UNIVERSITY OF MARYLAND 1856

MERIT FAIR
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The Institute for Systems Research

NSF

Maryland Robotics Center

Vision-based Micro-robot Control

Ken Tossell, Andy Hammond
Eduardo Arvelo, Prof. Nuno Martins

Objectives

- Design vision software to locate robots in a video stream

- Determine each robot's unique identity using physical or behavioral observation

- Track individual robots' motion throughout a video stream, maintaining an accurate estimate of each robot's position and orientation

Detection

A first-level processor identifies regions of interest using motion detection and existing knowledge of robots.

Two-model foreground separation is based on a long-term background model and uses short-term frame differencing to exclude regions that have not produced any robots. Promising blobs will be examined in the next step.

This foreground bitmap will be separated into connected components, which will be sent along for further examination.
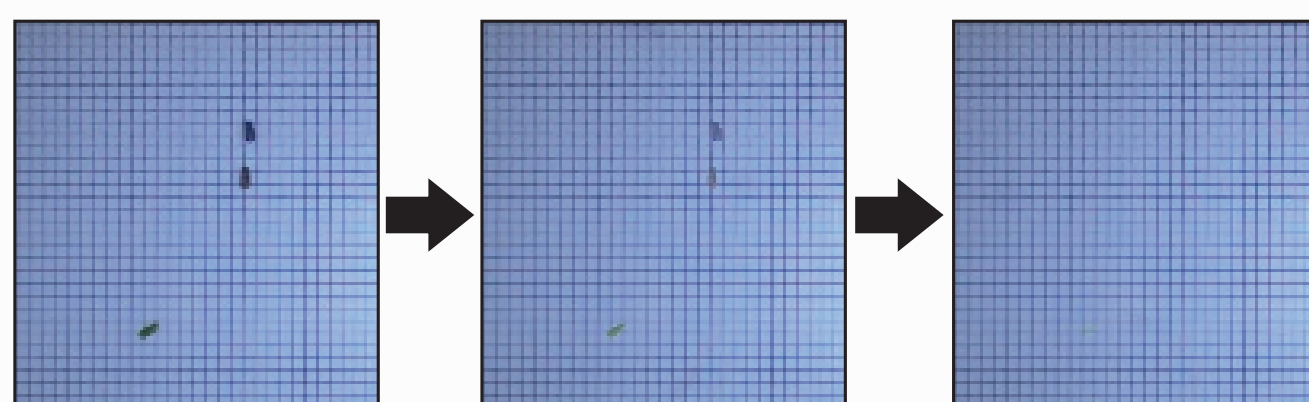

In two seconds, all moving robots have disappeared from the long-term background model.
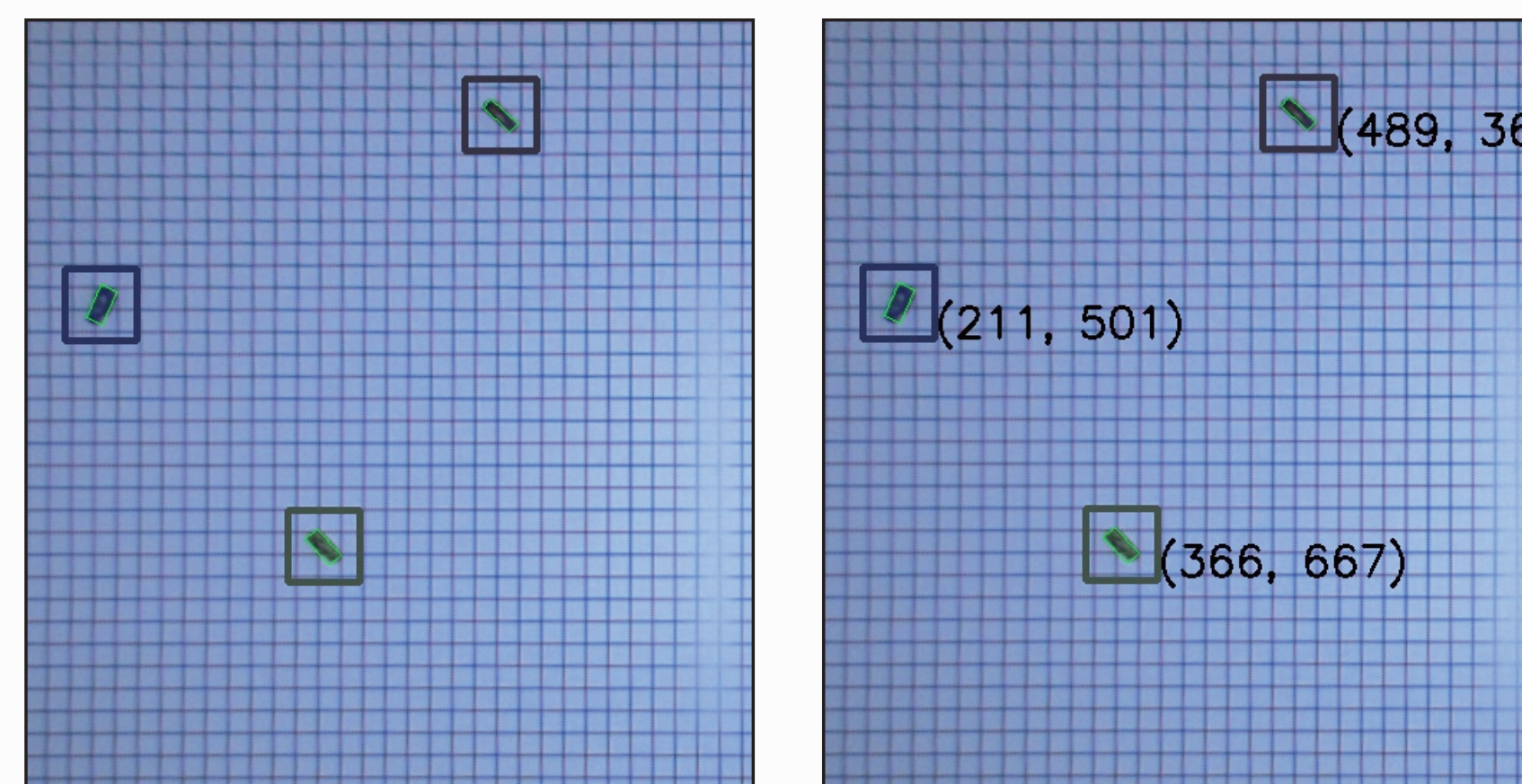
Identification

Static Identification: When robots have unique markings or colors, identity checking is enabled on each frame.

Dynamic Identification and Control*: Robots continually report the direction in which they're traveling (left or right), and the controller uses the process of elimination. **Or:** The controller specifies directions and observes robots for full-field identification in $\log_2(|\text{robots}|)$ steps.

 * Ongoing and future work
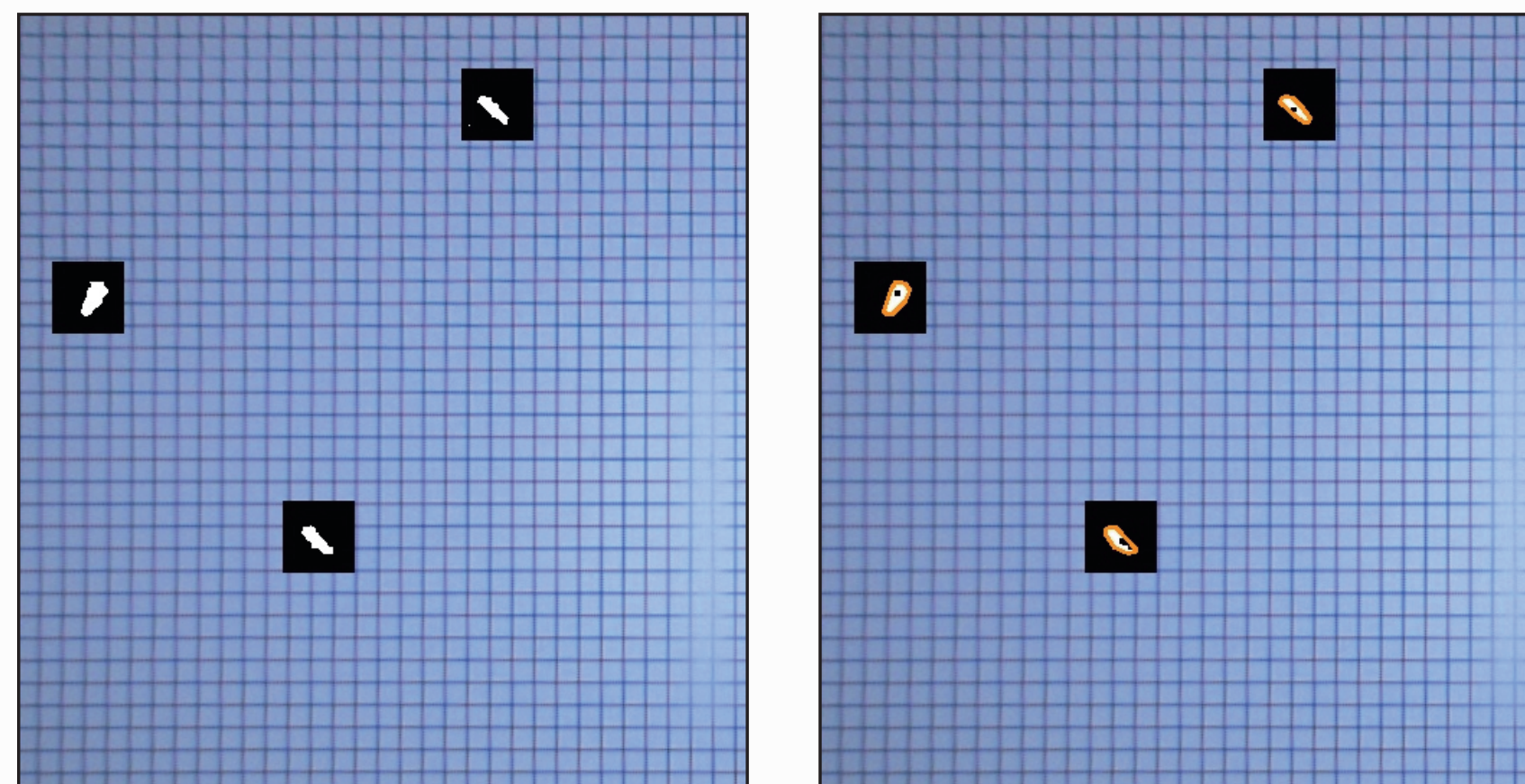
Local search: In this step, the software matches color and intensity, separates nearby robots and finds bounding rectangles.
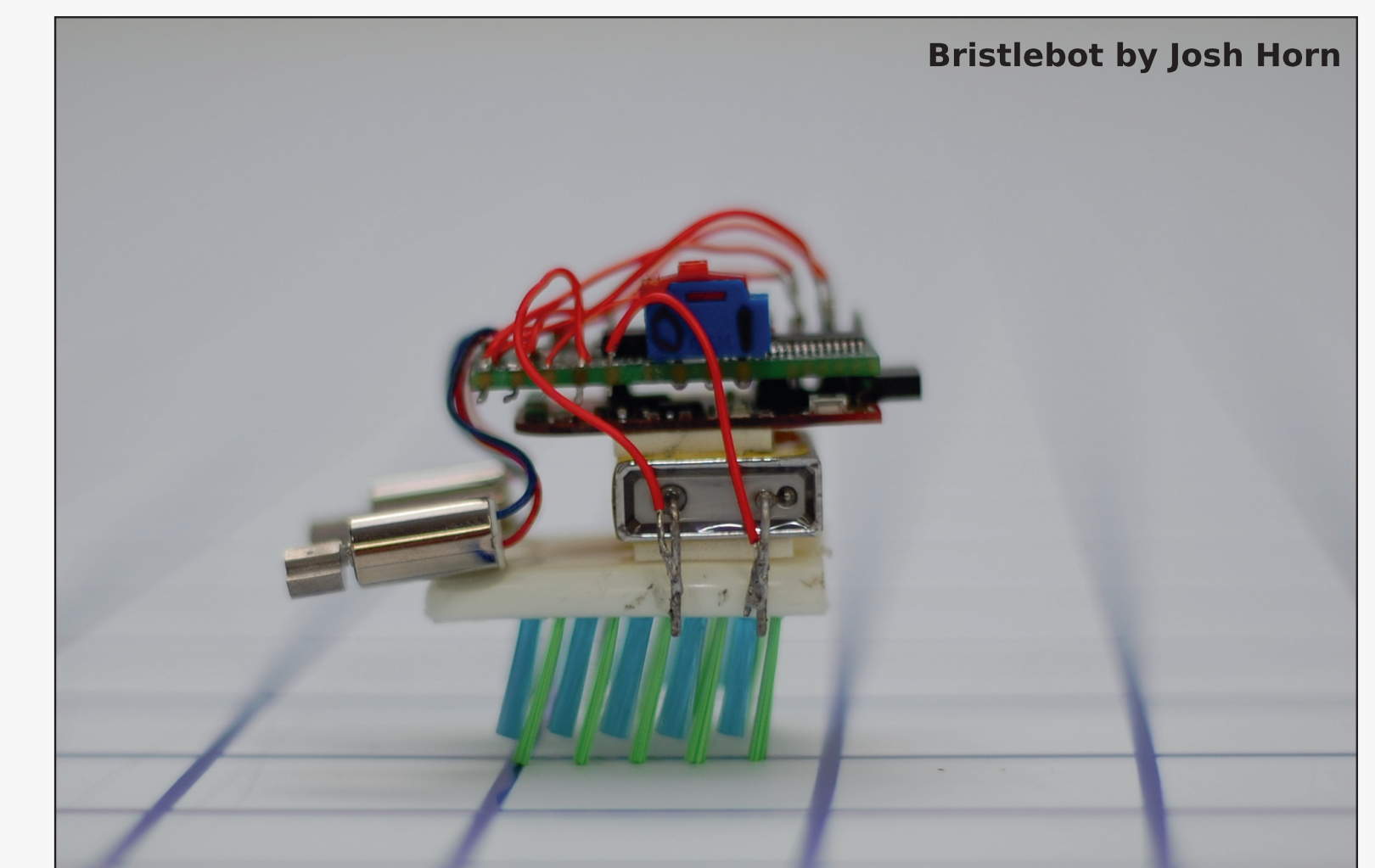

(489, 367)

(211, 501)

(366, 667)

The software checks box proportions and passes coordinates on to the identification and tracking subsystems.

Tracking

Motion Estimate: The tracking subsystem maintains Kalman-filter-based motion estimates, which it uses to match robots from frame to frame.

$\pi - \Theta$

v

ϕ

y

m

m

x
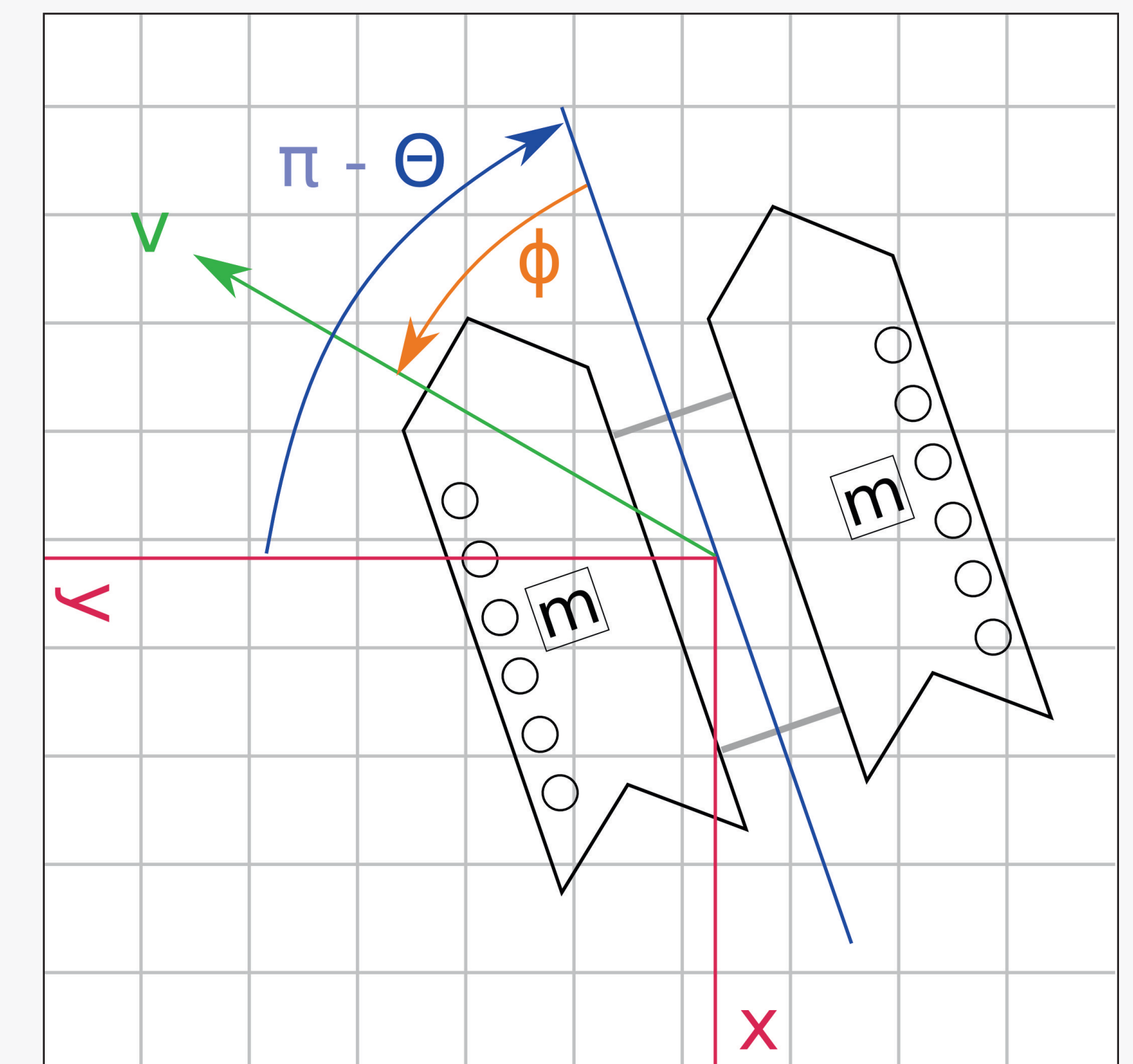
Possible bristlebot tracking parameters

Bristlebot by Josh Horn