



# Automatic Analysis of Bees' Waggle Dance

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Visual observation and analysis of Vertebrate And Insect Behavior 2020

- Bees are modified wasps!
- All bees are descended from a wasp species that took to feeding on pollen instead of insect prey.
- Bees are found on every continent except for Antarctica, in every habitat on the planet that contains insectpollinated flowering plants.



- Honey bees and bumble bees are social insects, living in colonies.
- One female bee called the **queen**, specializes in egg laying and others in working, daughter workers.
- Workers gather pollen into the pollen baskets on their back legs and carry it back to the hive where it is used as food for the developing brood.



- Bees are the most important pollinating animals (above flies, wasps, beetles, butterflies, moths, bats, rodents, birds, mongooses ...)
- Some plants with flowers can selfpollinate, but most require pollen from another plant of the same species to set seed.





- Scholar shows more than **600,000** entries related to honey bees.
- More than **11,000** entries have been recorded on honey bees in 2020 alone.
- To put in perspective, there are around **100,000** on COVID 19 in 2020.

# Google Scholar honey bee Articles About 11,600 results (0.04 sec) Any time Since 2020 Viral impacts on honey bee populations: a review A Ullah, IT Gaiger, A Majoros, SA Dar, S Khan... - Saudi Journal of ..., 2020 - Elsevier

A Olian, IT Gajger, A Majoros, <u>SA Dar, S Knan...</u> - Saudi Journal of ..., 2020 - Elsevier **Honey bee** is vital for pollination and ecological services, boosting crops productivity in terms of quality and quantity, and production of colony products: wax, royal jelly, **bee** ve **honey**, pollen and propolis. **Honey** bees are most important plant pollinators and almost ☆ 99 Cited by 8 All 2 versions

#### Sort by relevance

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Y Ortiz-Alvarado, DR Clark, CJ Vega-Melendez... - Biology ..., 2020 - bio.biologists.org Recurrent **honeybee** losses make it critical to understand the impact of human interven such as antibiotic use in apiculture. Antibiotics are used to prevent or treat bacterial infections in colonies. However, little is known about their effects on **honeybee** develope ☆ 99 Cited by 1 All 5 versions

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honey bee apis mellifera	honey bee foraging
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honey bee pollination	honey bee pollen

[нтмL] Mitochondrial genomes illuminate the evolutionary history of t honey bee (Apis mellifera)

<u>E Tihelka, C Cai, D Pisani, PCJ Donoghue</u> - Scientific reports, 2020 - nature.com Western **honey** bees (Apis mellifera) are one of the most important pollinators of agricul crops and wild plants. Despite the growth in the availability of sequence data for **honey** bees, the phylogeny of the species remains a subject of controversy. Most notably, the

- The honeybee waggle dance is one of the most complex forms of communication in the animal kingdom.
- Upon finding a profitable food source, the bee returns to its hive and performs a waggle dance to convey its location to her hivemates.



- Finding waggle dances and measuring their characteristics is traditionally a manual process, very intensive and error-prone.
- This work describe a methodology for the automatic analysis of the waggle dance of honeybees.
- The methodology analyses a video of a beehive with 13,624 frames, acquired at 25 frames/second.













- Traditional image processing:
  - Conversion to grayscale,
  - Low pass filtering,
  - Frame to frame background subtraction,
  - Thresholding,
  - Detection of dances,
  - Tracking,
  - Clustering runs into complete waggle dances.



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Record **all disconnected contours** above a threshold (¼ the area of the bounding box) Contours in high density regions assigned to the same **cluster**. Contours in areas of sparse activity are regarded as **outliers**.

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False positive removal Data points are evaluated by their **Euclidean distance to the previous point** and removed if the distance is greater than the 90th percentile. The emphasis is on **removing false positives**, even **at the expense of true positives**, which can be regained in the tracking phase.

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A cluster is created through an **interpolation** to estimate the bee's position in unknown frames. The tracker is verified against the interpolation to prevent **drift**. If the tracker drifts, it is reinitialized using the **estimated coordinates**.

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Meaningful Waggle Detections and Cluster Centroids by DBSCAN



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# Results

- The algorithm detected **44,530 waggle events**, grouped into **511 run clusters**. These were concentrated in one section of the hive.
- Over 50 manually inspected ROIs, the stage was successful with **92.8% precision** and **77.2% recall**. This suggests very few false positives were being detected by the algorithm, but up to 22.8% of waggle runs were missed.
- Tracking accuracy was measured against an overlap coefficient. The accuracy of the tracking was 90%.
- Metrics of **intra-dance variation** in **angle** and **duration** were found to be consistent with literature.





## Conclusions

- The algorithm was successful in extracting metrics that are normally obtained manually. Its simplicity allows for easy adaption if necessary.
- Whilst this algorithm was tested on a single video, the ideas and steps, which are simple as compared with Machine and Deep Learning techniques, should be attractive for researchers in this field who are not specialists in more complex techniques.



#### Thank you for lizzzzzzztening

