Automated Drosophila Sorting System

Integrated Systems Design II: Project Review
Spring 2026

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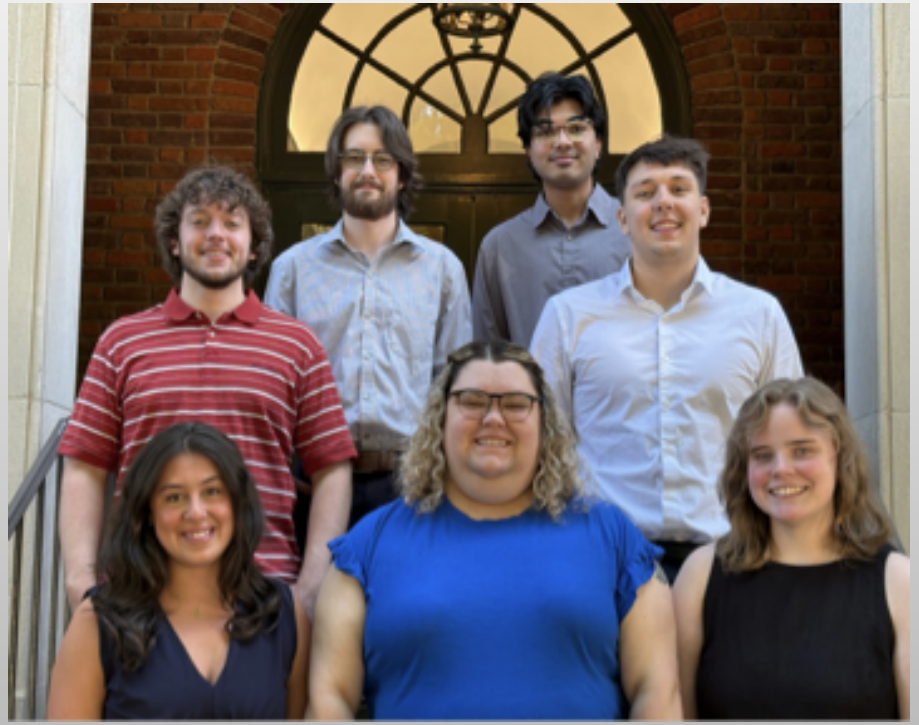
Who we are: Team 8



(From Top to Bottom, Left to Right)

Dylan Britch
Avi Patel
William McGlone
Camren Khoury
Ainara Garcia
Megan Mcnuer
Rivers Henderson

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Objective/Motivation

1. Hold Flies
2. Design and 3D print parts
3. Wiring and Motor Control
4. Sort Flies (M/F) , rate, by doing it with the camera, success rate
5. Computer Vision for identifying, sorting, and counting flies
6. Perform assay
7. Stay under budget

Given a vial of flies, a user could dump the vial into a channel and walk away. From then the execution was entirely robotic and hands free. Our motivating factor was to find a better use of the user's time elsewhere while their simple and automated tasks were completed in the background.

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Project Goals and Deliverables

1. All mechanical designs complete and function (movements complete start to finish done in 15 seconds)
2. Database trained, complete and working (with ~80-99% accuracy as the goal)
3. 4 flies sexed and sorted per minute
4. GUI with start/stop sequence, report generation and minor debugging
5. Assay complete with report generation through GUI
6. Instruction booklet complete and integrated clearly

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Workflow

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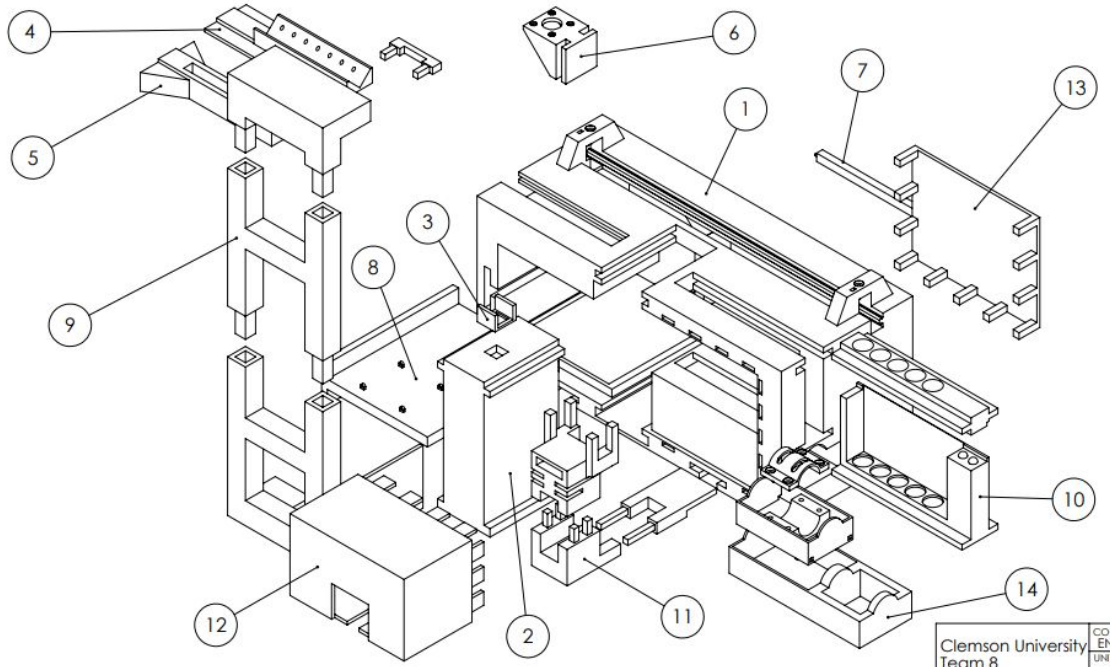
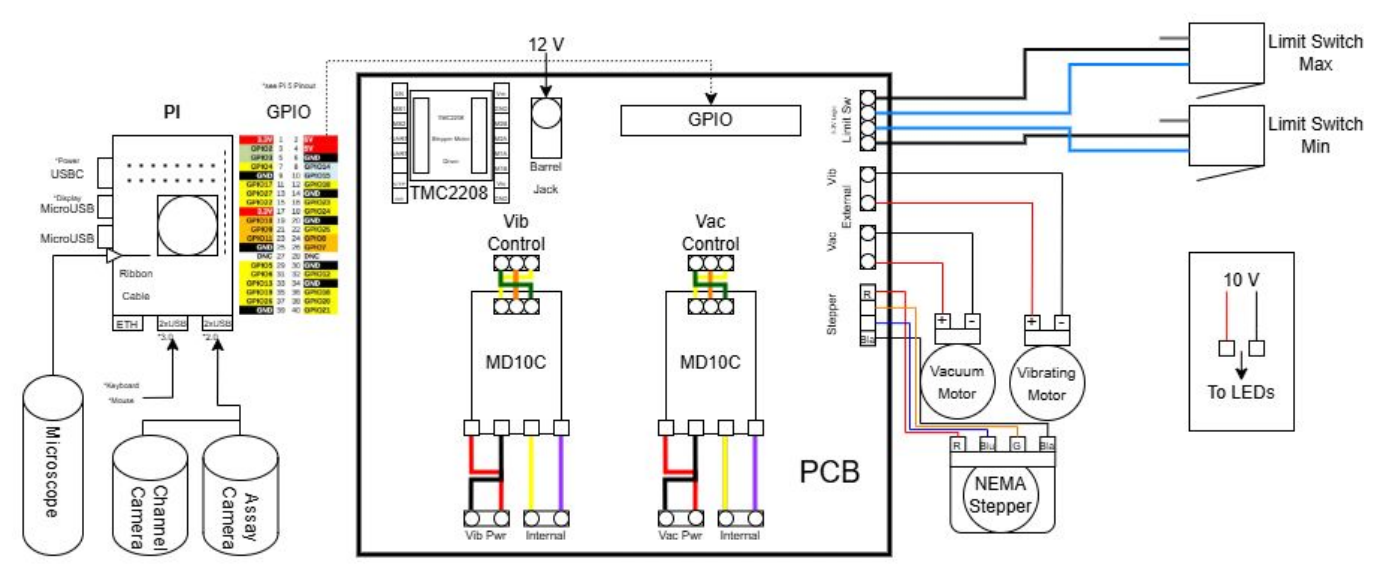
Hardware Design: 3D Prints

ITEM NO.	PART NUMBER	ITEM NO.	PART NUMBER
1	Table 3.0	8	Pi Shelf
2	Camera Box	9	Channel Camera Stand PARTS ASSEMBLY
3	Camera Box Top	10	Assay Tube Holder 3.0 Assembly
4	Channel	11	Assay Camera Stand Total Assembly
5	CO2 Attachment	12	Assay Camera Box 2.0
6	Stepper Holder	13	LED Holder
7	PCB Stopper 3.0	14	Electric Motor Holder Assembly



Hardware Design: Wiring



3 Motors:

- Nema 17 Stepper Motor
- 12VDC Eccentric Motor
- 12VDC Vacuum Pump

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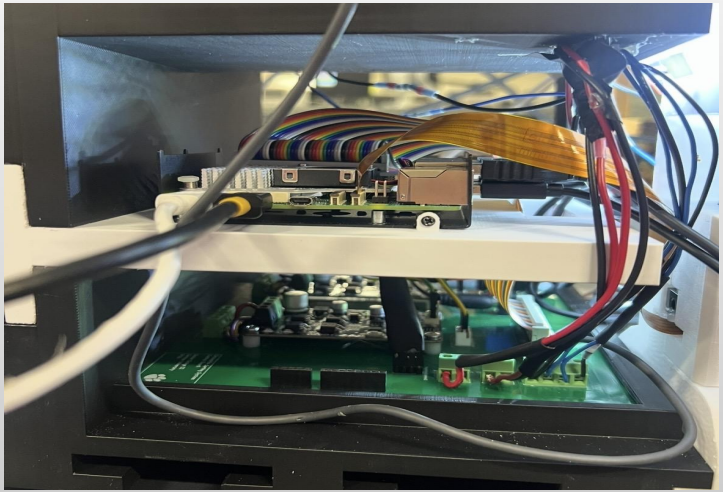
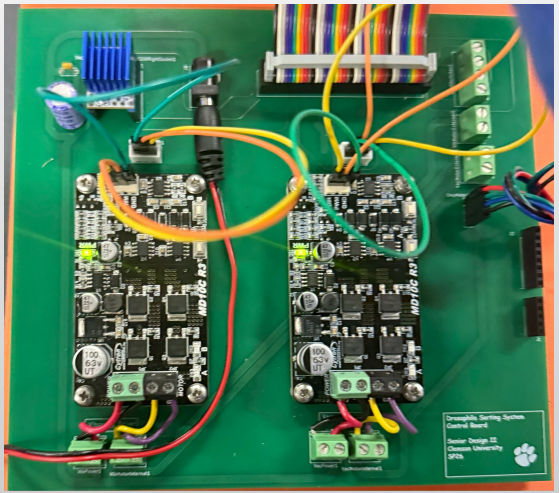
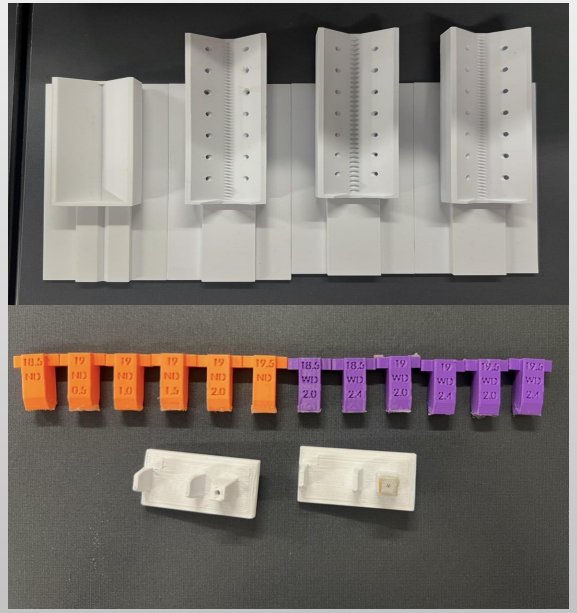
Hardware Design: Wiring

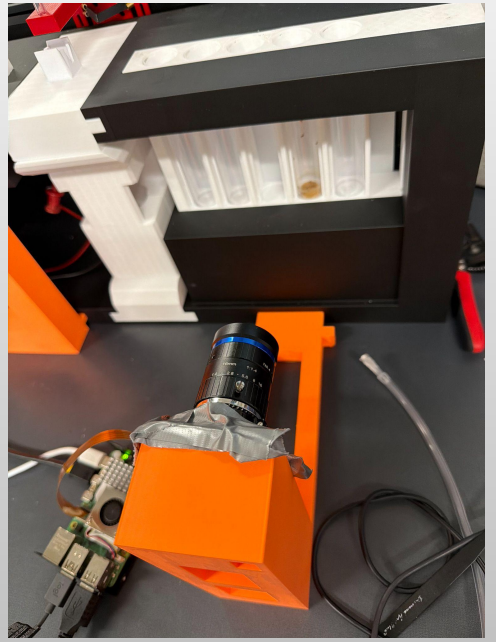




- PCB designed in KiCAD to simplify wiring
- Contains the stepper motor driver, DC motor drivers, barrel jack 12V connection, and GPIO pins

Methodology: Testing and Verifications





19.5 WD 2.0 (*Recently Live Flies, Mini Ridge Channel)	Even Distribution		0.9		0.9		0-50mm (first half)	5tubes*10
		0.8		0.9		0.8	50-108mm (second half)	5tubes*10
	Failure Modes	Hit Lip (1), Stuck/No Drop (1); Out of Range (1); Pickup 2 (1); Out of Range (1); Stuck/Nodrop (1), Out of Range (1)						
	Fail?							
	Over/UnderShoot?							
Completion/Error	Reduces Lip issues and pickups of 2, but more out of range issues, Can be used in hills instead						Overall	86%

Methodology: Testing and Verifications

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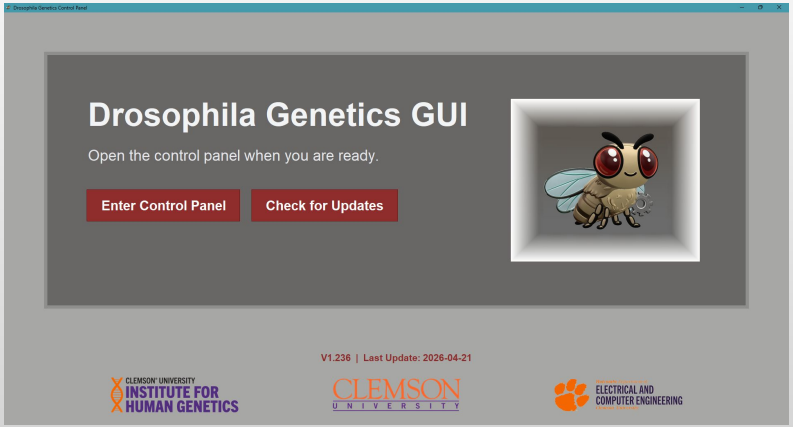
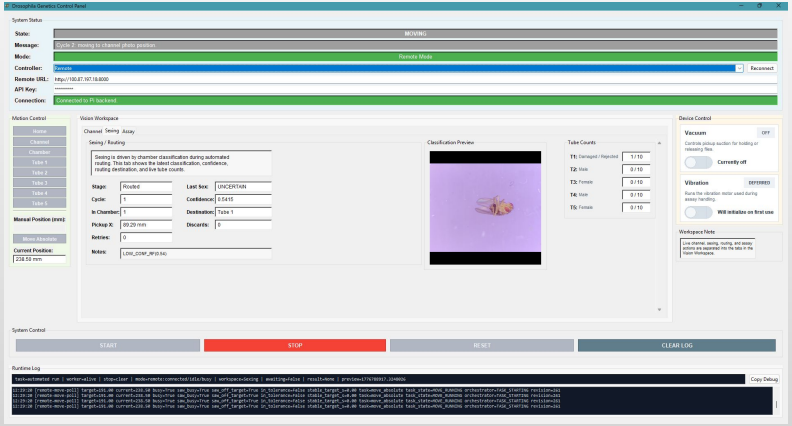
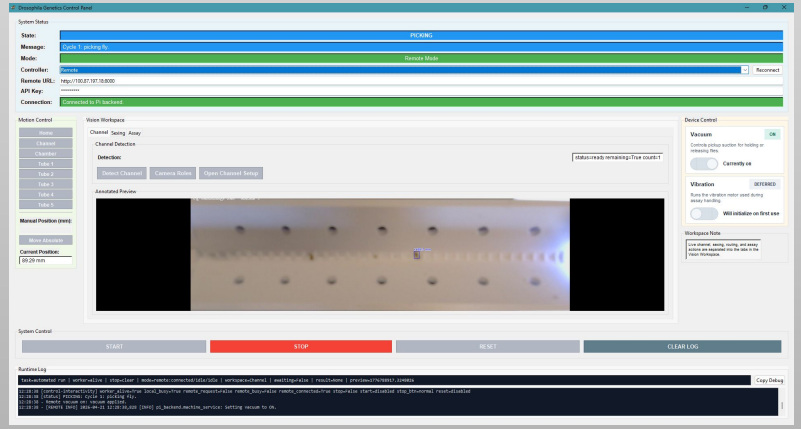
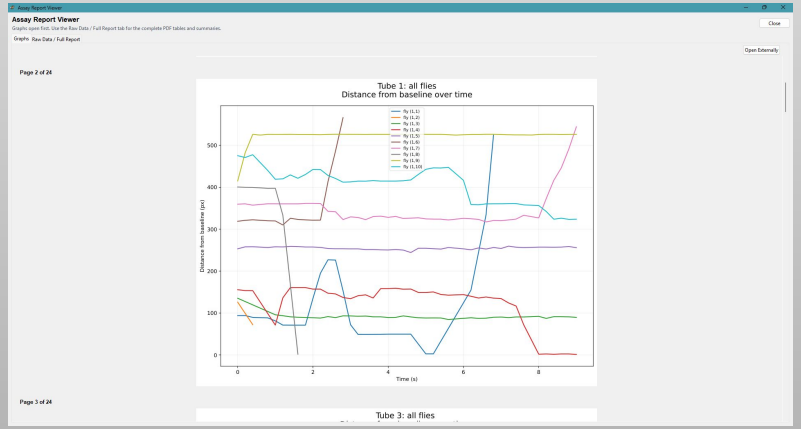
GUI









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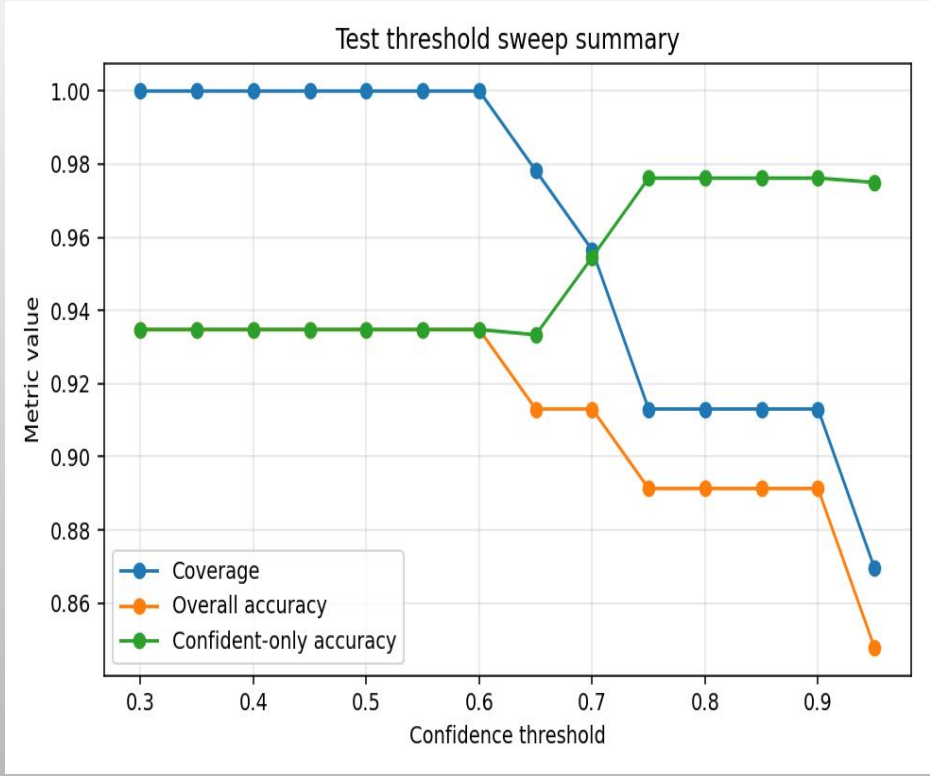
Computer Vision: YOLO Model

Example Predictions (See Green Hue)



Accuracy

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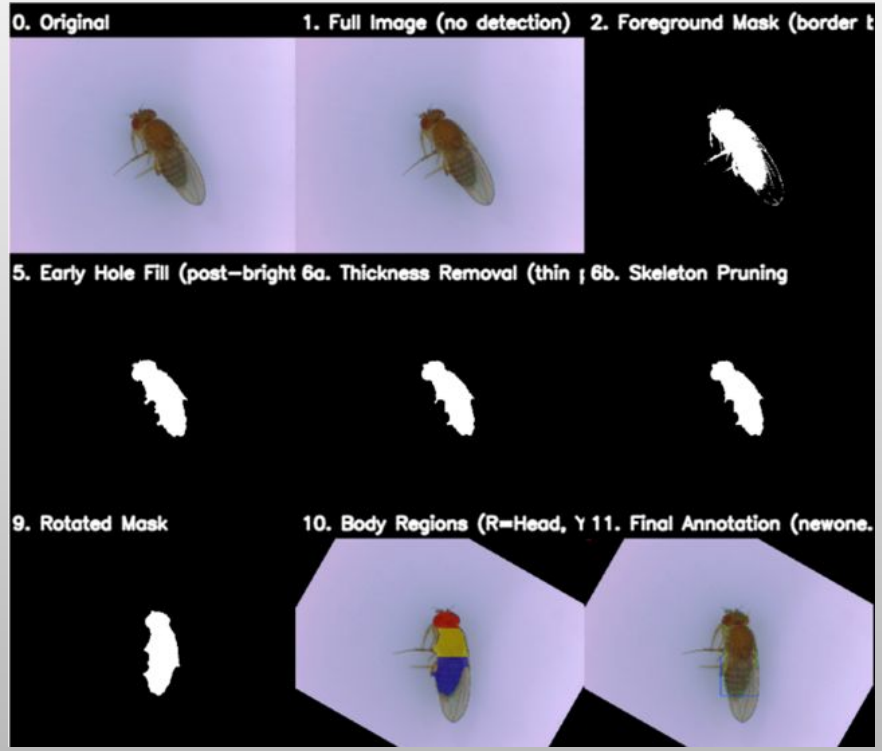
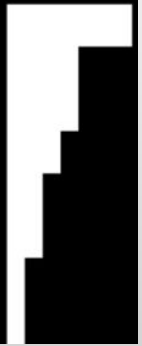
Computer Vision: Segmentation



Segmentation Process using Masking

```
Feature Importances:
  yolo_class                0.1497
  body_length_px            0.0892
  yolo_confidence           0.0838
  posterior_dark_frac       0.0663
  abdomen_tip_width_norm    0.0545
  abdomen_darkness          0.0442
  abdomen_aspect            0.0393
  eye_red_score             0.0381
```



```
body_length_px,body_aspect_ratio,head_len_norm,thorax_len_norm,abdomen_len_norm,thorax_abdomen_ratio,head_aspect,thorax_aspect,abdomen_aspect,abdomen_tip_width_norm,taper_rate,abd_width_peak_pos,abd_convexity,thorax_abdomen_width_ratio,centroid_pos,head_darkness,thorax_darkness,abdomen_darkness,posterior_dark_frac,striation_score,dark_band_count,abd_roughness,thorax_texture,thorax_stripe_contrast,eye_frac,eye_red_score,asymmetry,errors
```

```
Combined          0.9420
Morphology only   0.8333
YOLO only         0.8188
```

28 features extracted, including 2 from YOLO. Combined is better than either.

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Results

- All mechanical designs have been complete
- YOLO model has been trained to 95-99% accuracy
- Database of over 2000 fly photos
- 2 flies sexed and sorted per minute
- GUI with start/stop sequence, report generation and minor debugging complete and off loaded
- Assay complete with report generation through GUI and uploaded to BOX
- Instruction booklet complete and integrated clearly

Future Directions

- Updated YOLO when larger database is built
  - AI Hat on Raspberry Pi
- Redesign mechanical components as needed
  - particularly, linear rail for larger fly quantity/capacity
- Climbing Assay improvements on flies per tube, assay run time, etc, and optimize tube shapes
- Better fly isolation system with potential with 2D+ gantry
- PCB redesign/corrections
  - Integrate motor chip and LEDs in board
  - Minor orientation changes

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Conclusion

This project had an immense learning curve initially, but overall has been an incredibly valuable experience. Both Electrical and Computer Engineers have learned to debug code, model parts, train ML algorithms, and most importantly work together as a team.

Thank you to Dr. Raza, ECE, and IHG for their support and contributions.