Returning Home: Utilizing Computer Vision for Recharging Airboats

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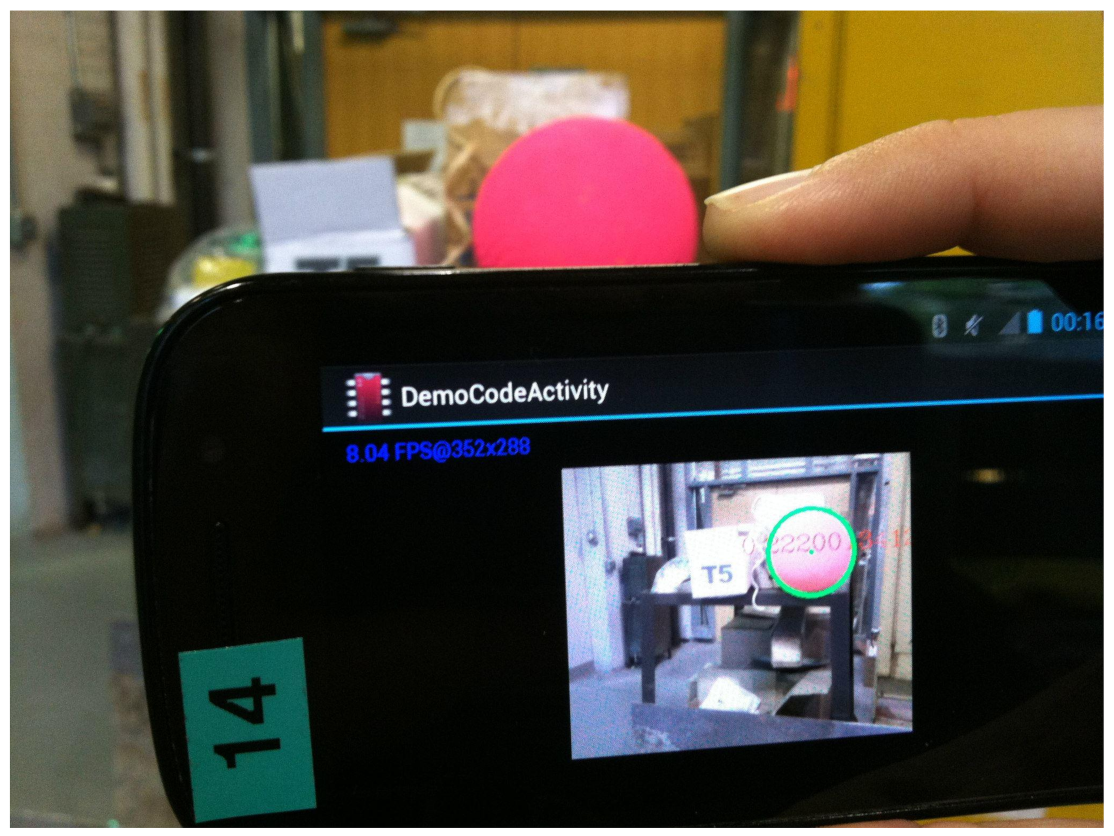
Problem

In order to obtain **long-term autonomy**, many issues and difficulties need to be solved first. A fundamental issue is recharging the airboats **without any human intervention** so that the airboats can **continuously monitor** an environment over long periods of time. To solve this we use on-aboard **computer vision** through an android phone to maneuver and drive the airboat into a recharge station.

Method

- Uses open source **OpenCv4Android** library
- **Android phone camera** for computer vision

Below is the basic algorithmic flow chart.



Preparing Image

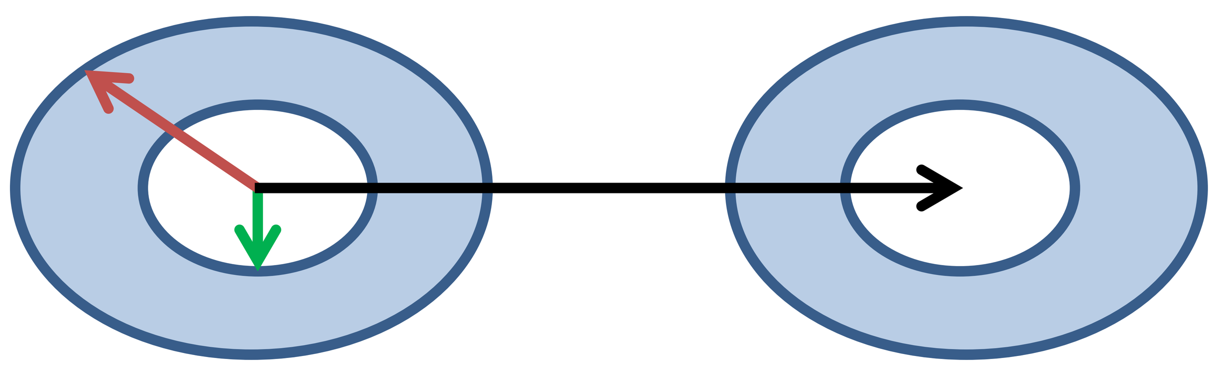
1. Threshold image for color of the balls
2. Gaussian blur the new image

Note: Lighting conditions may cause bleaching of color

Platypus Airboat

Hough Circles

- Parameters for function are set to find many circle, even **partial circles** (can find false ones)
- Three **dynamic parameters focus on circles**:
  - Minimum distance (**MinDist**)
  - Minimum radius (MinR)
  - Maximum radius (MaxR)

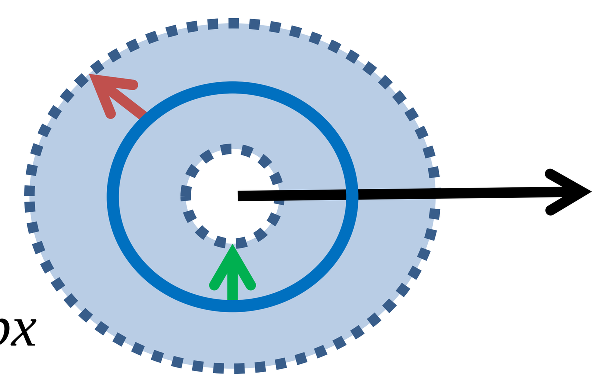


Set Parameters

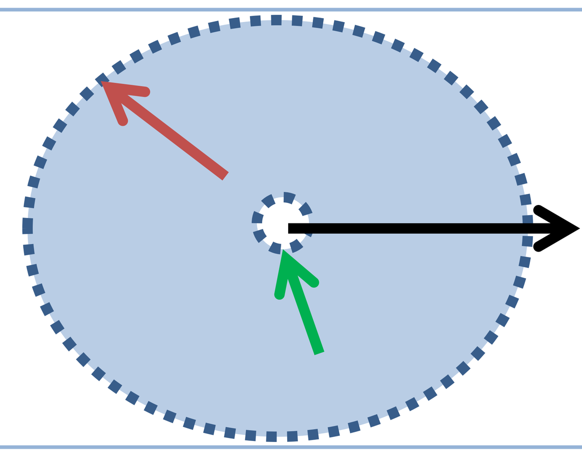
Default values: **MinDist** = 25, MinR = 5, MaxR = 80

BlueCircle is the average of both circles

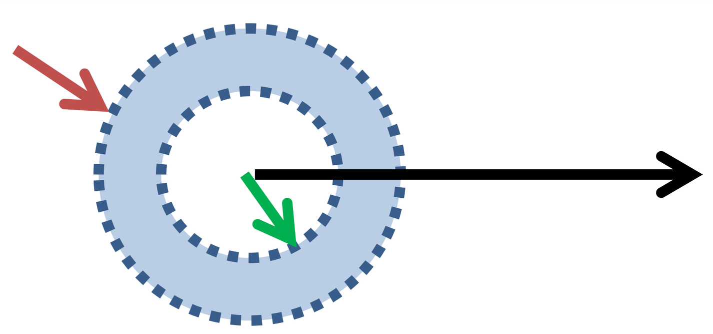
$$\begin{aligned} &If\,(circles = 2)\\ &MinR = (BlueCircle) - 10\,px\\ &MaxR = (BlueCircle) + 10\,px\\ &MinDist = (CircleDistance) - 10\,px \end{aligned}$$



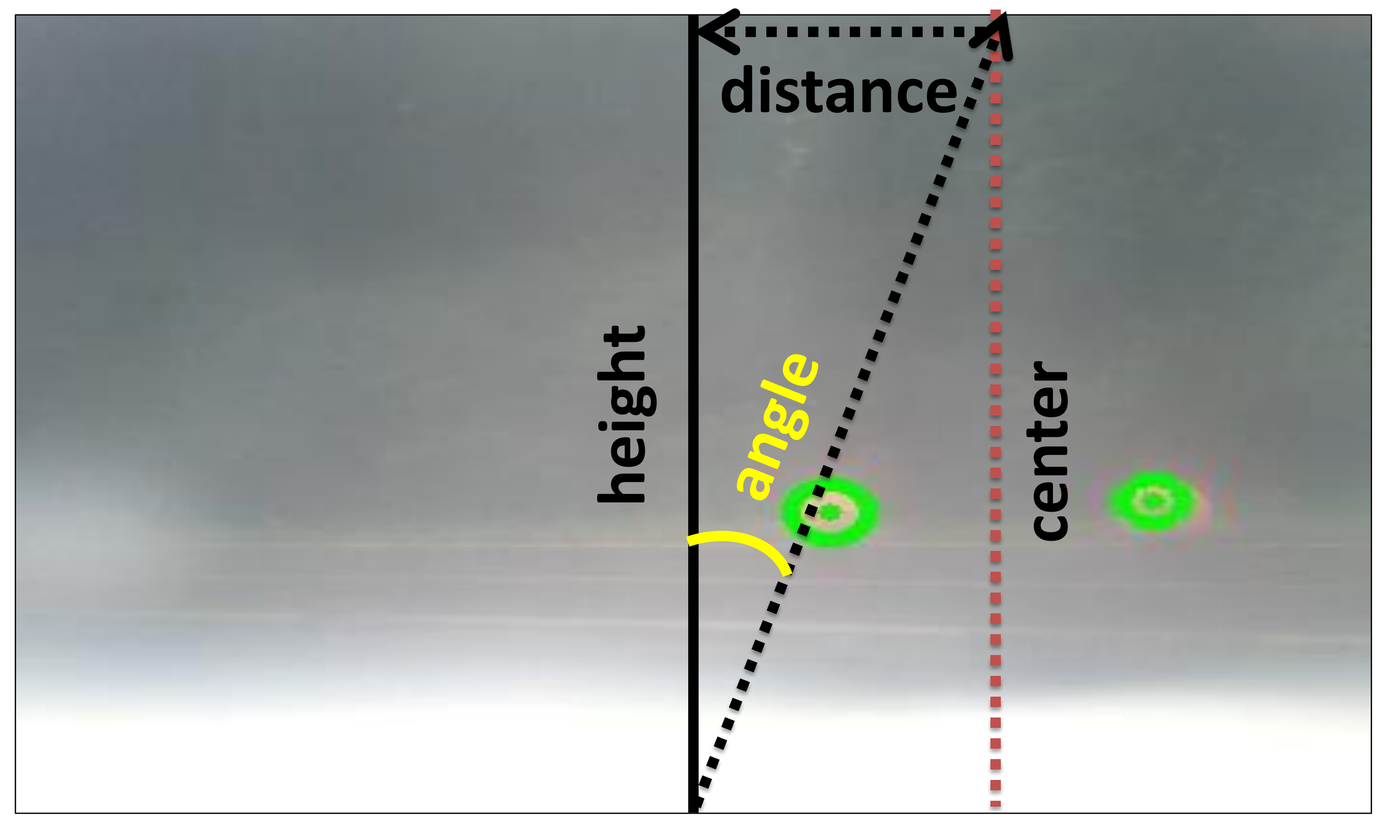
$$\begin{aligned} &ElseIf\,(circles < 2)\\ &MinR - 5\,px \geq 5\,px\\ &MaxR + 10\,px \leq 80\,px\\ &MinDist - 10\,px \geq 25\,px \end{aligned}$$



$$\begin{aligned} &ElseIf\,(circles > 2)\\ &MinR + 5\,px < MaxR\\ &MaxR - 10\,px > MinR\\ &MinDist + 10\,px < 100\,px \end{aligned}$$



Control Boat



$$angle = \arctan\left(\frac{distance}{height}\right)$$

$$angleChange = \frac{(angle - previousAngle)}{dt}$$

$$drz = \text{phone's gryo rotation rate of heading}$$

$$rudderAngle = angle * Kp + (angleChange - drz) * Kd$$

$$\text{sendBoatCommand}(ConstantTrust = 0.3, rudderAngle)$$

Preliminary Results

The recharge station is currently being designed and built. Therefore, experiments on driving the airboat into a station will be conducted in the near future. However, we have conducted many tests where the airboat needed to navigate in-between two balls. So far, the method has been successful in maneuvering the boat into the right position.

Discussion & Future work

Method works with:

- Fairly inexpensive camera
- Changing lighting conditions
- Poor image quality

Future work:

- Wrap with an intelligent controller
- Predict or estimate balls' positions
- Improve safety by calling home if continuous failure to access recharge station

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