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Incorporating Intelligence in Fish Feeding System for Dispensing Feed Based on Fish Feeding Intensity

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ABSTRACT The amount of feed dispense to match fish appetite plays a significant role in increasing fish cultivation. However, measuring the quantity of fish feed intake remains a critical challenge. To addressed this problem, this paper proposed an intelligent fish feeding regime system using fish behavioral vibration analysis and artificial neural networks. The model was developed using acceleration and angular velocity data obtained through a data logger that incorporated a triaxial accelerometer, magnetometer, and gyroscope for predicting fish behavioral activities. To improve the system accuracy, we developed a novel 8-directional Chain Code generator algorithm that extracts the vectors representing escape, swimming, and feeding activities. The set of sequence vectors extracted was further processed using Discrete Fourier Transform, and then the Fourier Descriptors of the individual activity representations were computed. These Fourier Descriptors are fed into an artificial neural network, the results of which are evaluated and compared with the Fourier Descriptors obtained directly from the acceleration and angular velocity data. The results show that the developed model using Fourier Descriptors obtained from Chain Code has an accuracy of 100%. In comparison, the developed classifier using Fourier Descriptors obtained directly from the fish movements acceleration, and angular velocity has an accuracy of 35.60%. These results showed that the proposed system could be used in dispensing feeds successfully without human intervention based on the fish requirements.

INDEX TERMS Accelerometer, artificial neural network, aquaculture, chain code, fish, fish activities, fish feeding system, Fourier descriptor, IoT devices.

I. INTRODUCTION

Aquaculture is an important food production sector with high-quality protein for human consumption. The contributions of aquaculture to the world's total fish production is indispensable. Nowadays, the demand for aquaculture products increases worldwide [1], [2]. Despite the continuous increase in demand for fish consumption, the rate of fish supply to meet the needs remains a severe challenge [3]. Sizeable fish cultivation that can meet the requirements is expected through the vertical and horizontal extension of the aquaculture system. This would largely depend on efficient fish farming practices and widespread aquaculture expansion [4].

The problem of overfeeding has become predominant in aquaculture. One of the causes of this problem is attributed to the inefficiency in the handling of the feeding process [5]. Fish feeding practice that can promote production effectiveness and reducing unnecessary feeding is essential for abundant income intensification [6]. The cost of feeding fish amounts to 40-50% of the total aquaculture operational cost [7], whereas about 60% of the feed dispense into aquarium ends up as particulates [8]. These accumulated particulates result in water pollution, which further used oxygen to

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