Verminator Wasp Drone

Senior Design

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Background

The Verminator Wasp Drone is a remote-controlled aerial spraying platform modelled after larger and more expensive agricultural drones. The drone is outfitted for the removal of wasp nests and is equipped with a first-person camera and an insecticide sprayer to neutralize wasp nests from a safe distance. Users can remotely pilot the drone with the first-person camera and industry-standard RC receiver. Custom firmware modules to control the sprayer allows for programmatic control and automation for future applications. The Verminator Wasp Drone proposes a new application of agricultural drones, but without the burdensome costs that stem from commercial operations.

Key Requirements

Wasps and other insects pose a risk to people, especially small children. This project is designed to bring aerial spray drones from the agricultural industry to hobbyists, homeowners, and small business owners.

This drone will allow the user to spray insects from a safe distance or apply insecticides to hard-to-reach areas.

Key requirements:

- Camera system allowing for easy to maneuver in tight spaces without line of sight.
- Sprayer needs to have enough range and pressure to spray insect nests from a safe distance.
- Drone should be modular to allow for various payloads and missions.
- Drone design and implementation must be free and open source

Architectural Design

Camera System

Provides a live camera stream for the camera application. Frames are sent through 5.8 GHz radio and are received by an analog video capture card.

Camera Application

Processes frames from the analog video capture card using OpenCV. Displays frames to the user with Qt6.

Sprayer System

The sprayer is toggled through a PWM-controlled switch. The PWM signal is sent by the flight controller in response to RC inputs, or programmatically through a custom module that was added to the PX4 firmware.

Controls System

Provides user input for the flight controller. Drone's functions can be controlled programmatically through the command line or radio control.

Avionics System

Serves as the brain of the drone and is centered around a flight controller with the PX4 firmware. The flight controller receives inputs from the user or automated commands through a RC receiver or telemetry radios. Those commands are used to execute functions on the flight controller.

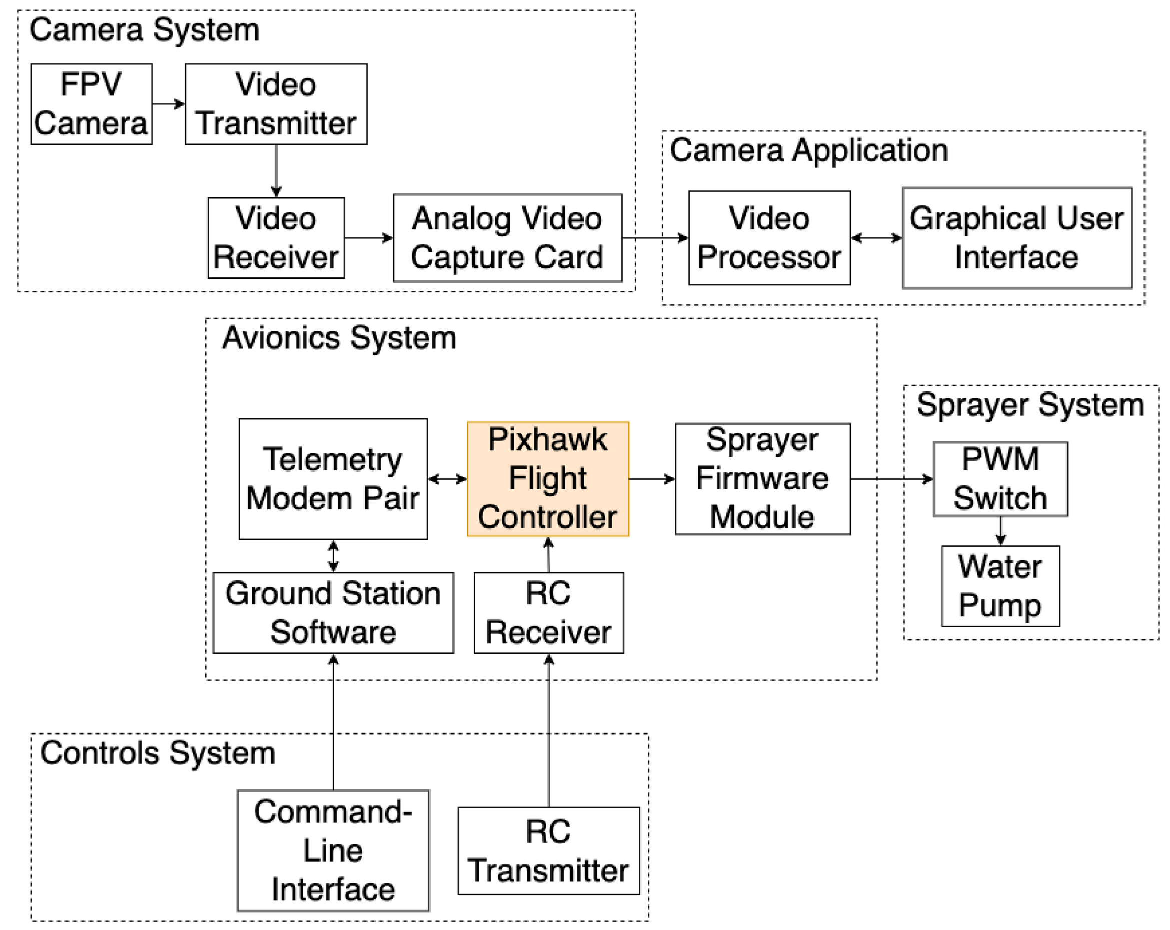

Figure 1. Architectural design diagram

Implementation Details and Test Plan

Hardware

Drone

- CubePilot Cube Orange+ flight controller with PX4 firmware
- 500mm carbon fiber airframe
- 2212 920KV motors with 10" propellers
- 4-in-1 40A electronic speed controller

Camera System

- RunCam Night Eagle 3 v2 low-light sensitive camera
- 5.8 GHz analog video transmitter and receiver
- Analog-to-digital video capture card

Sprayer System

- 12V 0.3A DC Water pump
- 12V 20A DC PWM controlled switch

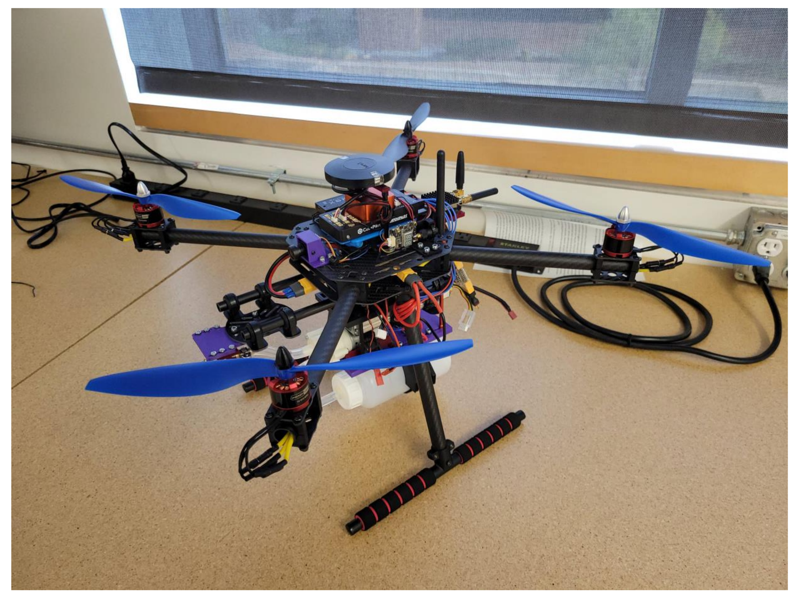

Figure 2. Completed build of drone.

Software

Desktop Camera Application

- Qt6 Multimedia for camera capture
- Qt6 for graphical user interface
- OpenCV C++ for alpha compositing frames and overlay images

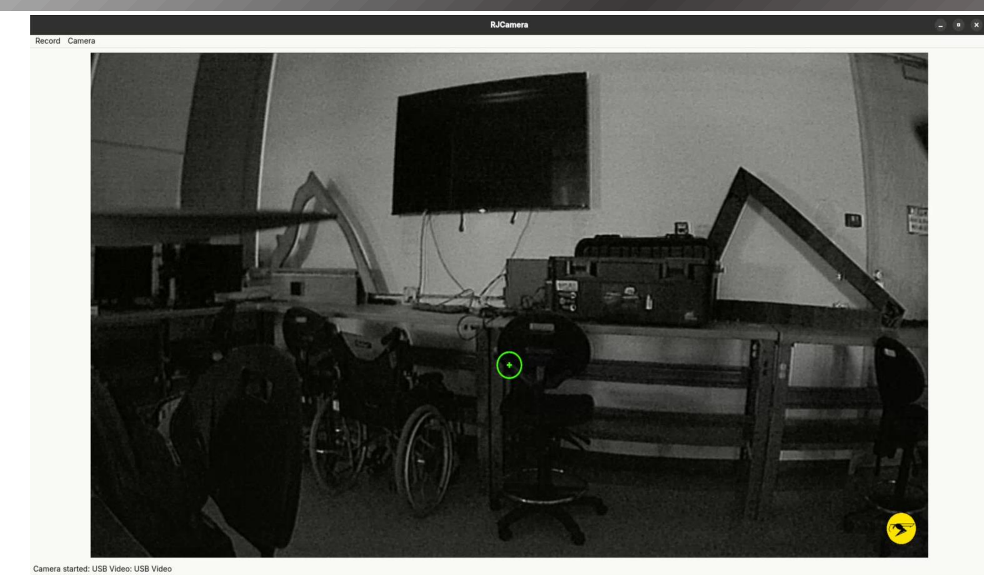

Figure 3. Camera application with feed in a very low-light environment.

Test Plan

Hardware

- Validated flight controller firmware modifications in controlled environments using test-driven development.

Software

- Tested using a variety of USB video devices for interoperability.
- Tested on a variety of Debian-based and RHEL-based Linux distributions.

Conclusions and Future Work

Conclusion

We successfully created a prototype that demonstrates the feasibility of an affordable aerial spraying platform and meets the requirements of our sponsor.

Future Work

- Switch to larger 650mm airframe and 6S power system for higher payload.
- Outfit the drone with different payloads to become a modular multi-role system.

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References

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