Autonomous Indoor Mapping and Environmental Detection

Using a Parrot Mambo Toy Drone

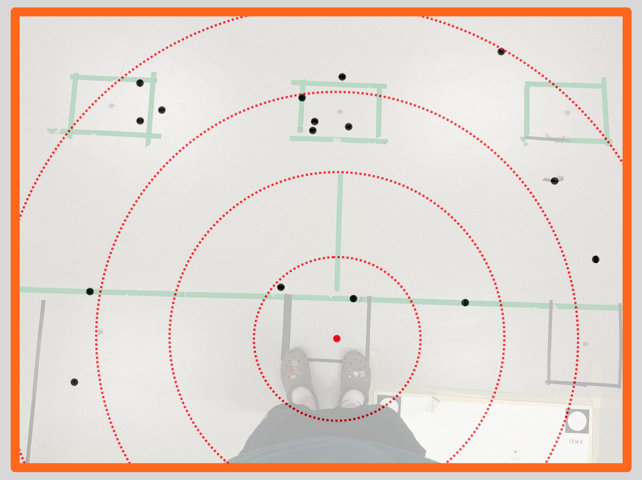
Mitchell Aitken, Braden Navarro, Julian Cramb, Macdonagh Dressler
Schulich School of Engineering, University of Calgary

Abstract

- Objective: Develop an autonomous indoor mapping system for the Parrot Mambo drone, performing autonomous tasks along the way.
- Methodology: Utilize the PyParrot Python library to program autonomous flight patterns, leveraging floor-based navigation queues and created object recognition algorithms.
- Innovation: Integration of environmental conservation aspects, demonstrating the drone's utility in spill detection, weed identification, and wildlife monitoring.
- Importance: Enhances safety, operational efficiency, and broadens the scope of drone applications in various indoor and potentially outdoor environments.
- Future Scope: Extending the project's application to larger-scale drones and outdoor mapping, with potential adaptations for environmental monitoring and data collection.

Drone Limitations

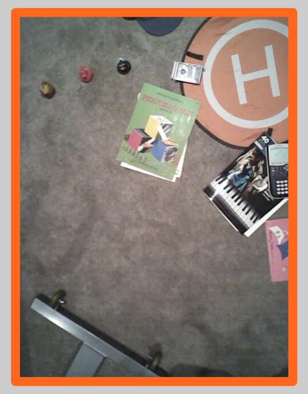
- Maximum payload: 30g
- Unable to add additional sensors
- Image download time over wifi
- Battery life: 7 minutes
- Inconsistent flight pathing
  - Reliant on positioning queues
  - Inconsistent drift
  - 12.5% landing accuracy with basic flight path
- Unpredictable latency in executing commands from the PC
- Unstable flight images
- Reliant on PyParrot Python Library
- Poor camera resolution

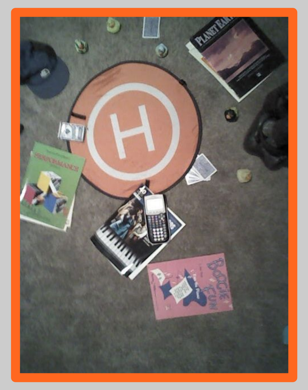


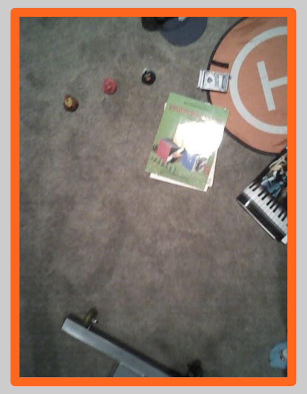
Energy and Environment

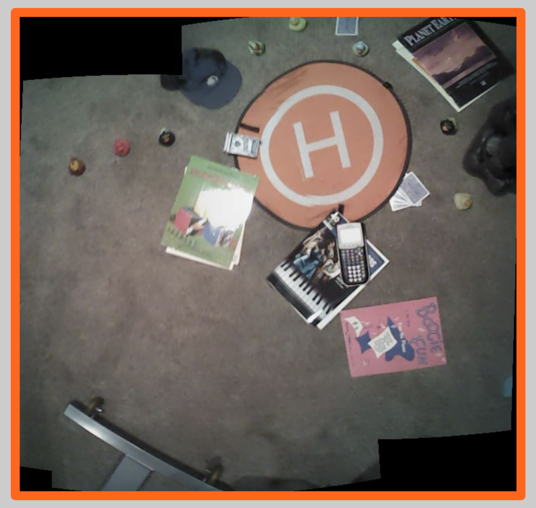
Drones can play a critical role in conservation. As detailed in the study by Jiménez López and Mulero-Pázmány (2019), drones offer versatile solutions for monitoring wildlife, ecosystems, and environmental changes, thereby assisting to protect biodiversity with economical and safer alternatives.

- Developed the ability to perform weed detection, potentially aiding in precise agricultural practices and reducing unnecessary herbicide usage.
- Created an algorithm to perform object counting which has the potential for broader environmental applications, including wildlife tracking, to provide accurate data without disturbing natural habitats.
- Incorporated the capability to detect spills while potentially using line detection to follow above-ground pipelines in Northern Canada, thereby enhancing environmental safety and operational efficiency.
- Explored the adaptability and scalability of drone technology, from simple educational tools to advanced data collection devices, showcasing their potential in environmental assessments and conservation efforts.









PSNR values for the overlap regions are below 20 dB (14.34, 13.04, and 16.06 dB), indicating low image quality with potential visible discrepancies from the original images, while SSIM values (0.55, 0.47, 0.58) suggest moderate similarity between the stitched and original images.

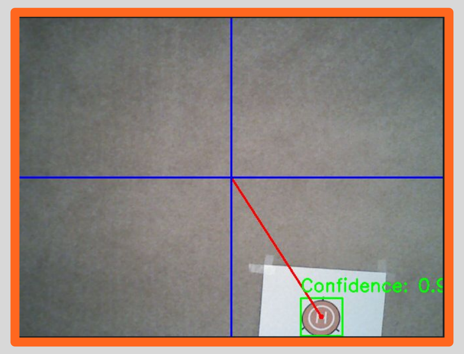
Results

Throughout this capstone project, the students have achieved a broad range of results with the Mambo Parrot Drone.

- The students used the YOLO image classification model to train and test images of landing pads. They implemented this model in the drone so that it could detect landing pads, position itself over the pad and successfully land.
- The students captured and stored images from the bottom and front camera of the drone that was then passed through a ransac algorithm and a homography transformation.
- The students used the YOLO image classification model to identify animals, plants and other objects in order to simulate various field tasks in the environmental industry.
- The students used OpenCV to identify shapes and lines for indoor navigation.
- They used the ultrasonic sensor in order to maintain a constant elevation.

Discussion

- The students were able to overcome the deficiencies in the drone by using frequent readjustments, and a wide range of computer vision techniques.
- In using the OpenCV library alongside the YOLO model, the students were able to cross reference and check their results, as well as provide a greater degree of redundancy for their drone's operation.



Conclusions

- The students were able to create many scenarios indoors, and prove that the drone would be able to use similar algorithms and models to function outdoors in real scenarios.
- The students tested environmental detection methods of objects and wildlife while indoor mapping.
- The students identified and quantified the deficiencies in the drone for future years, so that there is a more conclusive picture of the capability of the drone when capstone groups are planning their projects.

References

1. J. Jiménez López and M. Mulero-Pázmány, "Drones for Conservation in Protected Areas: Present and Future," in Drones, vol. 3, no. 1, p. 10, Jan. 2019. [Online]. Available: https://www.mdpi.com/2504-446X/3/1/10.

CONTACT
Mitchell Aitken, Braden Navarro, Julian Cramb, Macdonagh Dressler
Email: mitchell.aitken@ucalgary.ca, braden.navarro@ucalgary.ca, julian.cramb@ucalgary.ca, macdonagh.dressler@ucalgary.ca

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