An On-Line Closed-Loop Behavioral Control System Setup for Fish Experiments

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Introduction

- Our project focuses on the design and implementation of data collection system for behavioral control experiments with zebrafish.
- The experimental setup helps us to observe the stimulation of visual behavior of the fish while we are controlling the water flow direction.
- We have observed the fish's response via video processing techniques.

Application Areas

- This project is one of the first sample of its similar in the world. There are some similar ones, but the design is original and unique. This project can be used in laboratories where the fish experiments are done.
- The flow direction control with Arduino UNO and BLDC motor can also be applied for different water flow project in dam or rivers.
- Animal tracking with DeepLabCut can also be applied deep learning experiments and autonomous or unmanned systems such as unmanned vehicles.

Specifications and Design Requirements

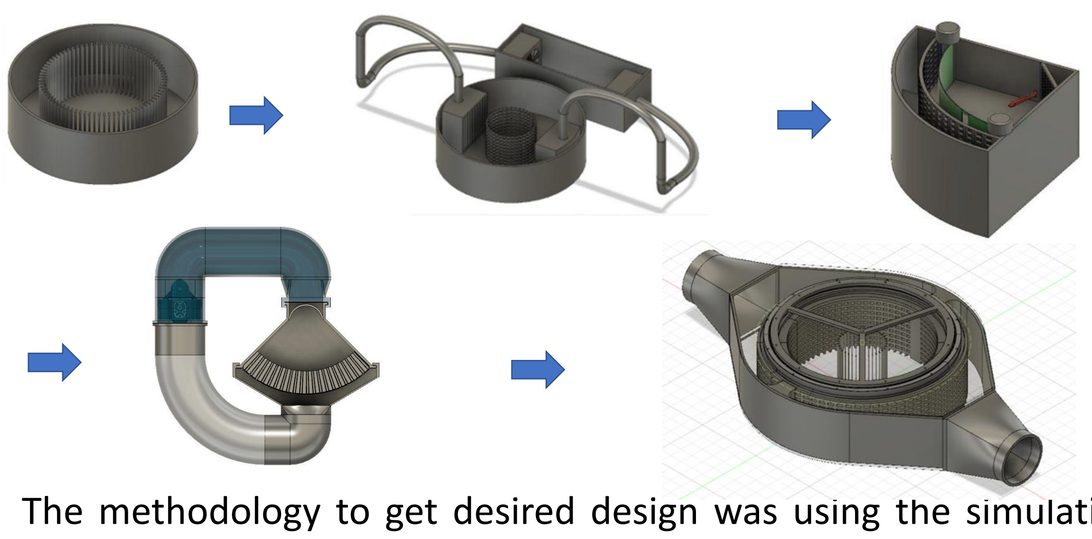
Design Requirements:

- Laminar Water flow in the PVC pipes by T200 thruster,
- Keeping the zebrafish in the center of the system.
- Having a rectangular gap to control to allow the desired flow direction.

Figure: Design requirements and expectation

Solution Methodology

- Mechanical Solution: Most critical part of the system is designing the proper mechanical solution. The difficulties are preventing the turbulences and undesired water flows.



- The methodology to get desired design was using the simulation program Autodesk cfd. We could predict the contingence of the turbulences.
- Electronic and Software Solutions: Arduino UNO was sufficient to control our brushless DC motor(Pololu motor with encoder and 19:1 reducer) with its driver. That was the aim to use that electrnics part is controlling the water flow direction combining this with mechanical solution.

Motor Driver:
- Subscribes the position information.
- Controlling the motor.

BLDC Motor:
- Changing the water flow direction.

Arduino UNO:
- Microcontroller that we used to control the BLDC motor to change water flow direction.

Aquarium System:
- Homogeneus water flow for each direction to observe fish's behavior clearly.

Figure: An overall description of the project components.

Results and Discussion

- The BLDC motor worked properly with sufficient torque to change the direction of the flow.
- The circular net helped us to keep the fish in the center of the fish.
- Arduino programmed well to work the driver without any issue.
- With the mobile phone camera, we obtained desired visuals to track the animal clearly.
- At the end with the help of the DeepLabCut we could get the tracking properly.
- For the near future experiments, our setup can be basically used and can be improved as well. Because the tracking results are satisfied as you see in the figure below. The zebrafish reacted to water flow accordingly.

Figure: Arrow shows the water flow direction

- As a conclusion this project made us to improve our system engineer skills, we designed all the mechanical and electronics part ourselves.

References

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