chamber simultaneously.
Approach: Familiarize yourself with the department motion capture chamber.
Deliverable: Position and velocity of each arm during operations.

Goal 2: Present motion capture chamber results.
Approach: Familiarize yourself with the department motion capture chamber.
Deliverable: Charts quantifying each arm position and velocity throughout the experiment.

Week 6

Goal 1: Support LeRobot policy training using both robot arms.
Approach: Familiarize yourself with the following sources for background knowledge. Implement the scripts as described.

- https://www.jetson-ai-lab.com/lerobot.html

Deliverable: Demonstrate the capabilities in the relevant scripts and programs. Generate a chart evaluating the trained policy. Use the assembled Koch v1.1 robots.

Goal 2: Support the proposed experiment design that extends the LeRobot results.
Approach: Familiarize yourself with the following sources for background knowledge. Implement the scripts as described.

- https://www.jetson-ai-lab.com/lerobot.html

Deliverable: Generate charts evaluating the extension of the LeRobot results.

Week 7

Goal 1: Present fully-built Crazyflie 2.1+ drone.
Approach: Familiarize yourself with the following sources for background knowledge. Follow the build instructions.

- https://www.bitcraze.io/products/crazyflie-2-1-plus/
- https://www.bitcraze.io/documentation/start/

Deliverable: Demonstrate the capabilities in the instructions.

Goal 2: Demonstrate 10" and Crazyflie drone flying simultaneously in motion chamber.
Approach: Familiarize yourself with the department motion capture chamber.
Deliverable: Position and velocity of each drone during operations.

Week 8

Goal 1: Support integration of the Jetson running edge VLMs with the 10" diameter propeller drone.
Approach: Connect a Jetson Orin in a breakout board with the drone in the lab.
Deliverable: Demonstrate the Jetson Orin integrated with the drone in the lab.

Goal 2: Support demonstration of an edge VLM controlling the 10" drone.
Approach: Use audio (converted to text) and video to generate control inputs to the drone.
Deliverable: A final report and presentation for Milestone 2 of summer research that emphasizes the capabilities of a custom, voice-controlled navigating agent using visual inputs and text outputs connected to a drone in the lab. Which of the edge VLMs perform the best?

Week 9

Goal 1: Support edge VLM drone maneuver experiment design.
Approach: Evaluate scenarios with isolated maneuvers (altitude changes, heading changes, etc.) and coupled maneuvers (e.g., simultaneous changes to altitude and heading).
Deliverable: A well-planned and justified experimental procedure.

Goal 2: Support edge VLM drone maneuver experiment results.
Approach: Evaluate scenarios with isolated maneuvers (altitude changes, heading changes, etc.) and coupled maneuvers (e.g., simultaneous changes to altitude and heading).
Deliverable: Experimental results.

Week 10

Goal 1: Support edge VLM drone audio instruction experiment design.
Approach: Evaluate scenarios with maneuvers from audio instruction converted to text.
Deliverable: A well-planned and justified experimental procedure.

Goal 2: Support edge VLM drone audio instruction experiment results.
Approach: Evaluate scenarios with maneuvers from audio instruction converted to text.
Deliverable: Experimental results.

Week 11

Goal 1: Support edge VLM drone visual instruction experiment design.
Approach: Evaluate scenarios with maneuvers in response to visual cues (written, symbols on signs, or human gestures) and recognition and response to landing zone (LZ) objects.
Deliverable: A well-planned and justified experimental procedure.

Goal 2: Support edge VLM drone visual instruction experiment results.
Approach: Evaluate scenarios with maneuvers in response to visual cues (written, symbols on signs, or human gestures) and recognition and response to landing zone (LZ) objects.
Deliverable: Experimental results.

Week 12

Goal 1: Present summer research final results as a report and slides.
Approach: Use LaTeX and a slides program.
Deliverable: Final results in a report and slides.

Goal 2: Submit revised final report
Approach: Address any issues raised.
Deliverable: A final report and presentation for Milestone 3 of summer research that emphasizes the results of drone experiments. Which of the edge VLMs perform the best?