ZEBRAFISH LARVAE LOCOMOTOR ACTIVITY DETECTION USING CONVOLUTIONAL NEURAL NETWORK (CNN)

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Abstract

Monitoring and understanding fish behavior is crucial to achieve precision in practices. The assessment of fish behavior has always been difficult due to the difference between aquaculture and experimental conditions and much sampling time taken. New technologies have been explored for this reason to get better fish behavior observation. However, most of it are high costing but still have limitations in monitoring the fish behavior. According to the studies, the changes in fish behavior may reflect to the changes of water quality. So, fish behavior can be a great indicator of water quality in aquaculture field. These reactions are also very important in behavioral neuroscience, which study on the physiological, genetic, and developmental mechanisms of behavior in humans and other animals. The zebrafish larvae are used as a model organism to examine the effects of neurotoxin to human behavior. To overcome the limitations, this works aims to develop an algorithm to elucidate the zebrafish larvae locomotor activity using Convolutional Neural Network (CNN). The model used for this project is ssd_mobilenet_v2 fpnlite and the result proved that it could detect the activity of zebrafish larvae with 99.05% of accuracy percentage.

1 Introduction

Previously, fish behavioral assessment is done manually by human vision. The manual scoring commonly used in small laboratory works, since it does not involve the use of advance instruments for the assessment purpose. Through this method, the changes of all parameters are manually ranked based on a set of severity scale [1]. However, since the process is known to be quite laborious, and the interpretation of observed parameters may vary between observers. This will lead to misclassification error for observer during assessment stage. In addition to that, manual monitoring and observing of zebrafish behavior by human vision is a tedious work if the observers need to monitor and classify hundreds to thousands of zebrafish larvae behavior. Hence, the automated quantification seems to be a much preferable analysis tool and several technologies have been developed recently to study the fish behavior. The developed applications are available from high cost to open source, which is free to use. The open-source software usually available to be used in limited time and functionality, for example ImageJ software. It is a free and an open-source software developed by National Institutes of Health (https://imagej.nih.gov/ij/), which provides extensive plugin and widely used in laboratories [2][3].

The commercial applications available in market are EthoVision (Noldus, Inc., Leesburg, VA) and Zebralab (ViewPoint Life Sciences, Lyon, France). This software require user to adjust parameters from the recording video and let the user to select the region of interest (ROI), which took longer processing time. Common problem faced when using the available applications is the occlusion matter. It can only track and observe the fish behavior for only a zebrafish or zebrafish larvae in a time. Usually, the applications in the market with significant functionalities, however, are high costing. Instead of using high-cost application, this work focusses to develop an algorithm to elucidate the zebrafish larvae locomotor activity using Convolutional Neural Network (CNN) deep learning-based method. The proposed algorithm is expected to encounter the occlusion problem and the longer processing time taken.

There are a few researchers explored and proposed their method based on deep learning approach. Most of them focus on fish detection to observe the fish population [4][5]. There is research using deep learning approach [6], but it is a trajectory-based behavior. Difference from this work, this study proposed a better method for behavioral analysis on zebrafish larvae, which will use locomotor activities of zebrafish larvae as the features to the developed algorithm. According to Moser [13], the behavior assessment can be