Visual Navigation of Airboat to Recharge Station

Jimuyang Zhang  
Mentor: Paul Scerri

**INTRODUCTION**

Airboat is designed for small bodies of water. It helps monitor the water quality parameters such as dissolved oxygen and pH.

Airboat used to be guided by GPS. However, because of the inaccuracy of GPS, this method cannot satisfy the requirement that the boat need to reach a specific point accurately. For example, when the boat is out of charge, it needs to go back to the recharge station. In this case, the boat has to use other guidance method. Visual guidance is one of the most common methods.

A checkerboard is put on the recharge station as a marker to be recognized by camera. By analyzing the corners of checkerboard, the position relation between camera and marker can be acquired. In this way, camera help finish the guidance task even when GPS does not work.

**RESULT**

- The position information can be revealed in the screen in real time. However, since time is limited, the raspberry pi has not been connected to the main control E-board. The rest future work will be done in the following 2 months.

**Method**

- We use Raspberry Pi 3 Model B and Pi Camera to acquire all the image data and process the images with OpenCV.

- Get the intrinsic parameters of camera

- Fix the intrinsic parameter and acquire the extrinsic parameters like rotation matrices and translation vectors every 0.25 meters forward from 5 meters

- The distance between two projective points changes with the distance between camera and checkerboard

**Future Work**

- Connect the raspberry pi to the odroid and complete the PID control algorithm with the data from camera

- Test the program on the boat in real lake

- Use binocular vision to increase the accuracy

**Checkboard**

- Platypus Airboat

- Checkerboard

- Raspberry Pi 3

- Raspberry Pi Camera

**Rotation Matrices**

\[
\begin{bmatrix}
X' \\
Y' \\
Z'
\end{bmatrix} = 
\begin{bmatrix}
R & t
\end{bmatrix} 
\begin{bmatrix}
X \\
Y \\
Z
\end{bmatrix}
\]

**Translation Vectors**

\[
\begin{bmatrix}
x \\
y \\
z
\end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} + \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}
\]

**The Relation Between image and camera coordination**

\[
X = f_x x' + c_x \\
y = f_y y' + c_y \\
u = x/z \\
v = y/z
\]

**The Relation Between BC and Real distance**

\[
y = 82.968x - 1.041
\]

**Testing in Real Lake**

- Binocular Camera Module

- Binocular Vision