Camera-Assisted UAV Sensor Package Deployment System

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Introduction

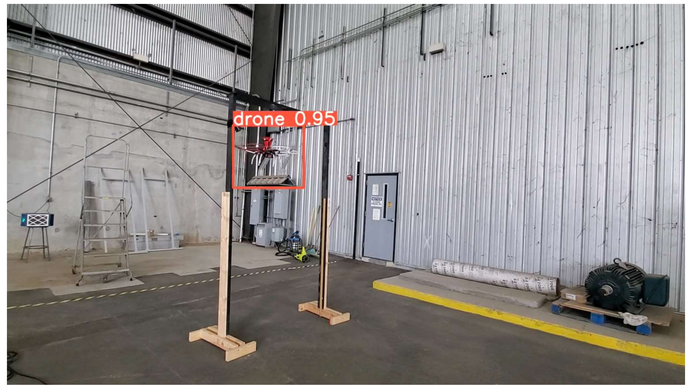
- Placing sensors can be difficult in hard-to-reach areas, such as in waterways or high altitudes
- Drones can mitigate this issue by attaching these sensors remotely
- Oftentimes, the point of view on drones does not provide a good perspective for accurate docking
- Placing a camera elsewhere (pointed at the drone) can utilize object tracking to allow accurate drone sensor attachment

Methods

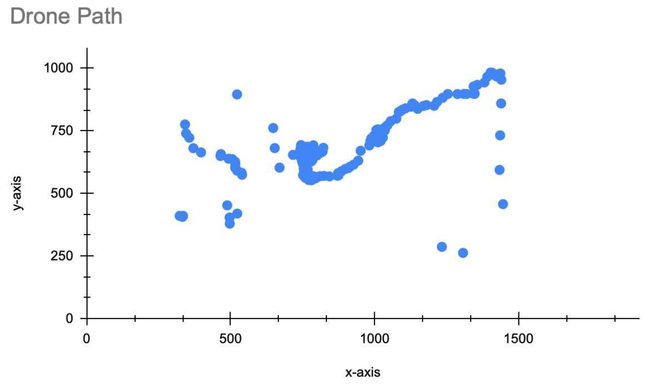
- A machine learning algorithm based on You Only Look Once (YOLO) version 8 was used to quickly train a single camera to detect the drone in a 2D space
  - This algorithm was chosen due to its ability to detect multiple objects at a time for fast object detection
- The algorithm was trained using Roboflow (to compile and label images in the proper format) using over 30 photos of the drone
  - The photos were adjusted and blurred to simulate training in a real world environment
- Used Python code to retrieve numerical YOLO bounding box outputs
- The centers of each bounding box coordinate was recorded in a Cartesian graph
  - Filters were created to remove erroneous data
  - To maintain high accuracy, filters were set to only include data at 95% confidence
- Training data was recorded in an adjustable format in case the drone is used in a different environment, or a different drone is used
- Video output with the bounding boxes layered on top were used to confirm the graph's accuracy
  - The graph was set using pixels as XY-coordinates for proper comparison

Results

- Video analysis showed the bounding boxes were accurately placed in reasonable distances of the drone, with probabilities mostly near 98-99%
  - Graphs of the drone path showed similar results, no apparent outliers through multiple tests
- Speed of analysis is very high with a decently powerful computer, at least 30 FPS
- A fixed FPS yields wider gaps in data when drone speed is high



Above: Snapshot of YOLO detection video overlay, in slightly less favorable conditions



Above (top): Snapshot of YOLO detection video overlay in favorable conditions
Above (bottom): YOLO graphical output, from same detection video

Conclusions

- Using video output from a single camera is an effective way to monitor an object in a 2D space
- XY-graphs from bounding box outputs picture 2D space very well, can possibly be combined to form a 3D array
- High speed of analysis would allow real-time drone adjustments using YOLO output in the future
- Drone speed can be monitored using the gaps in data

Image Highlights

- In the snapshots of the video output, 0.95 and 1.00 represents the YOLO algorithm's calculated probabilities, based on comparison to trained images. The image with 1.00 happens to be very similar to a trained image in that drone environment.
- In the graphical output, large gaps in data points are due to speed differences.

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