Cost-Efficient Drone Obstacle Detection and Avoidance

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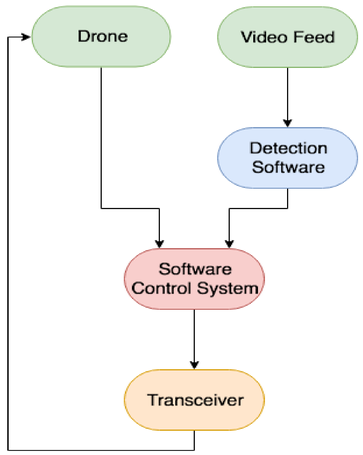
Abstract

- One problem with current drone technology is that specialized equipment is required in order to implement object detection and avoidance with high accuracy
- Current ongoing research and development within the computer vision field has yielded effective algorithms for both object detection and position estimation within images
- With a low-cost toy drone, these algorithms can be applied and programmed into the drone which will provide it with capabilities similar to top-tier drones on the market, such as DJI products
- We trained a convolutional neural network to recognize obstacles and the drone itself in order to produce bounding boxes from which collision trajectories could be calculated by which the drone would move accordingly

Drone Communication and Control System



- Live camera feed is passed to a software control system that acts as a processing node with a NVIDIA GeForce GTX 1060 GPU for fast neural network processing
- Control system processes images that are generated from the video feed at approximately 60 fps while updating data regarding the drone's flight path and any obstacles
- Control system communicates with the custom drone transceiver[2] to send flight commands[3] to the drone that the drone will follow

Hardware Components

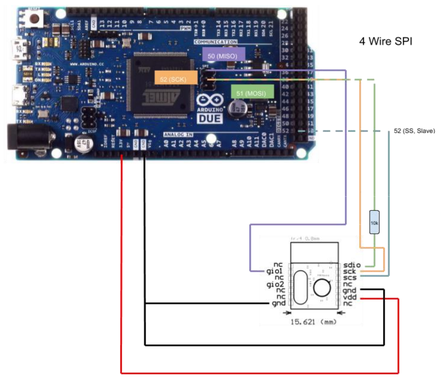


Figure 1: Transceiver circuit consisting of Arduino DUE and the A7105 Chip

Figure 2: Hubsan X4 Drone

Software Components

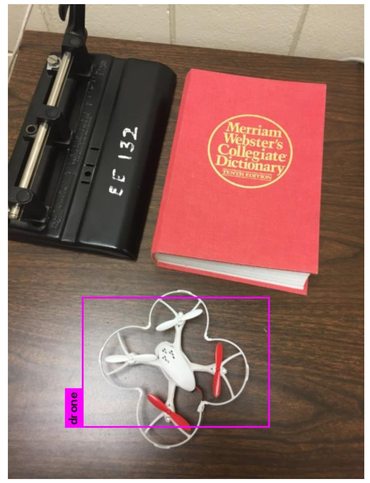
OpenCV YOLO python

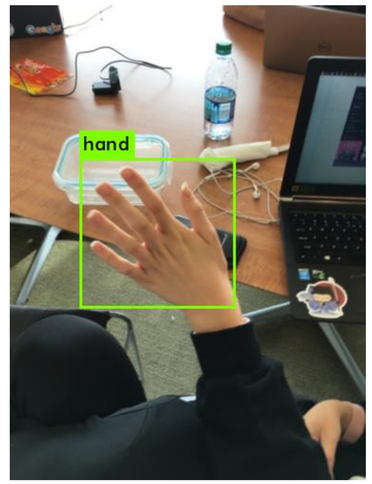
Challenges

- Hardware Challenges
  - Burnt A7105 Transceiver chip
  - Arduino MEGA logic level differences from A7105
  - Raspberry Pi not sending flight packets
- Software Challenges
  - Outdated dependencies for many object detection algorithms
  - Libraries are not well maintained for older software
  - Lack of documentation for some algorithm implementations

Object Detection and Identification

- You Only Look Once (YOLO)[1] is an extremely fast GPU-enabled real-time object detection algorithm
- YOLO functions by applying a single neural network to a full image input. The network divides the image into probabilistic regions for each class





Performance Results

	Selected	
Target	**Drone**	**Hand**
Drone	23	0
Hand	0	30

Table 1: Confusion matrix depicting the results of a trial on a set of 40 images containing hands, a drone, or both

	Selected	
Target	**Drone**	**Hand**
Drone	1	0
Hand	0	1

Table 2: Normalized confusion matrix

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References

[1] Joseph Redmon and Ali Farhadi. YOLO: Real-Time Object Detection. https://pjreddie.com/darknet/yolo/. Accessed: 2018-04-15.
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[3] Jim Ung. libhubsan. https://github.com/NotionalLabs/libhubsan. Accessed: 2018-04-15