Real-Time Object Detection for Unmanned Aircraft using Cloud-based Convolutional Neural Networks

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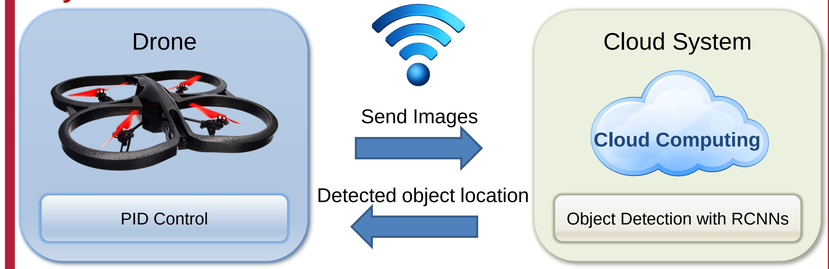
1. Introduction

- Real-time object detection is crucial for autonomous flight, especially in unknown and GPS-denied environments.
- But object detection is too computationally demanding for a lightweight, low-cost drone.
- We propose moving the computation to an off board computing cloud.
- We apply R-CNNs, a state-of-the-art algorithm, to detect thousands of objects in near real-time.

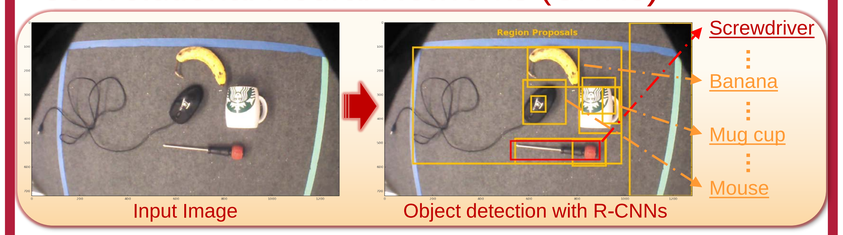
2. Method

System Overview



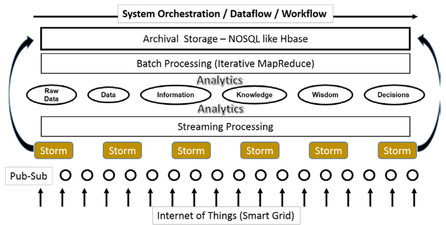
- Our autonomous flight system consists of three major components: object detection with R-CNNs, a cloud system, and a PID control for navigation.
- Object detection is processed on the cloud, communicating with the drone via WiFi.

Convolutional Neural Networks (CNNs)



- R-CNNs (Regions with CNNs) detect multiple objects, then send their locations to the drone.

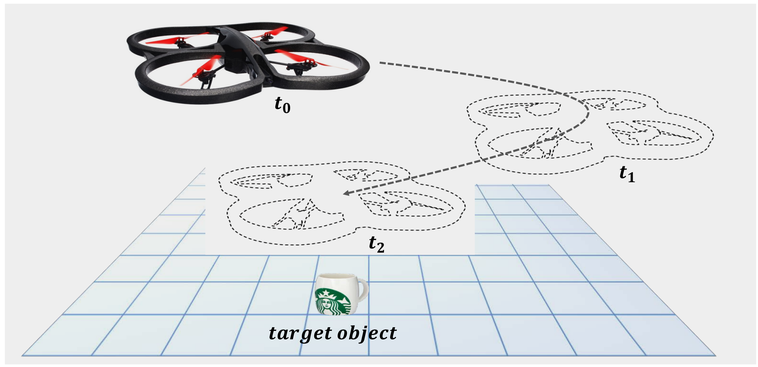
Cloud System



We use a low-cost quadrocopter but we are able to get real-time computing power with a cloud system.

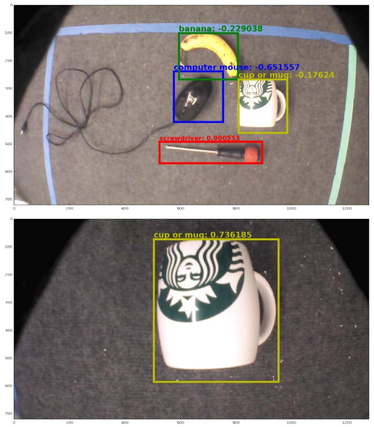
- Drone programmers can develop algorithms in an abstract framework, without knowing details of how data is distributed or transferred.

3. Experiment Results

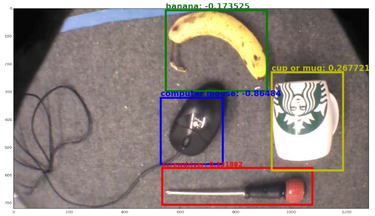


We demonstrate our approach with a simple scenario of a drone trying to find a target object in a GPS-denied indoor environment.

- First, a drone flies around the whole environment at high altitude to try to find a target object.
- If a drone detects an object (t_0) with high confidence, it approaches it to confirm ($t_0 \rightarrow t_1$).
- If a detection score decreases while approaching the object ($t_0 \rightarrow t_1$), the drone tries other candidates.



← (t_0) Drone detects a target object at high altitude with a low confidence.

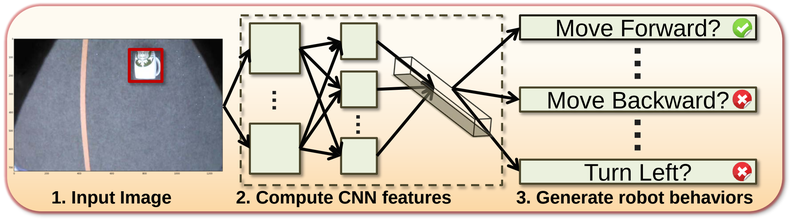


↑(t_1) Drone approaches the target object.

↑(t_2) Completed object detection with high detection score.

- If score is above a threshold, the mission is complete (t_2).

4. Conclusion and future work



We propose real-time object detection based on CNNs in the cloud for UAVs. In future work, we will use CNNs to learn navigation behaviors.

5. References

[1] Girshick, Ross, et al. "Rich feature hierarchies for accurate object detection and semantic segmentation." Computer Vision and Pattern Recognition (CVPR), 2014 IEEE Conference on. IEEE, 2014.
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