A Vision-based System for the Tracking of Mobile Mini-robots

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Introduction
Description of Setup
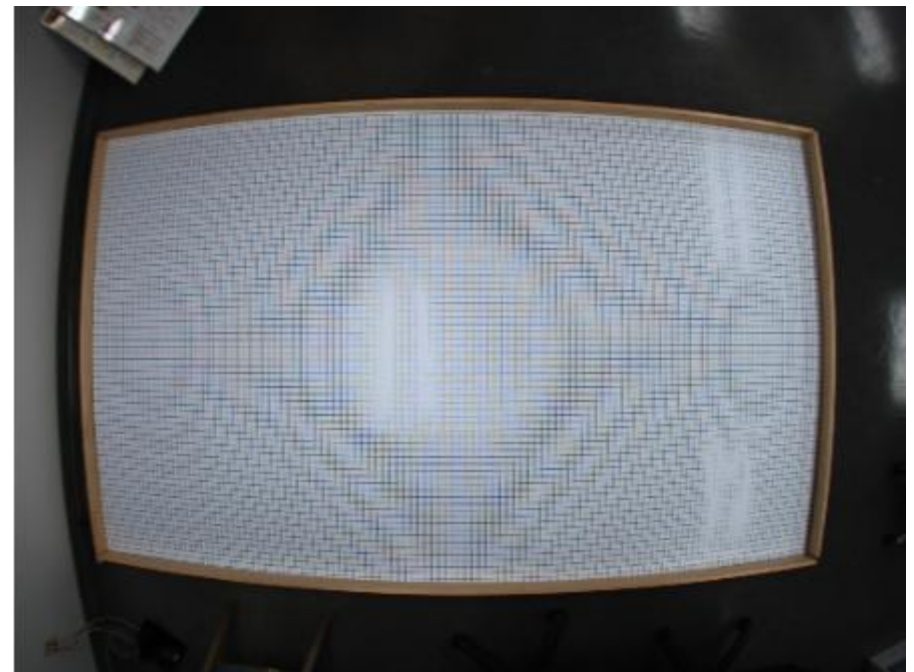Methodology
Areas for Future Work
Acknowledgements

Motivation

- Why an external vision-based tracking system?

  o Development of low-power and inexpensive robots
  o Equivalence to use of other sensing technology
  o Avoid error accumulation; fixed reference frame

Vision-based Control

- Use an overhead camera to observe movement of many small robots
- Track robots, building predictive motion model
- Direct robots using egocentric parameters
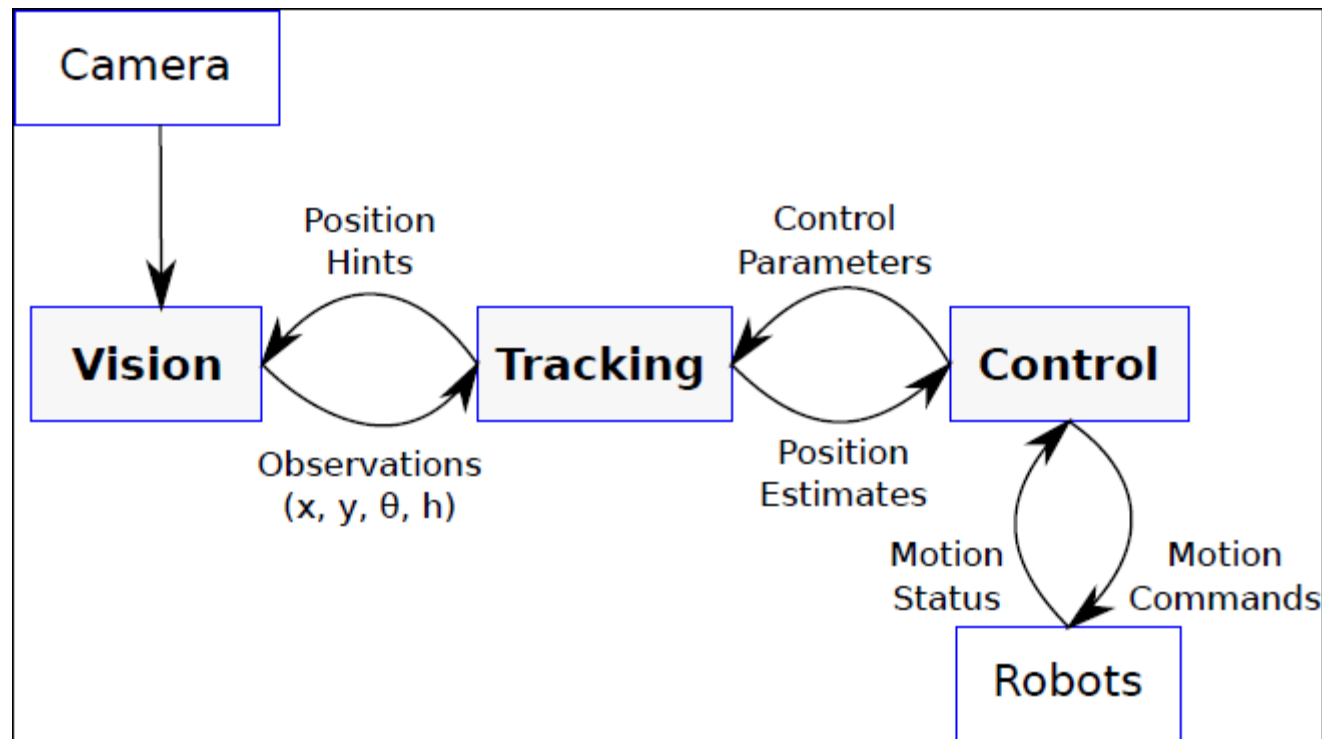
System Overview.

Search

Global Search

Find areas that could potentially contain a robot by using frame differencing and motion prediction

Local Search

Examine probable areas intricately and eliminate false positives for robots.

Areas with true robots are bounded by boxes, and the robot is bounded by the smallest rectangle

- Find regions of interest within 2MP image
  - Motion detection to find new robots
    - Run on low-resolution image to locate new robots
  - Look where we expect robots to be
    - Little change in position after 0.026 seconds

Search

- ## Identify robots within small area
  - ○ Need to find position and orientation
  - ○ Filter on darkness (< μ - 1.5σ intensity) or saturation (+)
  - ○ Construct bounding box, check dimensions
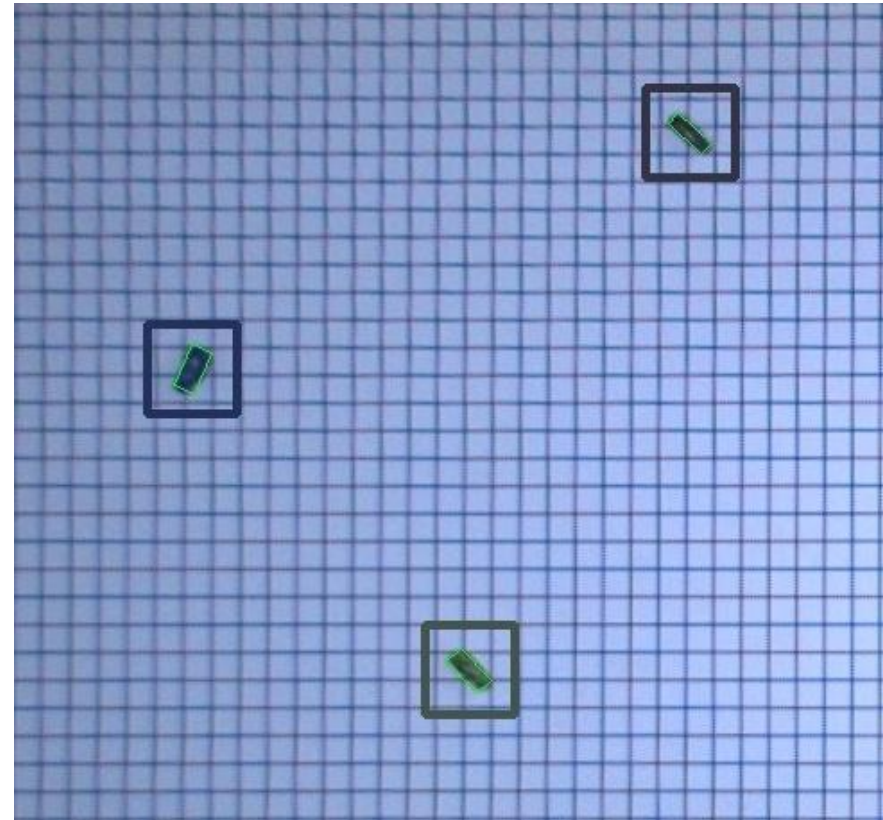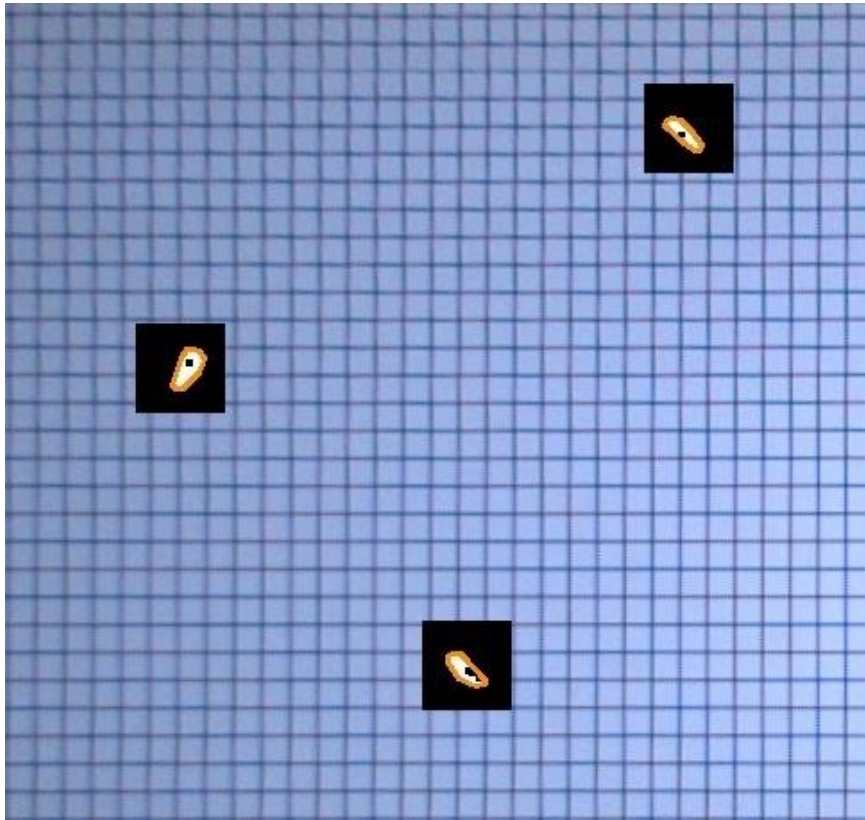
- # Need to tell robots apart
  - Distinct markings
    - Mean hue
  - Algorithmic approaches
    - One robot at a time vs. all unknown robots at once
- # Unusual motion model
  - Position **p** in {(x,y)}, global orientation **Θ**, motion angle **φ**, linear velocity **v**
  - Direction of motion varies separately from orientation
  - Tracking (x, y) using Kalman filter
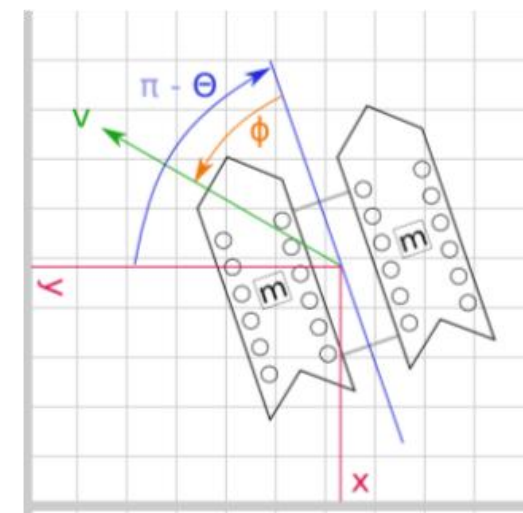
Future Work

- ## Vision
  - Feature-based detection and identification
- ## Identification and Tracking
  - Implementation of dynamic matching
  - Incorporate angles into tracking/matching
- ## Controls
  - Ongoing development of on-robot software for low-level motion control.
  - Development of swarm motion planning software using receding horizon control.

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