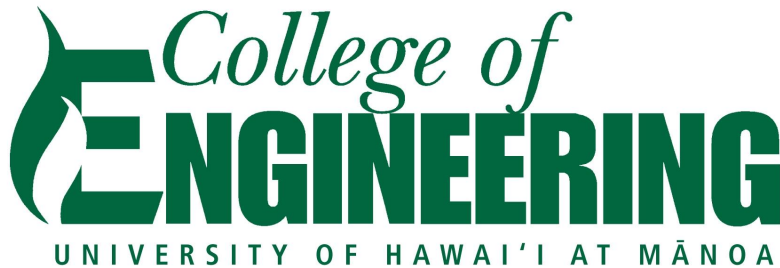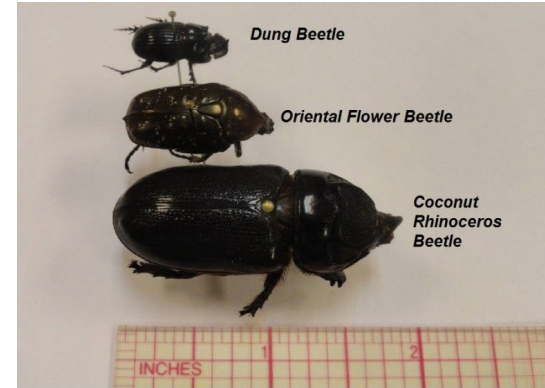# Machine Learning at Edge

REDLab

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Ryan Vizcarra, Kyle Neubauer, Delton Ky, Aaron Fujinaka & Tarena Monmaney

University of Hawaii at Manoa

Coconut Rhino Beetle (CRB)

What is it and why should we care?

- First seen in Hawaii in 2013
- Attacks the Coconut Palm and African Oil Palm
- Eradicated palms on some islands
- Over 3000 traps on Oahu island right now
- Labor to check traps is expensive and inaccurate
- We are creating a more efficient way!
- Making the traps automatic and smart!
- Incorporate machine learning at the edge

CRB as compared to other beetles (dlnr.hawaii.gov)

Palm affected by the CRB (dlnr.hawaii.gov)

OpenMV Cam H7 Plus Specifications

- MicroPython OS
- Supports Machine Learning Libraries
- OV5640 image sensor
  - 2.8mm lens
  - M12 lens mount
- Micro SD card slot that reads/writes at 100Mb/s
- WiFi shield (up to 12Mb/s)
- Low Power
  - Idle: 140mA @ 3.3V
  - Active: 240mA @ 3.3V
  - Suitable for IoT applications
- Has Solar panel and LiPo battery inputs

Full specs: https://openmv.io/products/openmv-cam-h7-plus

Computer Vision and Tensorflow

- Computer Vision: Field of AI that trains machines to understand the visual world

  - Has three steps: acquiring, processing and understanding the image
  - We can utilize pre classified image datasets to classify different objects
  - Namely, our project focuses on classifying images of CRBs

- Tensorflow: An open source library used for Machine learning applications

Why Tensorflow?

- Free & easy to use
- Code in Python language
- Tons of resources and codes to learn about it
- Easy process to export models to embedded systems like OpenMV

How is it used?

- Create desired models
- Train and classify data
- To increase accuracy can utilize transfer learning techniques

Computer vision

TensorFlow

Transfer Learning

- A machine learning technique that uses a pre-trained network that classifies a different dataset.
  - Higher accuracy
  - Faster training time
  - Computationally less intensive
- MobileNet Model [1]
  - Created by Google
  - Classifies 1001 classes
  - Input images: 224 by 224 Pixels
  - We used Transfer Learning to classify 17 desired classes
    - Ants, bee, butterfly, caterpillar, centipede, cicadas, dragonfly, rhino beetles, etc.

[1] Andrew G. Howard, et al, *Computer Vision and Pattern Recognition*, 2017

Transfer Learning of CRB on MobileNet model metrics
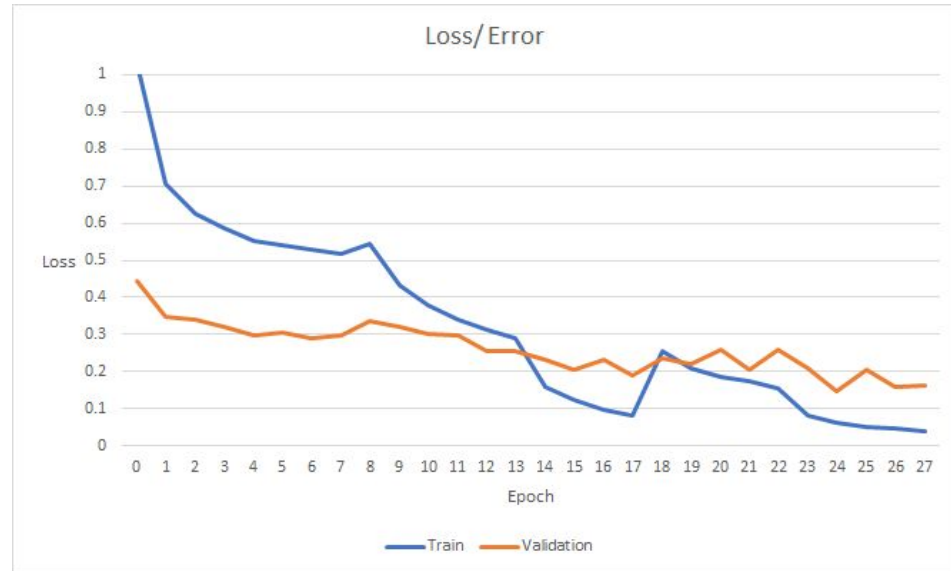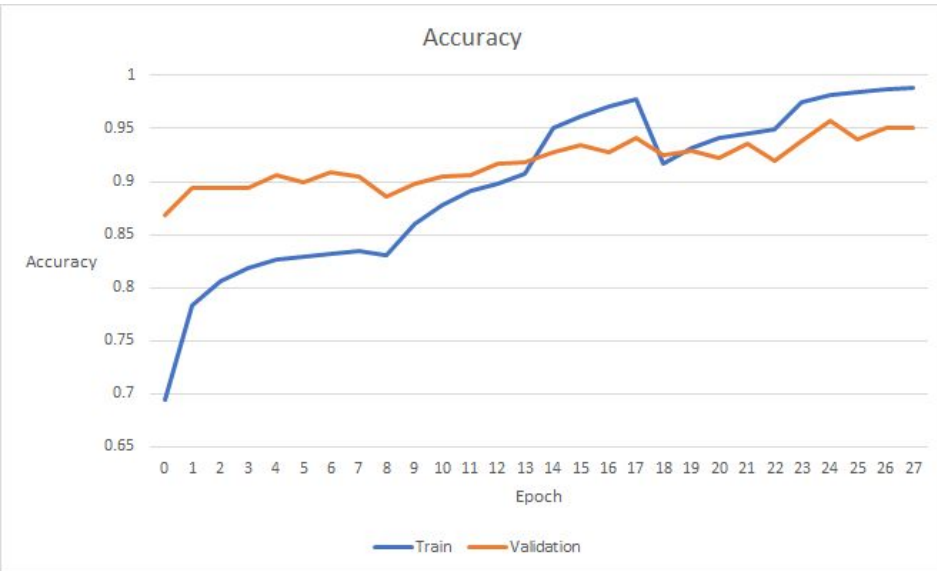
- After reaching desired accuracy, we will convert our trained model to a tensorflow lite file that can be read by the openMV device.

PHP: Hypertext Preprocessor and CRBvision.com

- POST requests can be sent with MQTT to a server
- By utilizing PHP, a server side scripting language, we can listen for POST requests that are sent externally to CRBvision.com
- When an image or message is sent to the server url, the data can then be collected and stored into a file to be displayed on the server such as an image gallery
- Because the data is saved in the online server it can be accessed at any time by the server administrator without requiring to be onsite to collect the SD card data
- Images, messages, and notifications include date, time, and location

OpenMV CRB detection Workflow

- OpenMV camera will connect to a designated network and to a MQTTClient.
- Reaches the NTP(Network Time Protocol) server to get date and time
- Import the quantized model into OpenMV IDE
  - Uses TensorFLow Lite model to detect Coconut Rhinoceros Beetle (CRB)

Serial Terminal

```
Trying to connect... (may take a while)...
Running in Station mode...
('192.168.1.25', '255.255.255.0', '192.168.1.1', '192.168.1.1')
*********
```
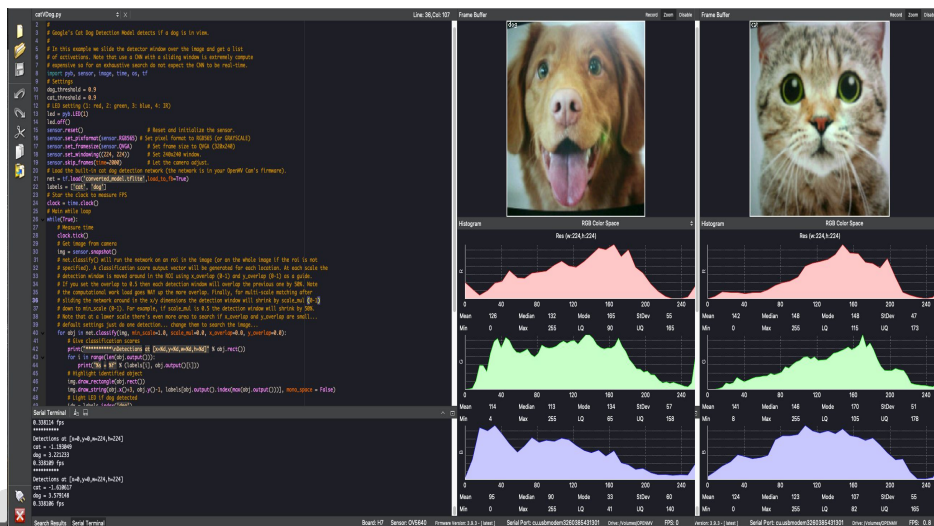
- If model detects a dog, a green LED is illuminated as can be seen in the glare of the dog image
- If cat, a blue LED is illuminated (with trained probability of Cat and Dog)
- OpenMV can also detect other things, but for this example a cat v dog is used.

OpenMV CRB detection Workflow

- If CRB, it captures an image and saves image on an a SD Card
- After image capture will publish a message to a server "Yo, I got a beetle here"
- After prolonged inactivity H7 camera will go into deep sleep for an hour.
  - Deep Sleep: To prolong battery life
- Sleep at night between hours of 6pm - 6am
- Repeats
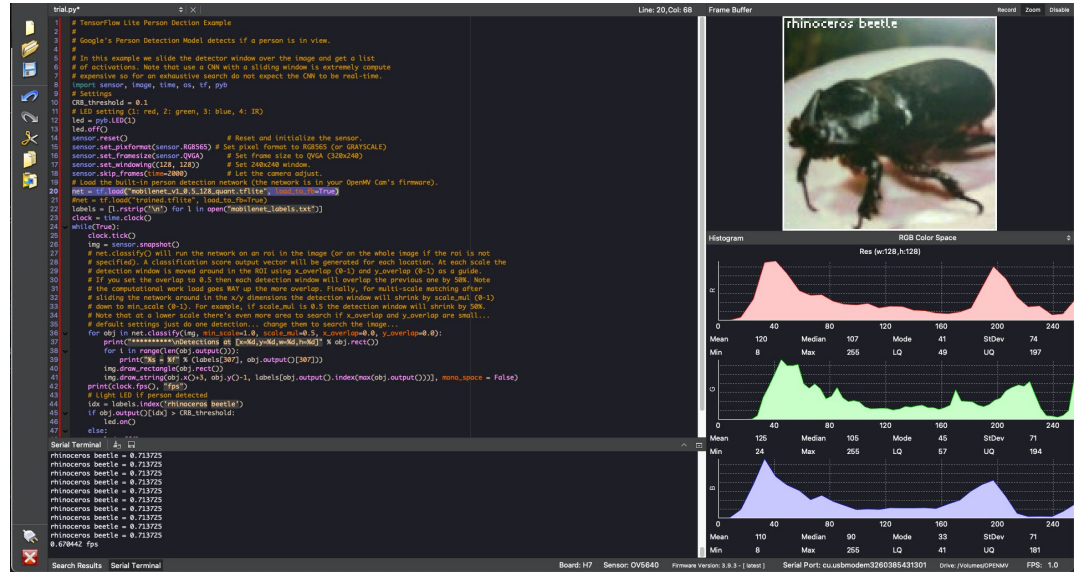
Results & Conclusion

Future Goals:

- Send image to a server using HTTP protocol or MySQL

- Improve machine learning accuracy.

- ## We Have Successfully…
    - Took a photo
    - Connected to WiFi
    - Reached NTP server for HST
    - Sent a message to an mqtt broker
    - Gone into deep sleep (and woke up after 12hours)
    - Created a PHP server
    - Detect images of cats and dogs
    - Detect images of beetles

YO THIS A BEETLE
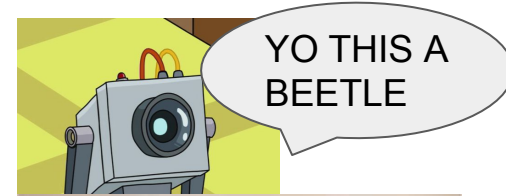
Thank you for your Time! Any Questions?