

# Using Deep Learning Techniques to Monitor Environmental Threats

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Image from: <https://www.kaggle.com/datasets/irvingvasquez/cactus-aerial-photos>

# Mexico seizes ship carrying 68,000 tonnes of illegal iron

1 May 2014

“Police confiscated an iron ore mining operation belonging to a drugs cartel near Lazaro Cardenas...”

In Mexico City's urban sprawl, an unexpected illegal logging network thrives

by Maxwell Radwin on 5 November 2021

- *A national park inside Mexico City experiences illegal logging overseen by cartels*
- *Law enforcement agencies have struggled to root out the illegal logging operations due to a lack of personnel and questionable enforcement strategies*

<https://news.mongabay.com/2021/11/in-mexico-citys-urban-sprawl-an-unexpected-illegal-logging-network-thrives/>



<https://www.bbc.com/news/world-latin-america-27233824>

# VIGIA project

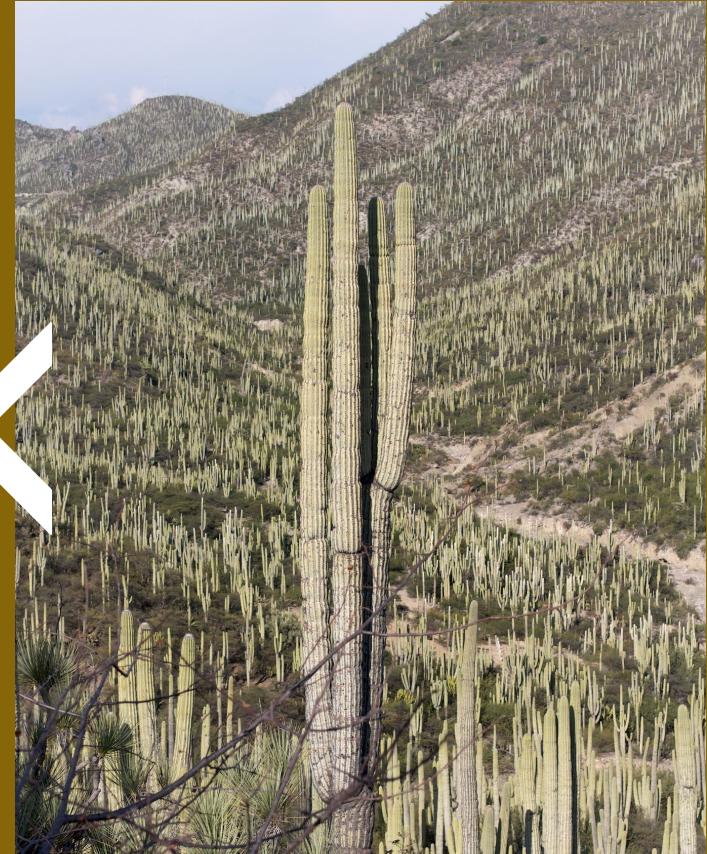
Mexico is rich in biodiversity; however, human activity is degrading these natural areas.

**Government efforts to declare natural areas “protected” and surveil them have, so far, been insufficient.**

Human monitoring is expensive, limited, and in some areas prone to corruption

**Can we develop a system for automatic surveillance of natural areas using artificial intelligence?**

–<https://jivg.org/research-projects/vigia/>



<https://benjaminblonder.org/2015/01/08/guess-the-cactus/>

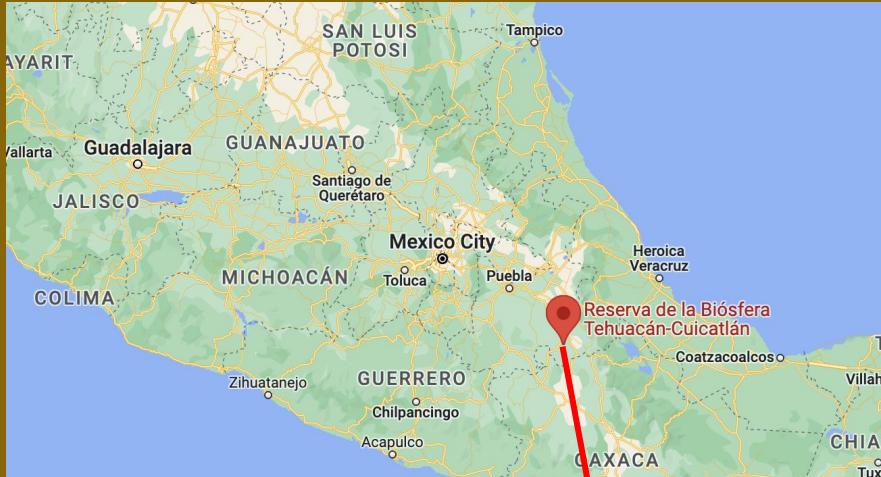


# Needed Surveillance:

- Detect smoke and fire
- Disrupt illegal hunting
- Prevent illegal logging or mining
- Identify cars/other human activity in protected areas

# Research Question:

- Can deep learning techniques, applied to small-sized, low-resolution surveillance/drone images, offer reliable image classification for automated monitoring?



# The Data:

## Kaggle dataset

- Tehuacan-Cuicatlán Biosphere Reserve
- Drone aerial images



# The Data:

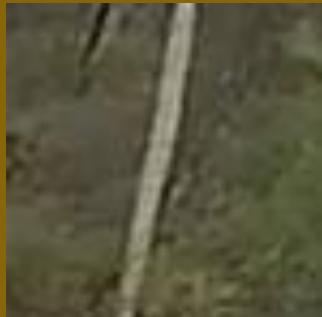
## Cactus Aerial Photos

Columnar Cactus (*Neobuxbaumia tetetzo*)

- 16,138 Cactus images
- 5,366 Non-cactus images
- 80% training, 20% test data

# Start with Transfer Learning

MobileNet (trained on ImageNet)

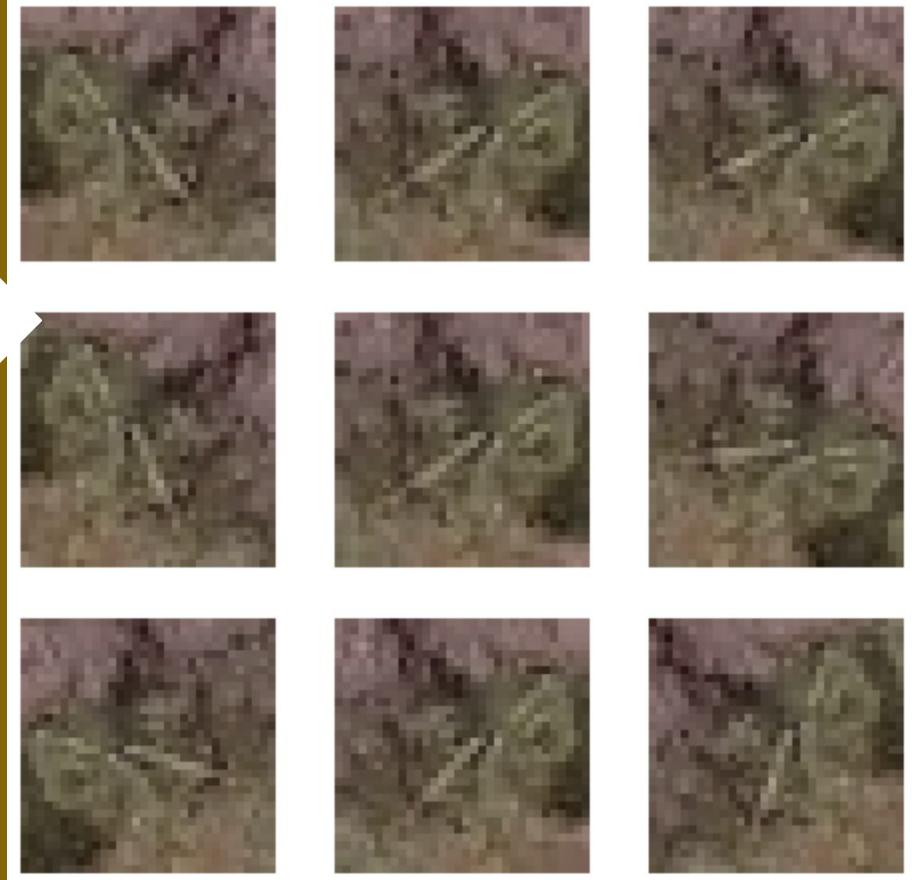


- window\_screen: 0.743
- shower\_curtain: 0.032
- prison: 0.021
- window\_shade: 0.020
- crossword\_puzzle: 0.018

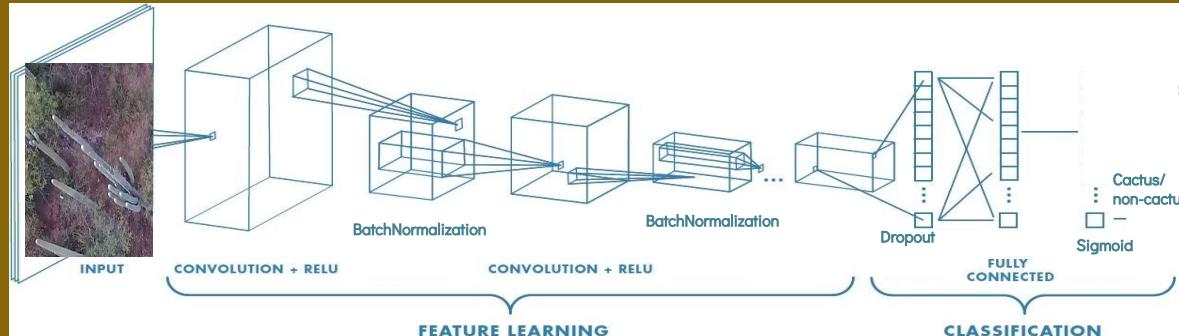
Not so helpful... proceed with model building

# Data Augmentation

- Random horizontal flip
- Random rotation 0.1



# Model Architecture



- Adam Optimizer
- Scaled data

02

Conv2D

11

Batch

Normalization

09

Separable  
Conv2D

02

Pooling

02

Dropout

02

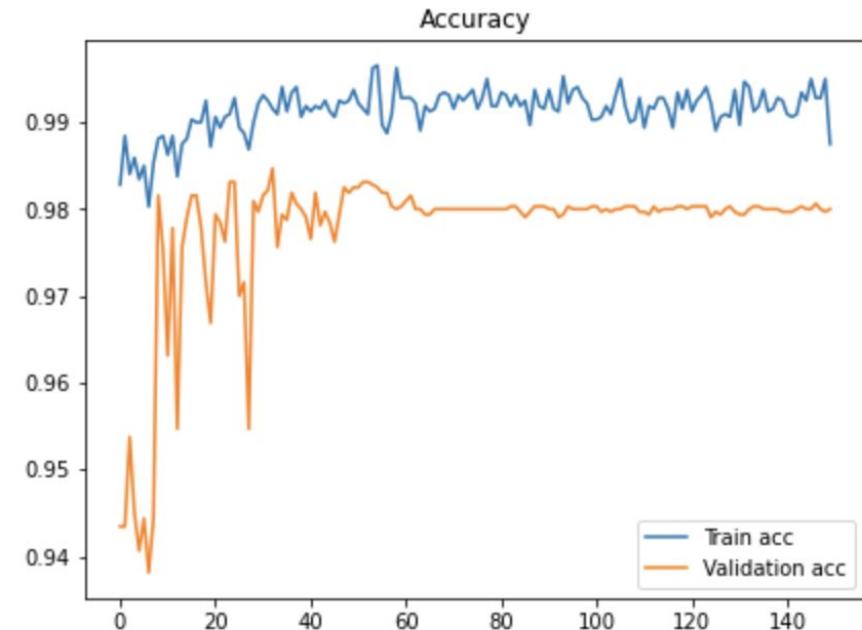
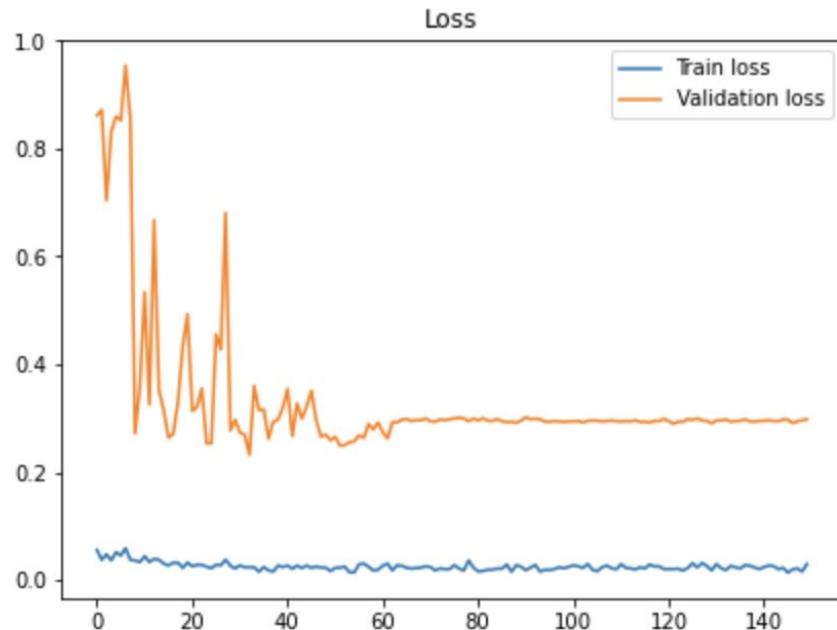
Dense Layer

# Results: Model Performance

Model Test Loss: 0.7113330364227295

Model Test Accuracy: 0.9524999856948853

Weights Saved



How does the  
model  
perform on  
other images?



# Model: “These are NOT cactus”



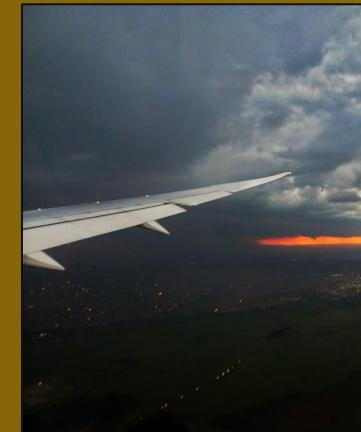
**CNN:** 1.13% likely a cactus  
**98.87%** likely non-cactus

MobileNet:  
75% megalith  
3% alp  
2% stone\_wall  
1% beacon  
1% worm\_fence



**CNN:** 0.34% likely a cactus  
**99.65%** likely non-cactus

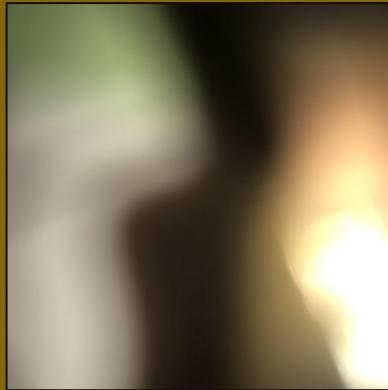
MobileNet:  
22% ant  
10% bee  
3% sulphur\_butterfly  
2% fly  
2% yellow\_lady's\_slipper



**CNN:** 0.00% likely a cactus  
**100%** likely non-cactus

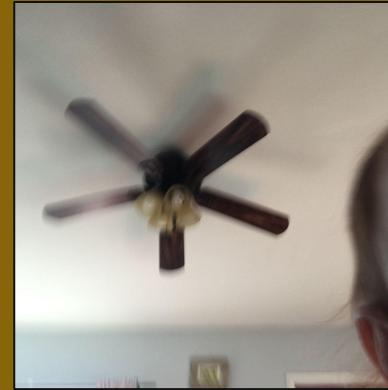
MobileNet:  
76% wing  
6% volcano  
1% airliner  
1% missile  
1% aircraft carrier

# Model: “*Maybe* these are cactus?”



**CNN:** 9.65% likely a cactus  
90.35% likely non-cactus

MobileNet:  
68% matchstick  
4% spotlight  
4% lighter  
2% volcano  
2% candle



**CNN:** 10.87% likely a cactus  
89.13% likely non-cactus

MobileNet:  
22% wall clock  
10% analog clock  
3% tripod  
2% matchstick  
2% tarantula

Horned owl



volcano



# Implications for misclassification

- Flag images that should be cactus but aren't
- Human review flagged images
- False negatives = No major implications
- Misclassification of negative class as positive could reduce effectiveness of security system
- False positives = security threat

# Next Steps:



Address  
Overfitting



Domain  
Adaptation



Residual  
layer



Transfer  
Learning



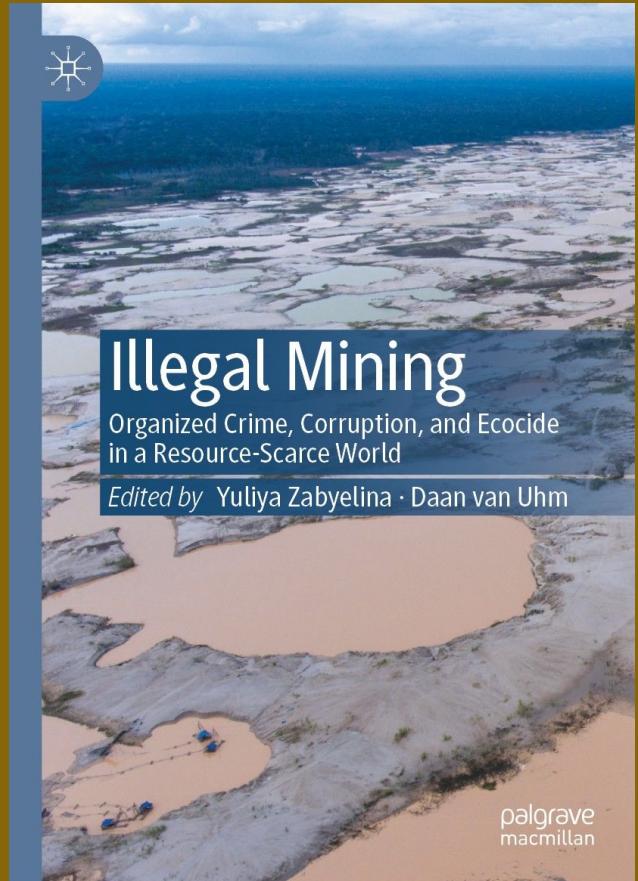
Multiclass  
Model



Video Analysis

# Summary

- Yes CNN can offer high performing models on low resolution images
- Transfer learning is not very helpful in this case
- Many models, trained on this data, perform well; fine-tuning improves marginally
- Need for this kind of solution growing
  - fire alert systems
  - security surveillance
  - environmental monitoring



# List of references

Used for project info and help with models:

- <https://jivg.org/research-projects/vigia/>
- [https://keras.io/examples/vision/image\\_classification\\_from\\_scratch/](https://keras.io/examples/vision/image_classification_from_scratch/)
- <https://www.kaggle.com/code/twhitehurst3/aerial-cactus-keras-cnn-95-accuracy>
- <https://ladvien.com/lego-deep-learning-classifier-cnn/>



# Thank you!

Questions?

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