Rohan Tummala
Ground School Week 6

Efficient Autonomous Drone Landing: A Computer Vision Approach Optimized for Low-Power Platforms

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Background / Motivation

- Drones are increasingly used in logistics, agriculture, surveillance, and rescue
- Full autonomy is still limited by manual intervention during landing, and current landing processes require accurate site detection and validation
    - Computationally heavy process
- Existing methods depend on deep learning, making them unsuitable for low power hardware like Jetson Nano
- The researchers' goal is to design a lightweight computer vision-based landing system that works efficiently on embedded platforms

Related Work and Challenges

- Prior works explored landing site detection using LiDAR, stereo vision, and CNNs
- Common problems include:
  - High computational load
  - Poor adaptability to diverse terrains
  - Hardware incompatibility across drone types
- This paper's approach balances accuracy + efficiency for real world low power systems

Proposed Method

- Vision pipeline optimized for Jetson Nano:
    - Uses YOLOv4-tiny to detect H-landing pads
    - Applies Canny edge detection to identify safe/unsafe zones
    - Tile-based analysis: checks edge density and selects stable zones for landing
- Integration:
    - DroneKit + Pixhawk translate visual data into flight commands
    - Safe landing spot determined via Manhattan distance and Haversine formula for geo-coordinates

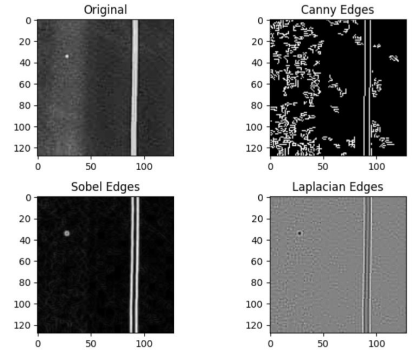

Fig. 3. Results of Canny, Sobel and Laplacian Edge Detection on plain surface

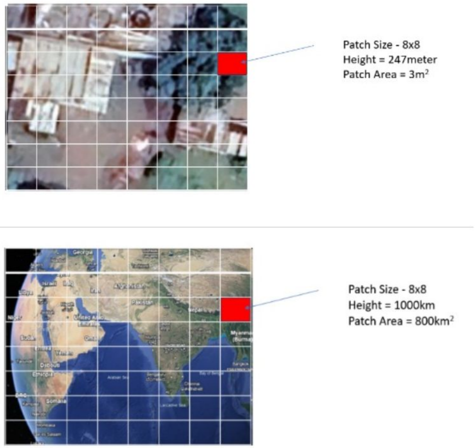

Fig. 4. Visualizing the effect of same patch size from different heights

Fig. 5. Algorithm to find dynamic patch size according to drones

Example Pipeline of Model

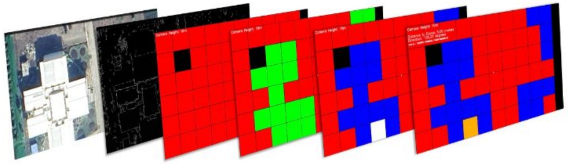

Fig. 10. Illustration of algorithm on a satellite image

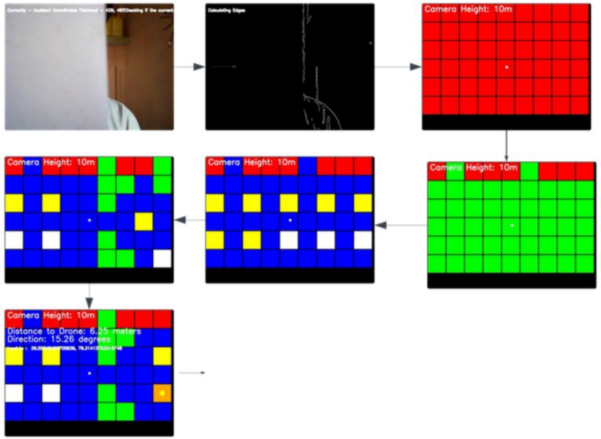

Fig. 11. Algorithm execution on real-world images from webcam.

Results and Implementation

- Deployed on Jetson Nano; validated in real-world tests
- 76% detection accuracy for H-pads
- +/- 5% landing error margin, low CPU/RAM use confirmed
- Demonstrated safe landings across various environments with real-time performance

Conclusion and Impact

- Achieves autonomous landing using efficient, non–deep learning computer vision
- Works on resource-constrained drones while maintaining high reliability
- Expands potential for logistics, agriculture, disaster response, and surveillance applications
- Lays groundwork for fully autonomous, low-power UAV systems