Classifying wildlife from aerial imagery using deep learning neural networks

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Agenda

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📄	Introduction
🖼️	Collecting/processing imagery
🧠	Development of deep learning classifiers
📊	Results and findings

Introduction

- Animals colliding with aircraft is a known risk for both animal and human safety

- Airport biologists and personnel may mitigate this risk by identifying animal area use and prioritizing management actions

- This starts with animal monitoring

Aviation24.be

BBC.com

Challenges

- Human bias

- Area

- Frequent monitoring requires large amounts of time and funding
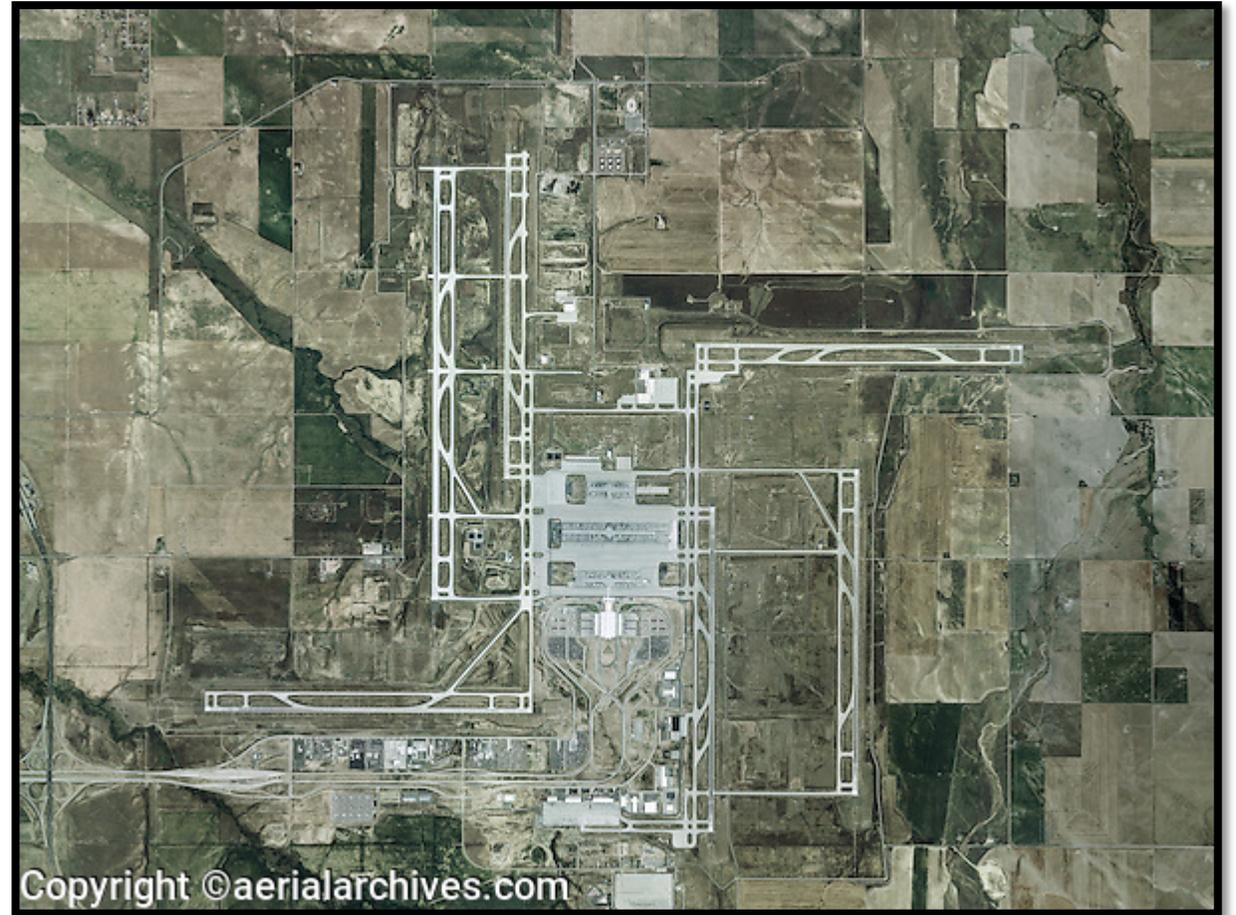
How to address these challenges

- Monitoring through small unmanned aircraft systems (sUAS)

1. Enable users to easily and safely access and cover expansive areas

2. Reduces labor costs and biases

3. Automated image classification on images to save time for processing images

23,987 Files, 100 Folders

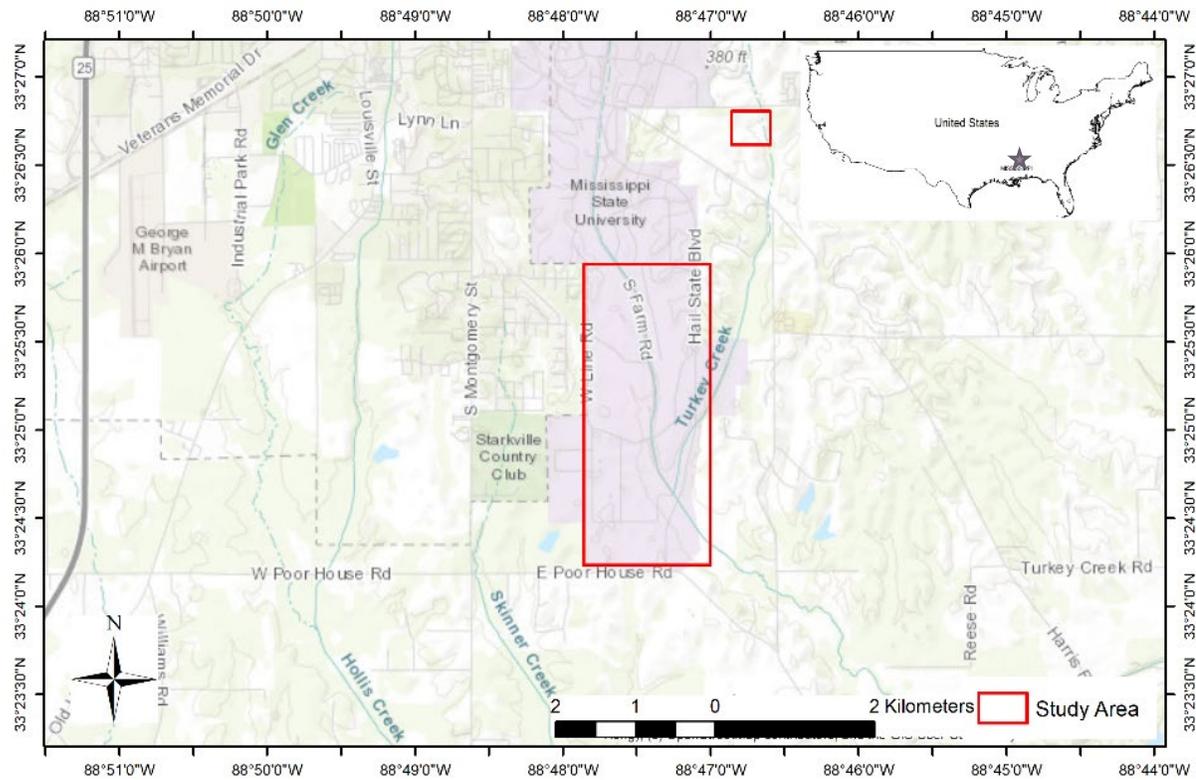|	
Type:	All of type File folder
Location:	All in E:\Drone_imagery
Size:	150 GB (161,538,160,658 bytes)
Size on disk:	150 GB (161,586,307,072 bytes)

Previous classification techniques
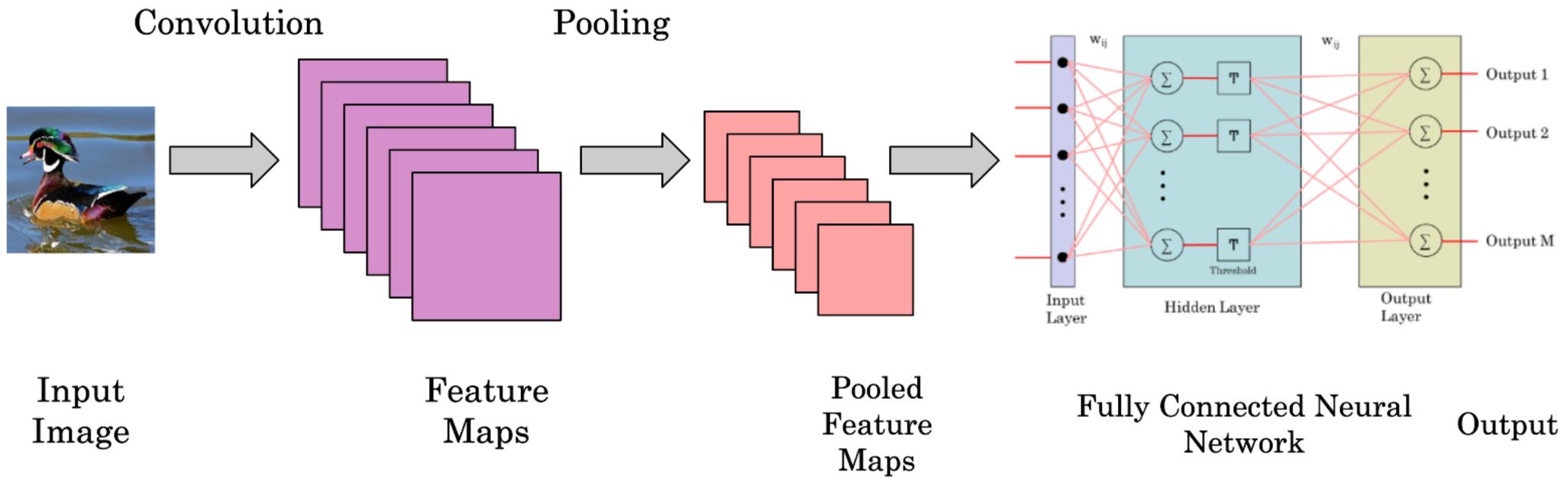
Objective of our study

- Compare the efficacy of different deep learning frameworks on animal imagery collected using sUAS

Zhou et al. *in review: Sensors.*

Study Area

- Mississippi State University properties

- Cattle pastures, row crops, captive facilities, and small farm ponds

- Flown between January and April 2021

- Varying altitudes of less than 60 m above ground level (AGL)

Zhou et al. *in review: Sensors.*

Imagery Acquisition

- DJI Matrice 200 V2

- DJI Zenmuse XT2 with an 8 mm visual lens (640x512 25mm lens thermal camera)

- DJI Zenmuse X7 with a 35mm lens

Zhou et al. *in review: Sensors.*
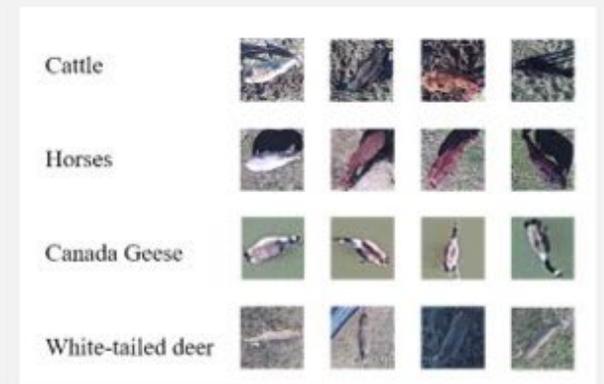
Processing Imagery

Full sUAS imagery

Extracted square images

Mini AWIR: 100 images per class

Cattle
Horses
Canada Geese
White-tailed deer

Zhou et al. *in review: Sensors.*

Our dataset

Zhou et al. *in review: Sensors.*

Development of Deep Learning Classifiers

Deep learning classifiers work like the human brain where you use a set of images to train the computer to recognize differences in images

We took the imagery and tested two different types of deep learning classifiers

- Convolutional Neural Networks (CNN)

- Residual Learning Networks (ResNet)
  - ResNet 18
  - ResNet 34

Experimental Setup

- Split data using a 10-90 and 20-80 split

- Overall accuracy (OA) and Kappa statistic used to measure classification

- Three different learning rates were tested: 0.0001, 0.001, and 0.01

- Different epochs were tested until the accuracy produced a relatively high accuracy

Zhou et al. *in review: Sensors.*

Comparison of best OA from CNN, ResNet 18, and ResNet 34 with different learning rates and two different training sizes

10 % Training Samples				
Algorithm	LR	Run Time	OA	Kappa
CNN	0.01	9m 24s	72.62%	0.634
ResNet 18	0.001	10m 8s	96.74%	0.961
ResNet 34	0.001	15m 26s	97.83%	0.971

20 % Training Samples				
Algorithm	LR	Run Time	OA	Kappa
CNN	0.001	9m 44s	80.54%	0.684
ResNet 18	0.001	9m 58s	97.89%	0.971
ResNet 34	0.001	16m 53s	98.48%	0.980

Comparison of best OA from CNN, ResNet 18, and ResNet 34 with different epochs and two different training sizes

10 % Training Samples

Algorithm	Epoch	Run Time	OA	Kappa
CNN	1000	13m 30s	71.27%	0.594
ResNet 18	200	147m 8s	96.20%	0.957
ResNet 34	100	83m 14s	98.48%	0.980

20 % Training Samples

Algorithm	Epoch	Run Time	OA	Kappa
CNN	150	3m	75.53%	0.662
ResNet 18	200	158m 16s	98.78%	0.981
ResNet 34	200	167m 11s	98.92%	0.985

Results Discussion

- All three deep learning algorithms can accurately classify four animal species.

- ResNet algorithms consistently produced better accuracies than CNN.

- ResNet 18 trained faster than ResNet 34

10 % Training Samples				
Algorithm	Epoch	Run Time	OA	Kappa
ResNet 18	25	9m 8s	94.04%	0.90
ResNet 18	50	36m 39s	94.03%	0.90
ResNet 18	100	73m 23s	95.93%	0.93
ResNet 18	200	147m 8s	96.20%	0.94

Zhou et al. *in review: Sensors.*

What do these mean?

- As automated classification improves, airport biologists and personnel will not need to manually sort through collected imagery

- A high classification accuracy means that animals can be identified quickly and accurately

- Help inform airport biologists to reduce aircraft strikes

Zhou et al. *in review: Sensors.*

Misclassifications

predicted: cows   predicted: horses   predicted: cows

Conclusions

- UAS collected imagery at 60m or less can be used to accurately classify four animal species.

- Both CNN and ResNet offer high classification accuracies.

- Future studies need larger datasets with more species that test more deep learning algorithms.