Search and Rescue Drone

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Background

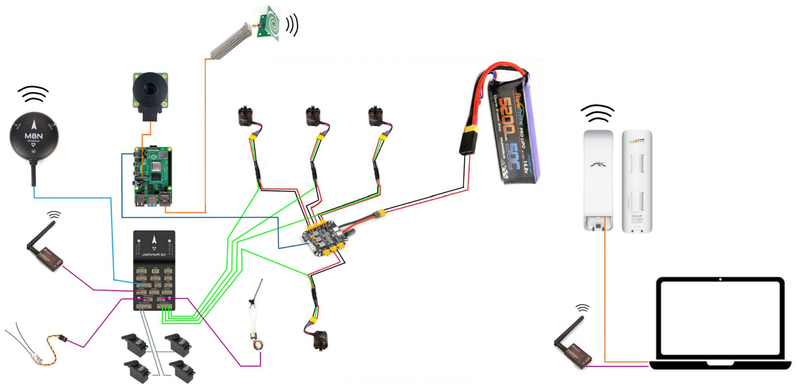
In Search and Rescue (SAR) operations, time is critical, directly impacting survival chances. As traditional methods often face limitations in accessing remote or hazardous terrains, the integration of technology has revolutionized the SAR landscape.

Our team designed an autonomous drone, equipped with an onboard camera to swiftly scour remote areas and locate victims. By employing drones capable of covering vast territories faster than ground teams, we aim to expedite the locating process, giving rescue teams more time to plan and execute interventions.

Our drone presents a more cost-effective alternative to helicopters, owing to its smaller size and reduced resource demands. Feasible integration and testing is key to the system design offered by our quadcopter drone, camera payload, and real-time VCSi ground support solution.

Drone Hardware Integration

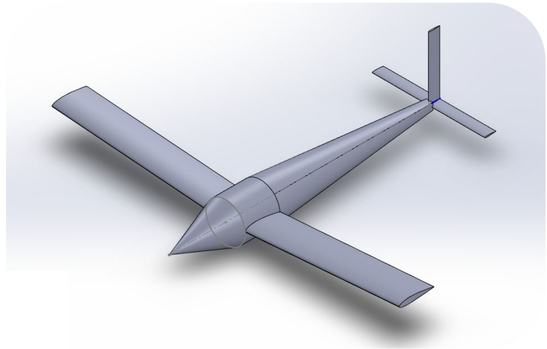
- **High-Performance Pixhawk 6C Flight Controller**
  PX4 Autopilot architecture to control stabilization, waypoint navigation and mission planning. Versatile communication peripherals
- **Sik Telemetry Radio V3 Transmitter/Receiver Pair**
  Real-time MAVLink Protocol message exchange for VSCi Software integration, telemetry, and control
- **GNSS Module** for precise drone geolocation and navigational tracking
- **Power Distribution System**
  Regulated 15V to 5V voltage levels ensuring proper electrical power delivery for on-board electronics
  920kV quadcopter motors deliver robust thrust and precise maneuverability
- **Raspberry Pi HQ camera**
  Removable IR-Blocking filter and M12 lens-mount to provide infrared sensitivity detection and flexible FOV views
- **Ubiquiti radios for video transmission and reception**
  Appropriate data rate capability for reliable video communication



Fixed Wing Integration

Our mechanical objective was to develop a hybrid configuration of a drone and fixed wing aircraft that would allow for longer flight time from the fixed wing and higher versatility from the drone by being able to vertically takeoff and land, eliminating the need for a runaway. In our design, we concluded that the following dimensions/measurements would be efficient for the design:

- **Aerodynamic Calculations**:
  Determined sizing of the main wing as:
  Wing span: 2.1 m
  Chord Length: 21 cm, using an aspect ratio of 10:1
  Determined sizing of the fuselage as:
  Length: 1.6 m
  Diameter: 24 cm
- **Stability Analysis**
  To minimize pitch during steady flight, the sizing of the horizontal tail is:
  Wing Span: 0.70 m
  Chord Length: 7 cm
  To minimize yaw during steady flight, the sizing of the vertical tail is:
  Wing Span: 0.40 m
  Chord Length: 4 cm
  To ensure spiral stability, a dihedral angle of 4.5 degrees was added to the main wings to minimize rudder movement from the pilot during steady flight.
- **Motor Dimensioning**
  Performed thrust curve analysis to determine the proper motor needed for fixed wing flight for the aircraft.
- **SolidWorks Computer-Aided Design (CAD) Model**
  Created a CAD model in Solidworks to build the fixed wing aircraft and design how the drone will be integrated into the fixed wing.



Software Functionality and Implementation

Our software objective in designing our drone centered around creating a system that combines efficiency and reliability to address the challenges of emergency scenarios. Leveraging VCSi as our flight control software, we aimed to streamline the following objectives using a plugin architecture:

- **Mission Planning**
  The path planning functionality utilizes a convex hull for precise area drawing on the map. Along with a turn-minimizing spanning tree coverage (A*-based) algorithm which determines the flight path/waypoints for the selected mission area.
- **Vehicle Specific Module (VSM)**
  The VSM facilitates communication between the Ground Control Station (GCS) and the drone, translating messages from our Mission Planning plugin, to MAVLINK protocol using MAVSDK.
- **Target Identification**
  With OpenCV, our computer vision algorithm enables the drone to identify potential targets based on temperature. Targets meeting the criteria are delineated by bounding boxes, sent for operator review along with their geographic coordinates.
- **Notification System**
  Designed to provide operators with real-time mission updates including potential targets, battery status, and path interruptions, the notification system generates colour-specific alerts for the operator to view, enhancing situational awareness.

OpenCV PX4 autopilot GAZEBO MAVSDK