Ant Tracking

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Introduction

Biologists are interested in studying the social network of ants. Manually watching many ants to learn how they interact is a time-consuming and monotonous task. Using computer vision to automatically track ants can provide a more efficient alternative method of tracking ants. This work provides a method for computing the acceptance ratio for positions of paint-marked ants, and presents a time-saving variation on tracking multiple targets with Markov Chain Monte Carlo using temporal difference to adjust the probability of a target being chosen.

This is the first of 1000 frames in the data set used in this research.

Background

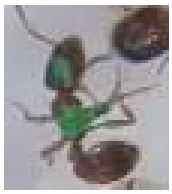
Markov Chain Monte Carlo is a common approach to multi-target tracking. The usual procedure is to select a target from a uniform distribution, propose a new state by perturbing only its location, and then accept based on an acceptance ratio, dependent on how well the state matches the expected observation. In ant tracking, previous researchers have found generic models for unmarked ants using machine learning. Interaction factors have also been used to penalize crossing tracks, but in the data used in this work, ants do cross each other on a regular basis.

Research

- Acceptance Ratio
  - Appearance Modeling
    - Pixel-by-pixel template comparisons of new positions to the original, user-specified appearance for each ant
    - Uses classification of pixels into paint colors, ant, and background
  - Foreground Maximization
    - Consider how many foreground pixels in the entire image are being tracked by the particle
- Target Distribution
  - Temporal Difference
    - Greater change between two frames at the previous position gives that ant a greater probability of being selected as the target for which a new state is proposed.

Impact

- Accuracy
  - Just using Appearance
    - 80% accuracy
    - Fails when ants curl, changing appearance, shown below




  - Just using foreground max
    - 90% accuracy
    - Fails when ants touch, cross each other, or classification is imperfect

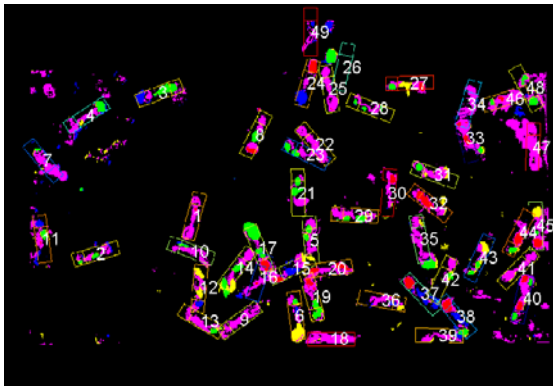
Ants crossing, causing the green ant to be occluded

  - Combination
    - 99% accuracy
    - Momentarily derails when ants occlude each other, but regains tracking

- Efficiency
  - Temporal Difference
    - 25% decrease in time

Conclusions

- Ants deform – through turning and rolling – so that just template matching is not enough
- Foreground maximization is a powerful tool for tracking the ants, but some concern must be placed on appearance.
- The amount of motion can be effectively estimated by temporal difference to predict how many particles an ant will need.
- Time saved by using fewer particles is far greater than the time needed to compute temporal difference once each frame.



This is a classified frame. This classification is used in all comparisons.

Future Work

- Integrate automated initialization
- Integrate updating appearance models
- Vary proposal distribution based on temporal difference
- Evaluate the algorithm on more video