Computer vision - Technical interview task

Introduction and Purpose

This task simulates how you would approach developing the computer vision module for Munin's camera-guided micro missile. Below is the context of what you are building, followed by a set of tasks. Complete these tasks as if you were actively working on the project; ask questions where needed, prioritize based on your judgment, and make decisions as you would when working toward a functional system prototype.

You will have a maximum of 8 hours to complete the work, culminating in a presentation and demo. More details on that at the end.

Context

The Micro-MANPAD is a camera-guided missile designed as a last line of defense against drones. When a soldier opens the launcher lid, the missile and its computer vision module power on. The camera in the nose of the missile detects flying objects and provides a vibration alert to the user when a lock is achieved.

The system does not classify objects (e.g., birds vs. drones) but must ignore clouds, smoke, and ground-based objects. It only locks onto targets above the horizon within a range of 30–350m. The primary target is a 7-inch racing quadcopter carrying a warhead and battery (approx. 30x30 cm). The closing velocity between the missile and drone can reach 150m/s.

Computer Vision Phases

The system operates in three distinct phases, all run on the same camera and processing board:

1. **Pre-Lock-On** – The module scans for a viable target.
2. **Tracking from Ground** – The seeker identifies and actively tracks a target while the soldier holds the missile.
3. **Tracking in Flight** – The missile is launched and tracks the target until impact.

System Components

1. **Camera** – Mounted at the front of the missile.
2. **Processing Board** – Handles image processing and communicates with the flight controller.

3. **Flight Controller** – Not your responsibility, but your board must send the relative direction of the target drone. You may read IMU data (accelerometers, gyros, magnetometer) if needed for stabilization or tracking.

The system prioritizes the **most centered object** if multiple flying objects are detected and continuously tracks it.

Constraints

- **Processing board size:** Must fit within a 30mm diameter, ideally ≤55mm length. Some flexibility exists, but not much.
- **Camera + included PCB:** Should fit within 32mm diameter.
- **Seeker budget:** Prototype: $1000 | Production: $250.

Tasks

For these tasks, imagine you are working toward a flyable prototype within 6 months to intercept moving drones. Your priority is to get a reliable system working first, so while supply chain considerations and mass production are factors, you are free to use non-scalable solutions and Chinese components if they help achieve a working prototype faster.

Approach this as if you were actually building the product—question assumptions, prioritize effectively, and focus on the most critical engineering decisions.

Task 1 (10%) – Camera Selection

- Select a commercially available camera suitable for integration into the missile.
- Justify your choice based on the specifications that you deem to be important

Task 2 (15%) – Processing Board Selection

- Choose a processing board that fits within the missile's size constraints.
- If necessary, if you select one that is slightly larger, propose how to make it fit while maintaining functionality.

Task 3 (15%) – Development Process & Timeline

- Outline a development plan with an approximate timeline.
- Define key phases and explain how you will execute each one. For example, if you need to collect training data, describe your proposed setup.

Task 4 (60%) – Drone Detection & Tracking Pipeline

- Develop a preliminary computer vision pipeline for detecting and tracking drones.
- Use the provided dataset for training and testing. After signing the NDA, request access and message me on the contact info as a reminder. The dataset contains videos from our sensor, which is what the pipeline should be optimized for. It also contains a link to a publicly available labelled dataset.
- Implement an approach that runs on a laptop initially, with a clear path to deployment on the selected board. Only test algorithms which you believe can be feasible to run on your selected board.
- Prepare a live demo on your laptop running on a video file of your choice from the dataset.
- Provide calculations on expected frame rates and processing speeds when running on the missile's hardware.
- If you cannot implement a complete system, prioritize the parts you think are most critical to test.
- You may not use any versions of YOLO and it is preferred if your solution leans toward classical methods.

Practical

After finishing, schedule a call where you will present your findings and the demo. Do the work in your own time but with a cap of 8 hours including presentation preparation, brainstorming and everything else you do. Feel free to schedule one 30 minute call with me (Magnus) to ask questions. Short form questions can be sent on signal (app found on app store) to +47 99480512.