Using Deep Learning for Quantifying Bat Flight Maneuvering

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INTRODUCTION TO APPS

DLTdv8 is a MATLAB application that can digitize points and annotate videos in both 2D and 3D. This program can train deep learning networks to track multiple moving points within a video. Deep learning has been used in the past to train computers to track animals in the past. The purpose of this lab was to apply this technology to bat species. By tracking these points through space, researchers could gain more insight into how bats move through the air within different contexts, such as while socializing or while hunting. We hope to use DLTdv8 to track these points more efficiently and accurately, and to automate a process which has previously been manually done frame by frame.

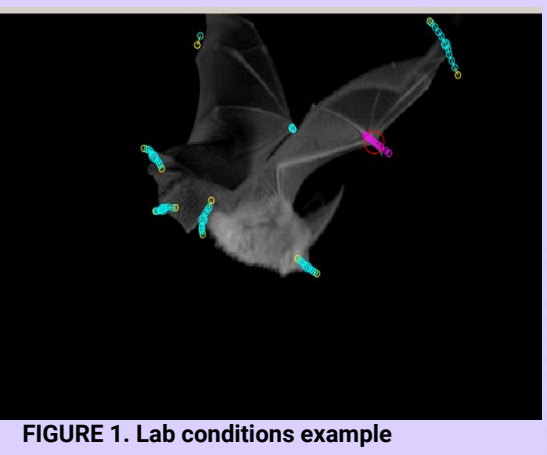

FIGURE 1. Lab conditions example

FIGURE 2. Field conditions example. Bat can be seen in top right corner as a white object.

LAB APPLICATION- part one

First, 8 points in 7 total videos were manually tracked. Three networks were trained with 3, 5, and 7, datastores to investigate how the amount of data affected the accuracy of the network Each network was applied to the same video. As seen below are the accuracies of each network when applied to the same video.

Baseline Network Testing	Left Wing Tip	Right Wing TIp	Nose Tip	Tail Tip	Left foot	Right Foot	Left Thumb Joint	Right Thumb Joint
3 Datastore Network Accuracy(%)	60-70%	45-55%	25%	2%	15%	15%	>1%	60%
5 Datastore Network Accuracy(%)	8-9%	35%	5%	>2%	>1%	>1%	>1%	40%
7 Datastore Network Accuracy(%)	10%	30%	10-15%	3%	>1%	5-7%	>1%	35%

FIGURE 3. Estimate of the accuracy of each point for each network. It is important to note that each network was trained with the video it was applied to and more data likely caused more inaccuracies.

LAB APPLICATION- part two

After the initial testing, the focus was to try to increase accuracy. This was done by isolating 2 point at a time to train networks and applying to those networks to both a video the network was trained on and not trained on. Below are the breakdown of those results.

WING TIPS	Left Wing Tip	Right Wing Tip
4 Datastore Network*	60-65%	55-60%
4 untrained Datastore Network	40%	35%
7 Datastore Network*	20-25%	20-25%
7 untrained Datastore Network	55-60%	50%

NOSE TIP AND TAIL TIP	Nose Tip	Tail Tip
4 Datastore Network*	20-25%	7-10%
4 untrained Datastore Network	60%	50%
7 Datastore Network*	70%	10%
7 untrained Datastore Network	10-15%	10-15%

FEET	Left Foot	Right Foot
4 Datastore Network*	12-15%	12-15%
4 untrained Datastore Network	15-20%	15-20%
7 Datastore Network*	30-35%	30-35%
7 untrained Datastore Netowrk	7-10%	7-10%

THUMB JOINTS	Left Thumb Joint	Right Thumb Joint
4 Datastore Network*	55-60%	55-60%
4 untrained Datastore Network	20%	20%
7 Datastore Network*	50%	10%
7 untrained Datastore Network	20-25%	7-10%

FIGURE 4. Each set of points has its own network specifically trained. The networks were trained using the same videos and then applied to the same videos, one that was used to train the networks indicated by '*' and one that was not used to train the network indicated by 'untrained'.

FIELD APPLICATION

We attempted to track the wing movements of bats in the field. We trained networks on manual datasets containing data on three points: both wingtips and the center of the body. Footage was ran through a program called ThruTracker. This would track an object around the frame and create a new clip centering on that object. We used this to retrieve footage that was always cropped around the target bat. Applying the deep learning networks to these clips successfully tracked the points on the bat.

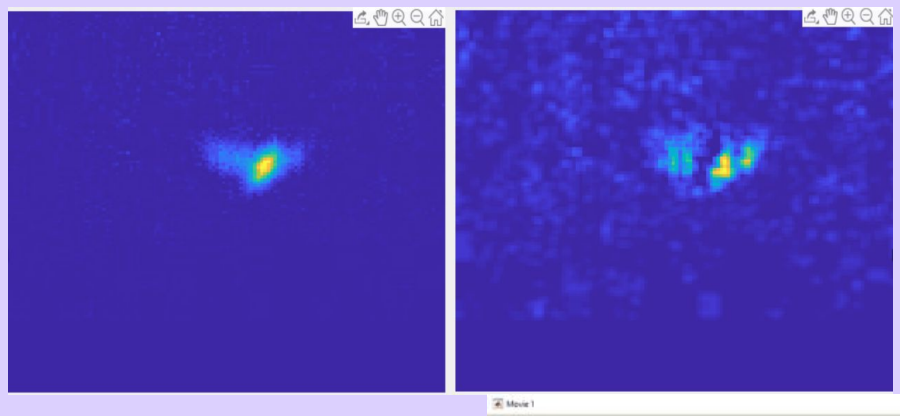

FIGURE 4. ThruTracker tracking the moving objects within a raw video

FIGURE 5. A frame from the cropped clip of a field bat showing the three, manually added points that were tracked on the bat's body.

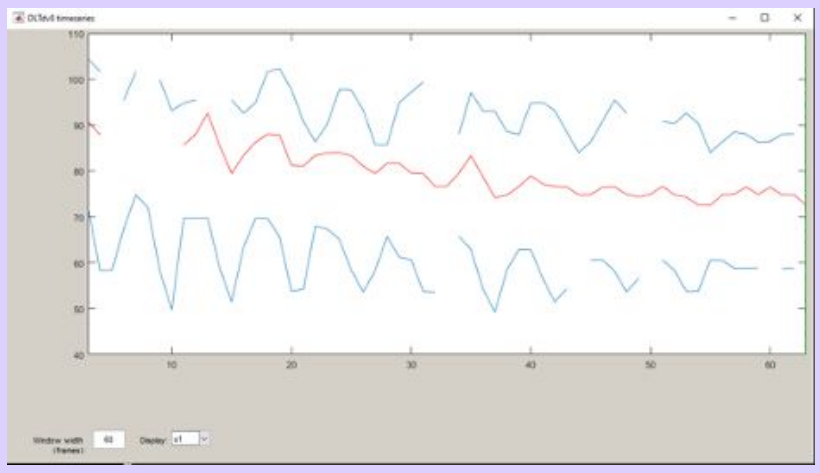

FIGURE 6. The position data showing the deep learning network tracking the movement of the three points it has been trained on. The red line is the movement of the center of the bat's body and the blue lines are the movement of the wings.

MOVING FORWARD

Going into the semester, we knew that the DLTdv8 app in MATLAB had never been used to track bats in this way before and there were issues. One of the main issues within lab applications was realizing that networks needed to be applied to videos that the network was not trained on in order to determine how effective the network is in practical application. In the field, the main issue was having other objects in the frame. This made it more difficult for the network to differentiate between the bat and those objects therefore thru tracker had to be applied in order to crop around only the bat. Trial and error was a large part of this experience and learning the best way to achieve results within the app is an ongoing process. Hopefully our progress this semester will allow for an automated tracking system for bats in the future. This would allow for more analysis of flight patterns rather than time spent manually tracking. Some success in tracking this semester was a achieved but there is more trial and error needed to refine these techniques.

Acknowledgements-

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Sources:
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