

Mosquito Vision Mini-Checkpoint



EN.601.456 Computer Integrated Surgery II

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Project Summary

Goal: To create a ROS-integrated computer vision system for mosquito detection and keypoint identification to guide an automated mosquito dissection robotic system for live malaria vaccine production

Background:

- Malaria is a global problem, causing over 400,000 deaths and \$12 billion USD of loss in 2017
- Sanaria has developed a live malaria vaccine shown to be 100% effective in clinical trials
- Extraction of salivary glands vital for vaccine production
- Currently done manually; but automatic mosquito microdissection system (MMS) proposed

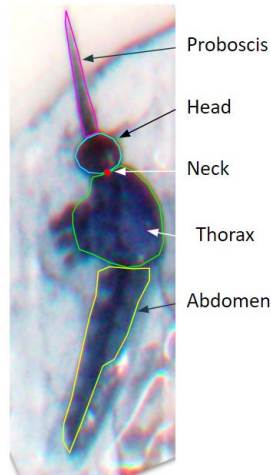


Figure 1. Parts of a mosquito

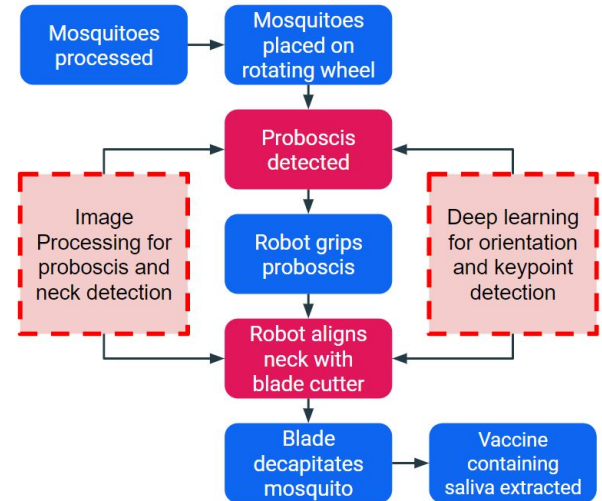


Figure 2. Process flow diagram for mosquito keypoint localization

Deliverables - Progress

Minimum

Expected

Maximum

IP

- Mosquito finder algorithm
- Neck finder algorithm
- Proboscis finder algorithm
- Algorithm + design documentation

In addition to minimum...

- Library creation
- Library documentation
- Integration with ROS

In addition to expected...

- Validation of CV algorithms
- Validation methods + results documentation

DL

- Orientation algorithm
- Framework for training keypoint detection
- Documentation of design choices, algorithms, and code usage

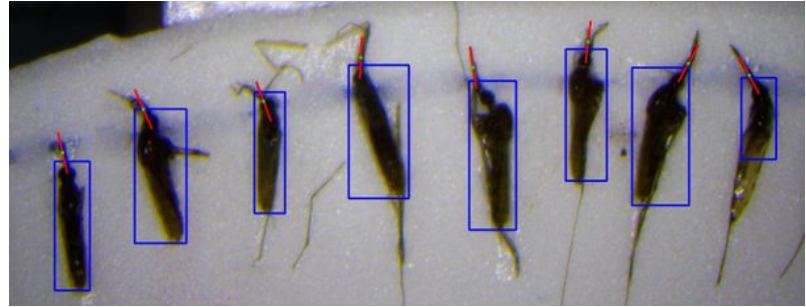
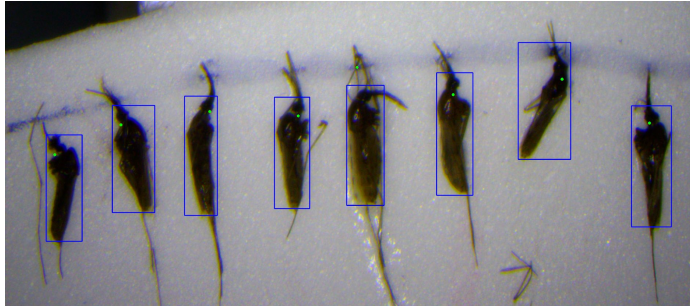
In addition to minimum...

- Implementation of DL orientation algorithm in a ready-to-be-integrated class-based model

In addition to expected...

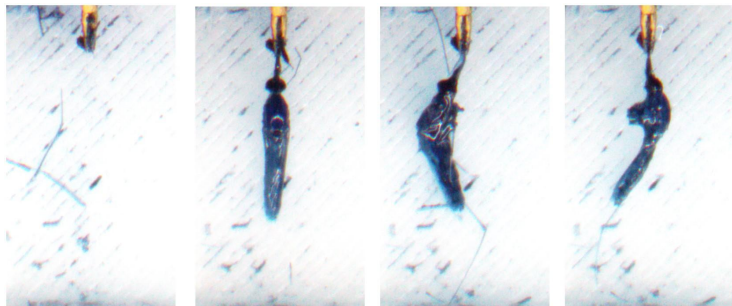
- Creation and validation of library to streamline process of training mosquito keypoint detection

Image Processing Results



Mosquito Finder		Proboscis Finder		Neck Finder	
# Mosquitos	306	# Proboscis	261	# Necks	272
# Found	291 (95%)	# Found	251 (96%)	# Found	259 (95%)
Avg. IOU	0.736	Avg Lateral Error (pixels)	3.46	Avg y-axis Error (pixels)	10.91
STDEV	0.126	STDEV	3.39	STDEV	7.62

Deep Learning - Orientation Classification



Missing

Back

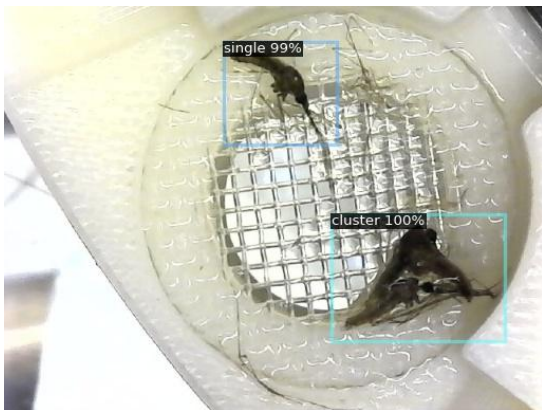
Left

Right

Model	Accuracy	System	Inference (s)	Inference + Processing (s)	Inference + Processing + Importing (s)
ResNet18	96%	CPU	0.102	0.104	0.190
		GPU	0.004	0.005	0.090
ResNet152	97%	CPU	0.588	0.590	0.701
		GPU	0.028	0.029	0.110
VGG16	94%	CPU	0.614	0.616	0.705
		GPU	0.016	0.017	0.107
DenseNet121	96%	CPU	0.297	0.299	0.391
		GPU	0.022	0.023	0.120

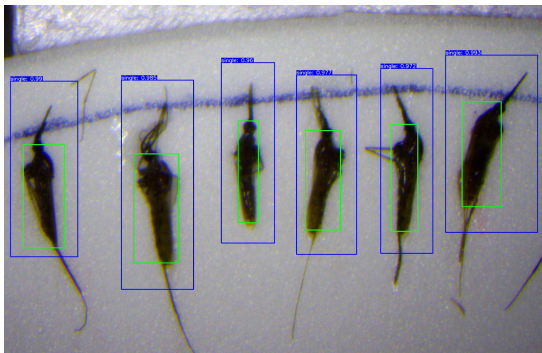
Deep Learning - Mosquito Detection

Validation Images



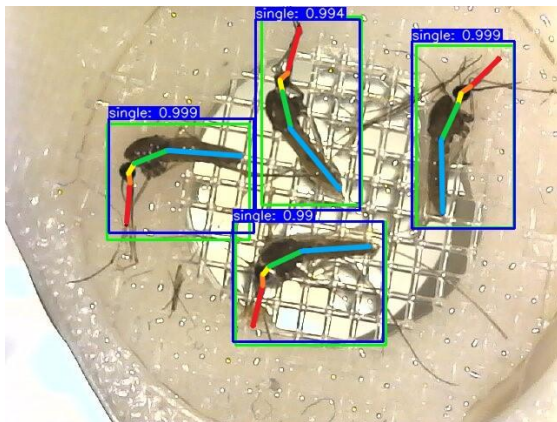
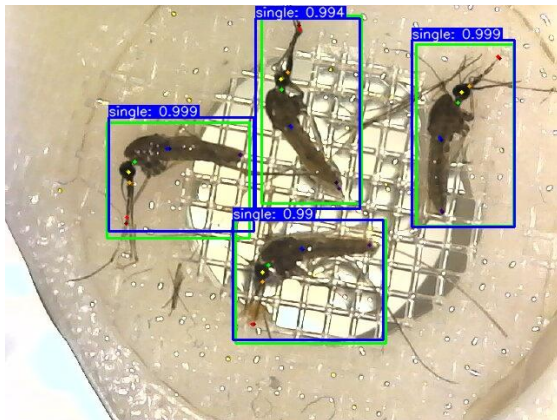
Model	mAP@IoU=0.75	mAP@IoU=0.5	Inference Time
Wu et al.	0.84	0.96	~400 ms
Mask RCNN R50 FPN	0.894	0.975	~100 ms
Faster RCNN R50-C4, VOC	0.895	0.981	~200 ms
Faster RCNN R50 FPN	0.895	0.970	~60 ms

Testing Images

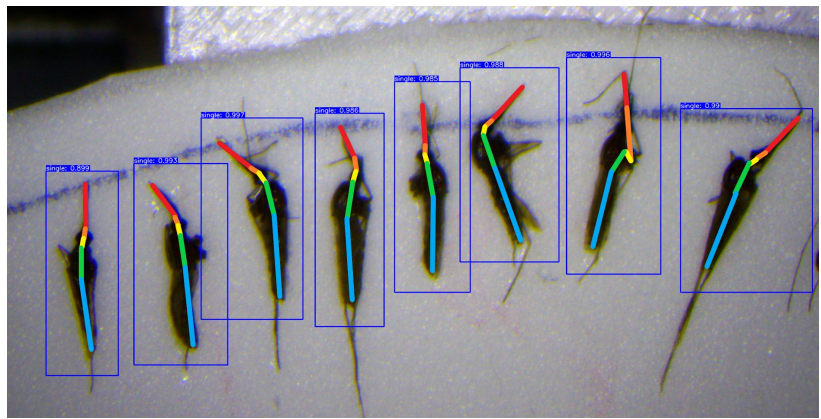


Model	Total Mosquitos	# Detected	% Detected
Image Processing	306	291	95%
Faster RCNN R50-C4, VOC	306	306	100%

Deep Learning - Pose Estimation



Model	Wu et al.	R50_FPN_3x Detectron2	
RMSE	Old Images	Old Images	New Images
Proboscis Tip Error	7.1	7.17	22.15
Proboscis End Error	2.2	1.91	16.64
Head Error	1.6	1.40	
Neck Error	2.0	1.89	44.70
Thorax Error	2.6	2.71	
Abdomen Error	3.0	3.68	



Next Steps

Image Processing

- ▷ Documentation of validation methods + results

Deep Learning

- ▷ Documentation of pose estimation
- ▷ Labeling datasets

Thank you! Questions?

References

[1] Wu, H., Mu, J., Da, T., Xu, M., Taylor, R. H., Iordachita, I., & Chirikjian, G. S. (2019). Multi-mosquito object detection and 2d pose estimation for automation of PfSPZ malaria vaccine production. In 2019 IEEE 15th International Conference on Automation Science and Engineering, CASE 2019 (pp. 411-417). [8842953] (IEEE International Conference on Automation Science and Engineering; Vol. 2019-August). IEEE Computer Society. <https://doi.org/10.1109/COASE.2019.8842953>