Low Cost, Real Time Computer Vision for Surveying, Navigation, and Beyond

UNIVERSITY OF MARYLAND HONORS COLLEGE

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Introduction

- Following a natural disaster, repair of critical infrastructure plays a large role in determining the number of casualties [1,2]
  - Flood water or other impediments can delay or prevent inspections to infrastructure like power lines due to the danger the environment poses to crews.
- Unmanned Aerial Vehicles (UAVs) equipped with computer vision systems allow for autonomous surveying [3]
  - Existing solutions suffer from accessibility issues [3,4]
- Open-source processors and commercial UAV components provide a low-cost alternative to commercial CV systems

Design Overview

a) Use commercial UAV components for video transmission
   i) Allows for direct integration of data output with existing First Person Video (FPV) systems
   ii) Use onboard processing to reduce the impact of transmission losses on CV accuracy
b) Use Raspberry Pi 4 and Coral Ai EdgeTpu ML Accelerator for CV processing
   i) Raspberry Pi 4 is a low-cost, common processor that provides analog video output, USB3, and camera support
   ii) Multiple cores allow for parallel processing
   iii) Separate ML accelerator allows for performance increases as the technology develops

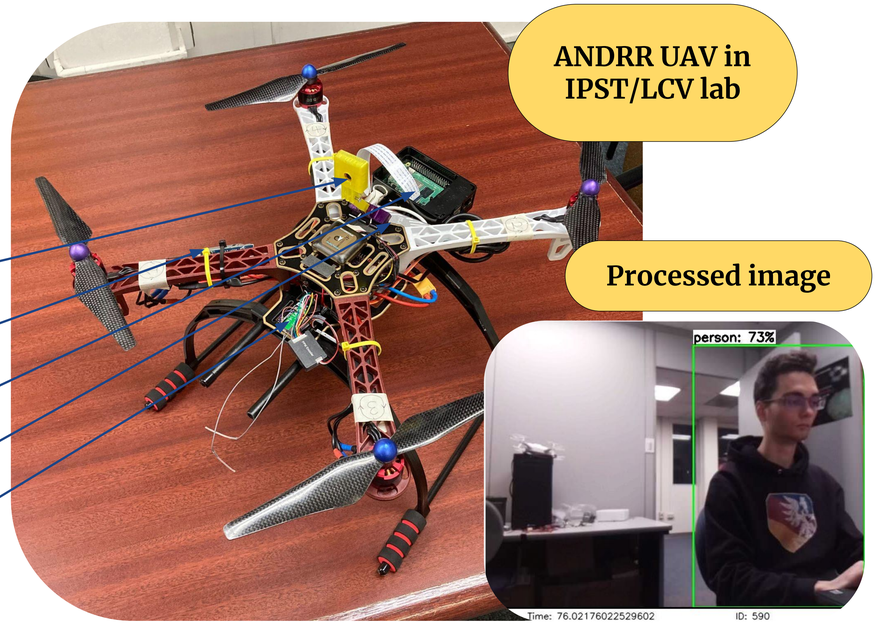
Major systems

- Image capture - Raspberry Pi camera 4
- Processed feed reporting- Commercial FPV transmitter
- General processing - Raspberry Pi 4
- CV processing - Coral Ai Accelerator
- Control interface - Commercial UAV telemetry

CV model comparisons

Model	Speed	COCO mAP (mean average precision)	Elapsed Time (Seconds)	Number Recognized	Average Recognition Percentage
efficientdet_d0_coco17_tpu-32	39	33.6	7.030	16/16	75.35
ssd_mobilenet_v2_320x320_coco17_tpu-8	19	20.2	5.876	14/16	68.92
centernet_resnet50_v1_fpn_512x512_kpts_coco17_tpu-8	30	29.3	5.759	12/16	72.70
faster_rcnn_resnet50_v1_640x640_coco17_tpu-8	55	31.8	13.223	15/16	97.64
ssd_mobilenet_v2_fpnlite_320x320_coco17_tpu-8	22	22.2	5.201	14/16	68.92

- Compiled and tested images with identifiable humans on different models to compare efficiency and speed
- Will be repeated with a larger dataset of images to identify a model that still operates effectively on a Raspberry Pi for future testing
- Creating a breakdown of all models to be utilized by the end users of our product software will be constructed--given their hardware, they will be able to best identify which computer vision model should be used



ANDRR UAV in IPST/LCV lab

Processed image

Processor performance comparisons

Program	Coral AI Accelerator	Frames per second (FPS)
CV detection	Yes	30
	No	5.5
CV detection, data output	Yes	20
	No	4.8
CV detection, data and video output	Yes	14
	No	4.5

- Data collected using an SSD mobilenet model trained on the COCO dataset [5] and an image resolution of 608x608
- For comparison, previous real time systems achieve between 20 and 30 fps for the same image size [6]
- Coral AI Accelerator allows for real time use without critically limiting travel speeds at lower cost

Future work

- Complete development of power-line CV model
- Develop navigation software prototype
- Optimize system software
- System flight testing and verification
- Publish system software and schematics to public GitHub

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References

Sea Grant MARYLAND