SwarmSight: Real-Time Insect Antenna & Proboscis Tracking

J. Birgiolas[1], C. M. Jernigan[1], R. C. Gerkin[1], B. H. Smith[1], S. M. Crook[1,2]

[1] School of Life Sciences, Arizona State University

[2] School of Mathematical and Statistical Sciences, Arizona State University

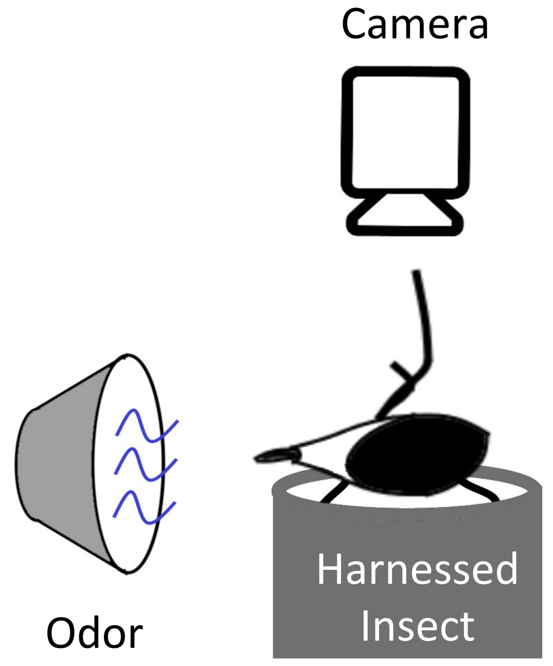
http://iconlab.asu.edu

justas@asu.edu

Problem: Insect Head Appendage Tracking is Inefficient

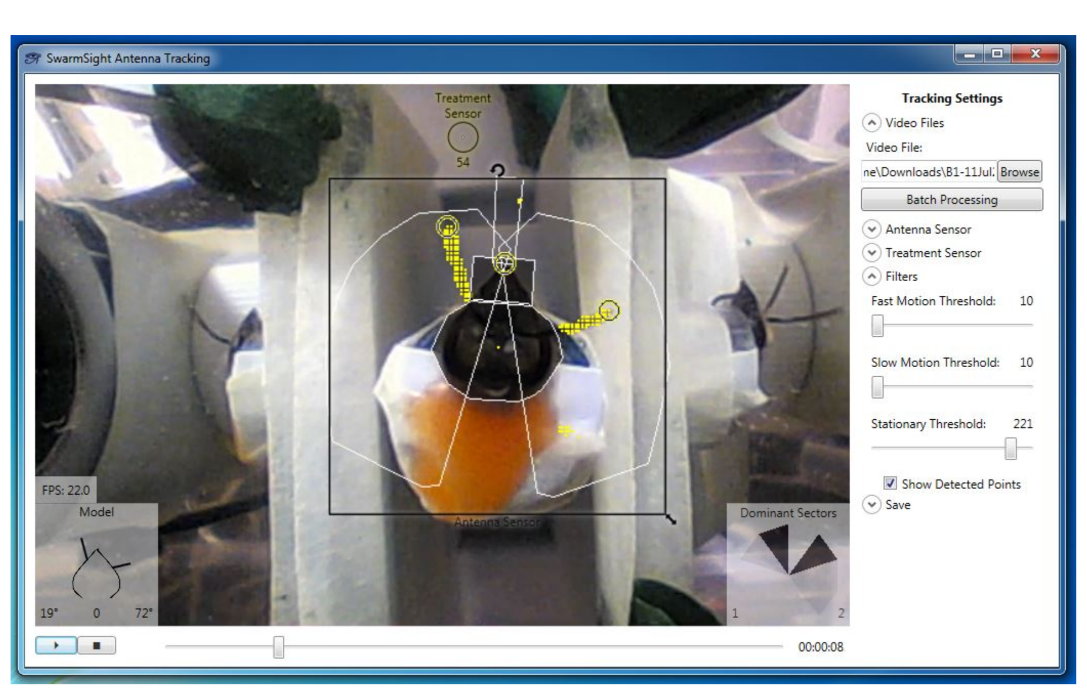
- Insects sample air with olfactory receptors on their antennae.
- Research requires efficient measurement of insect antenna and proboscis movements.
- Previous methods: high-speed cameras, tip painting[1], long processing times[2].
- We have developed an efficient method to film and analyze antenna and proboscis movements.

Machine Vision Algorithms Can Efficiently Track Antenna and Proboscis Locations in Videos of Harnessed Insects

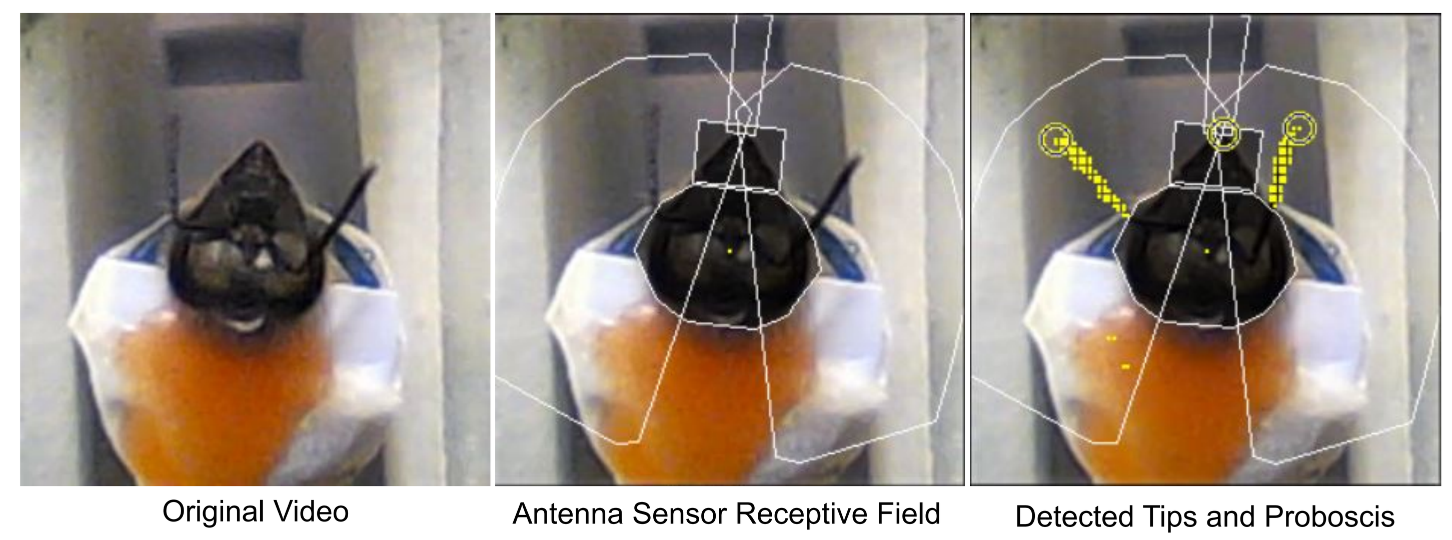


Animal: The insect and its head are harnessed.
Stimulus: Odor cartridge supplies odor to the insect.
Measurement: Video camera films the insect from a top-down view.

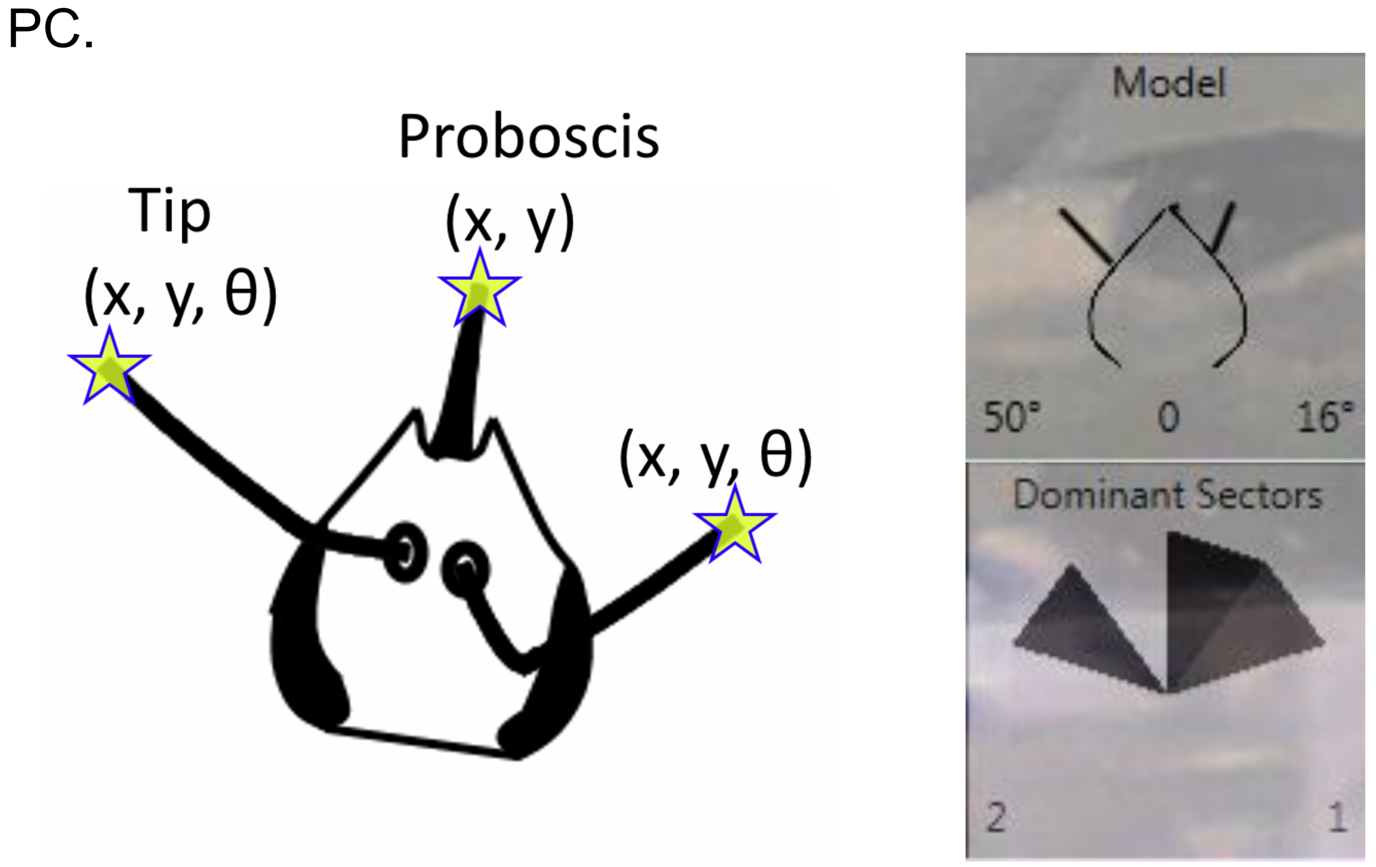
We have developed SwarmSight machine-vision software[3] to analyze these insect videos to obtain the frame-by-frame positions of the antennae and proboscis tips.



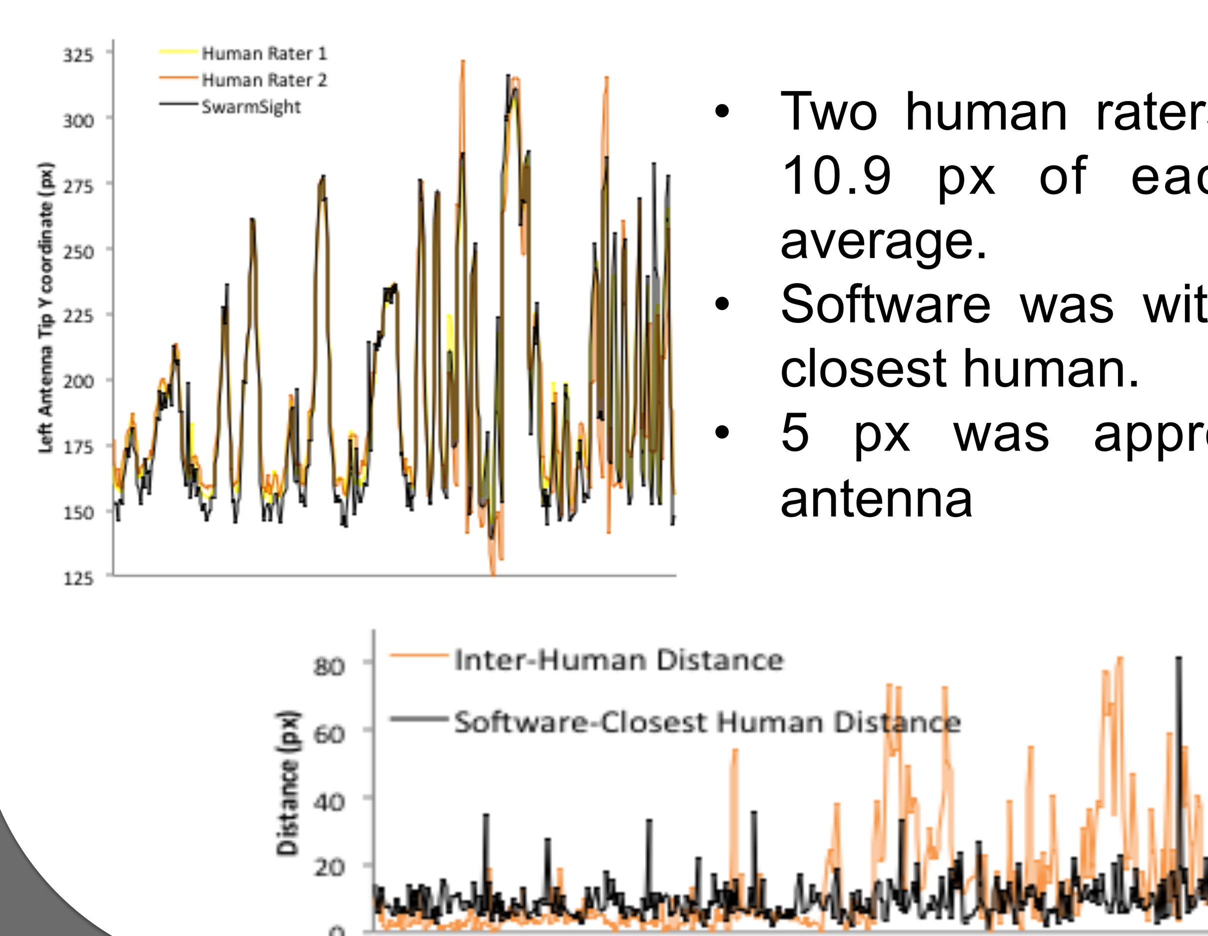
SwarmSight



- User provides head location and orientation.
- SwarmSight detects likely antenna and proboscis points.
- The software computes appendage locations and dominant antennae sectors.
- Software runs at 60-70 fps on Dual-Core Windows 7, 2GHz PC.

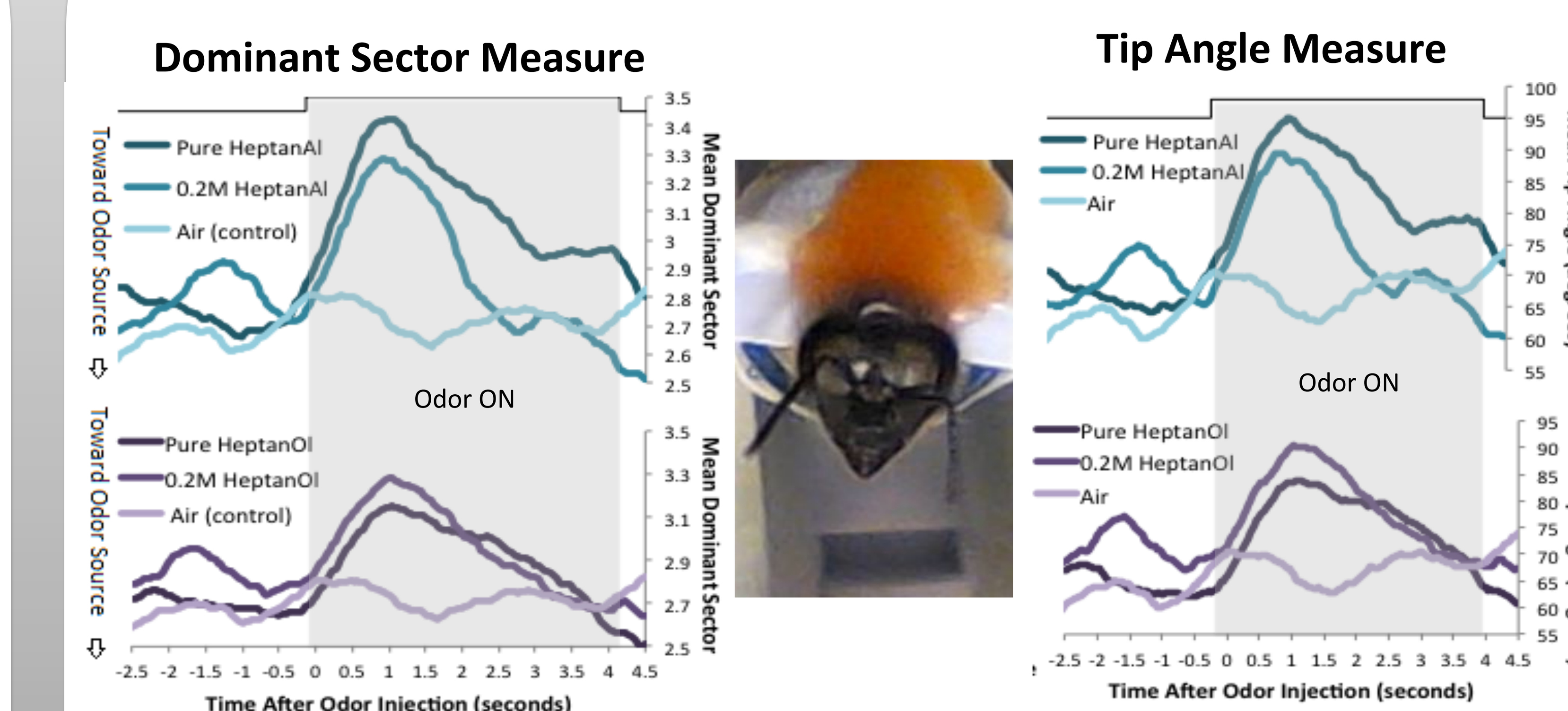


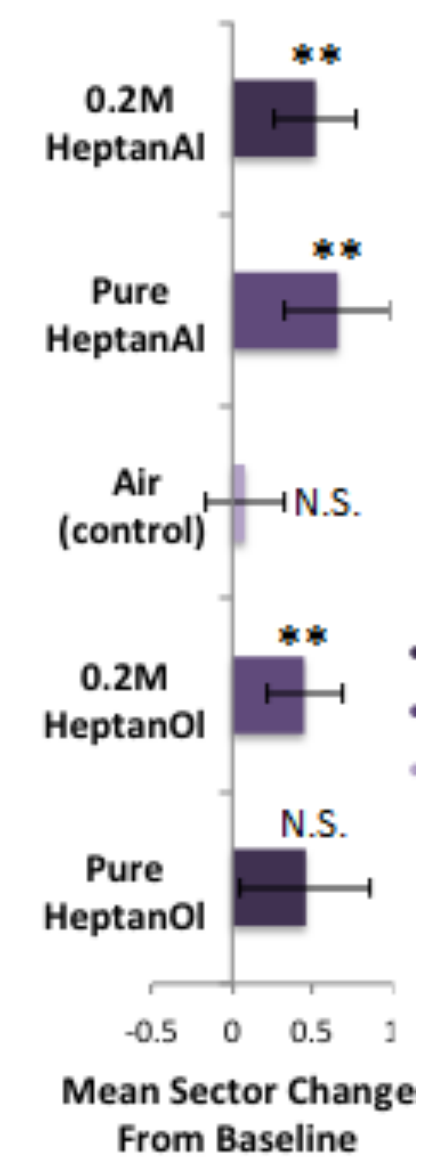
Super-Human Antenna Tracking Accuracy and Speed



- Two human raters were within 10.9 px of each other on average.
- Software was within 8.5 px of closest human.
- 5 px was approx. width of antenna

Software Detects Significant Changes in Antenna Movement in Response to Olfactory Stimulation





Experimental Protocol & Results

- 23 harnessed female honey-bees (*Apis mellifera).*
- Bees presented with 2 odors: heptanOl and heptanAl at pure and 35x diluted versions. Air was odor carrier medium and control.
- Antenna tip angles and dominant sectors detected with SwarmSight.
- Pre-odor-presentation means were compared to peak post-presentation means for each measure type and condition across all bees.
- Changes from baseline were significant (t-test $p < 0.01$, Shapiro test N.S.) for both measure types.
- Peak response ~1s after odor onset.
- The simpler dominant sector measure could be used instead of tip angle measure.

REFERENCES

[1] Cholé, Hanna, et al. Learn. Mem 22 (2015): 604-616.
[2] Shen, Minmin, et al. Journal of Neuroscience Methods 239 (2015): 194-205.
[3] Birgiolas, Justas, et al. Behavior Research Methods (2016): 1-12.

This work was funded in part by NIH R01MH1006674 to SMC.

Download Today:
GitHub.com/JustasB/SwarmSight