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# The Identification of Hunger Behaviour of *Lates Calcarifer* through the Integration of Image Processing Technique and Support Vector Machine

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# The Identification of Hunger Behaviour of *Lates Calcarifer* through the Integration of Image Processing Technique and Support Vector Machine

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**Abstract.** Fish Hunger behaviour is one of the important element in determining the fish feeding routine, especially for farmed fishes. Inaccurate feeding routines (under-feeding or over-feeding) lead the fishes to die and thus, reduces the total production of fishes. The excessive food which is not eaten by fish will be dissolved in the water and thus, reduce the water quality (oxygen quantity in the water will be reduced). The reduction of oxygen (water quality) leads the fish to die and in some cases, may lead to fish diseases. This study correlates Barramundi fish-school behaviour with hunger condition through the hybrid data integration of image processing technique. The behaviour is clustered with respect to the position of the centre of gravity of the school of fish prior feeding, during feeding and after feeding. The clustered fish behaviour is then classified by means of a machine learning technique namely Support vector machine (SVM). It has been shown from the study that the Fine Gaussian variation of SVM is able to provide a reasonably accurate classification of fish feeding behaviour with a classification accuracy of 79.7%. The proposed integration technique may increase the usefulness of the captured data and thus better differentiates the various behaviour of farmed fishes.

**Keywords**: Fish Feeding Behaviour; Support Vector Machine; *Lates Clacarifer*

## 1. Introduction

There are several factors that one must consider when studying characteristics of a fish, for instance, the behaviour, locomotor activity and sensory cues. Feeding anticipation has been known to increase the locomotor activity either for individual or in a group of fish [1]. The movement and marginalise between the fishes and their ecology will affect the hunger demand as this issues still in an exploring phase amongst the researchers. A study was done to investigate the behaviour between less fed and satiated individuals to measure the cover area scavenging actions within a confined space and demonstrated that individuals in a hungry state display larger coverage area but secluded apart from the confinement walls [2]. Circadian rhythm which is naturally imparted biologically is generally categorised under endogenous rhythms in fishes. It portrays a similar pattern with other mammals sleeping anatomy which may relate to feeding rhythms [3]. The rhythms routinely persist around 24 hours period as some researchers called the free running. With a mannerly scheduled feeding time, hunger behaviour can be modelled accordingly based on the measurements that are required for example the amount needed, capacity that it can withstand and intervals between each feeding time. In this case, to monitor a fish hunger rate, these parameters can be adjusted into manipulating the fish appetite either in famish or satiated state. In most cases, the searching endeavour reduces once the fish is satiated, in turn suggest the lower movement of the fish [4]. In addition, the circadian cycle may fluctuate given that the fish swim as a whole. Another study has implied that the fishes tend to be more adventurous and lurk the area more when they are hungry and consequently alter the fish movement either as individuals or group [5]. A different study has demonstrated that hunger could be influenced through exposing the fish under ultradian rhythm of light and dark environment that replicates day and night moment pulses [6]. They used the self-demand feeder for the fishes to get their food whenever they require it. The present study applies the similar concept that will be further elaborated in the subsequent section.

Self-demand feeder mainly used to ensure the feeding does not exceed the required amount and the time taken for each meal can be measured accurately during the experiment. This echoes the findings of an earlier study where the frequency of growth can be evaluated by an optimal value of feeding for Asian sea bass or *Lates Calcarifer* in net cages [7]. There has been a debate on how the circadian rhythms results were obtained and the reliability of analysis that was acquired since the need of standard of experiment setup is necessary. Vast numbers of variables must be considered such as environmental, social interactions, phenotypic, species amongst others. To date, different type of fish species has been used for such experimentation. Barramundi which is often referred to as the Asian sea bass has shown as a practical specimen for collecting data, where a study conducted has evaluated the growth rate of the fish where the day and night moment are manipulated [8]. Other common species that have been examined are the zebrafish or *Danio rerio* and razor fish or *Xyrithchys novacula* in which the boldness between genders during hunger and circadian rhythms for resting time and active state, respectively are examined [9-10]. The latter study also demonstrates the implementation of using acoustic tracker to evaluate the motion of the fishes by means of hidden Markov models. The concept of presenting valid hunger behaviour representation is adopted into this current study by using image processing for tracking the behaviour and subsequently applying a machine learning technique namely Support Vector Machine (SVM) that will be discussed in the ensuing sections.

Various studies have applied SVM or other classification methods as an analytical tool to support their hypothesis, and it is deemed to be reliable [11-12]. A classification of fish hunger behaviour was done for rainbow trout or *Oncorhynchus mykiss* by evaluating the muscle activity to determine whether the fish are hungry or fed [13]. The present study will evaluate the efficacy of a variation of SVM to classify the state of hunger of *Lates Clacarifer* based on relevant identified paramaters namely center of gravity as well as school density. The structure of the paper is as follows: Section 2 describes the experimental setup employed for the present study as well as the classification method used, the results obtained from the study is presented and discussed in Section 3 and lastly Section 4 draws the conclusion of the study as well as provide some recommendation for future research.

## 2. Materials and Methods

To incriminate an appropriate behaviour of fishes in group, laboratory conditions must meet several requirements to ensure the results acquired is sufficient and reliable. This section will elaborate on the specimen used, self-demand feeder functions, image recording process and classification method proposed for the study.

### *2.1 Fish*

The fish that was selected for this experiment is the Asia sea bass, as it demands food in a full day cycle regardless either in light or dark environment. The fish are taken from a Fisheries Research Institute, Gelang Patah Johor, Malaysia, and was transported to a laboratory at the International Islamic University Malaysia for safe keeping and experimental setup. A total number of 20 juveniles Asian seabass were taken to form a sizeable school for the purpose of capturing image and to analyse the group size motion.

*2.2 Experiment Setup*
The experiment tank area is (92cm x 46cm x 46cm) and filled with 130L of water in which the fishes will be lace in the confined tank. The self-demand feeder were installed above the tank with the infrared sensor suspended from the feeder, and the sensor slightly submerged below the water surface to allow the fish to trigger the sensor. For each time the sensor was triggered, roughly 0.5g of pellets in voume with the diameter of 3mm for each pellet will be dropped. The cycle continues until none of the fish triggers the sensor again. The time taken for the feeder to drop the pellet will be recorded from a microcontroller and sent to the computer. This will determine the time taken for the parameters used for the classification method i.e. Before Feeding (BF), During Feeding (DF) and After feeding (AF). A webcam modeled Logitech, C270h was installed from the front view to record the fish behaviour for a certain period of time. The video was converted into .avi file and was transferred to Roborealm software for evaluation. This program tracks the Centre of Gravity (CoG) of the school fish and the box size. Therefore each parameter had (x, y) coordinates (in pixels). Hence, the position of the school size as well as the school density is determined as the indicator for the fish feeding behaviour. The data obtained that has been clustered with respect to BF, DF and AF is further evaluated for the classification efficacy of SVM.

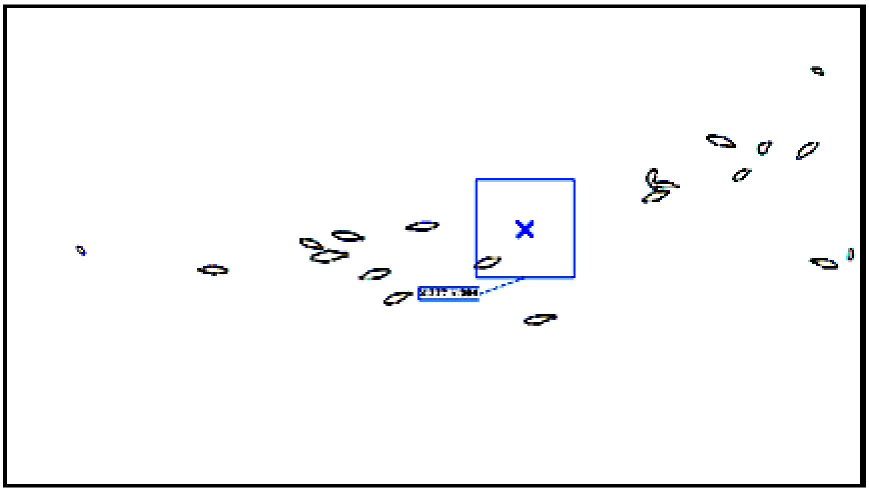

**Figure 1.** Screenshot from Roborealm for CoG of the box which gives *x* and *y* coordinates for the school.

*2.3 Classification method*
In this study, six different kernel functions are investigated linear, quadratic, cubic, fine RBF, medium RBF, and Coarse RBF. fine, medium and coarse RBF is defined by $\frac{\sqrt{P}}{4}$, $\sqrt{P}$, and $4\sqrt{P}$, respectively where P is the number of predictors i.e. two. The solver used for the training is the sequential minimal optimisation algorithm. A fivefold cross-validation method was utilised in this study owing to its desirable traits of mitigating the issue of overfitting. The performance of the SVM models were assessed and evaluated via MATLAB 2016a (Mathworks Inc., Natick, USA). The variations of the SVM employed in this study are evaluated by means of classification accuracy (ACC), sensitivity or recall (REC), and precision (PREC).

## 3. Results and Discussion
It is apparent from the SVM classification results tabulated in Table 1 that the Fine Gaussian kernel was able to provide reasonably accurate classification with a classification accuracy of 79.7 %. Figure 2 depicts the confusion matrix obtained for the Fine Gaussian SVM. Furthermore, it could also be seen that the cubic variation performs the worst amongst all SVM methods. However, it is worth to note that

the ability of the Fine Gaussian SVM is dependent of the parameters selected namely the centre of gravity as well as the school density, suggesting that the selected parameters are nontrivial or vital in describing the feeding behaviour of *Lates Calcarifer*. The importance of the aforementioned parameters i.e. COG and box size density has been reported in a previous study for understanding fish feeding behaviour [10].

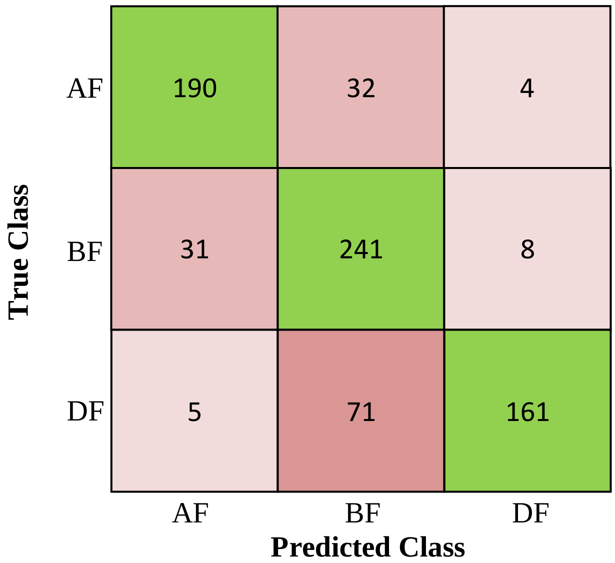


**Figure 2.** Confusion matrix for Fine Gaussian SVM

**Table 1.** SVM classification results

| SVM Variation | ACC (%) | RECALL (%) | | | PRECISION (%) | | |
|---|---|---|---|---|---|---|---|
| | | BF | DF | AF | BF | DF | AF |
| Linear | 67.0 | 56.4 | 77.8 | 74.1 | 67.9 | 63.7 | 69.5 |
| Quadratic | 69.2 | 57.0 | 89.3 | 77.2 | 80.4 | 63.3 | 61.5 |
| Cubic | 56.4 | 49.5 | 64.1 | 54.6 | 38.6 | 69.2 | 65.0 |
| Fine Gaussian | 79.7 | 70.1 | 93.1 | 84.1 | 86.1 | 67.9 | 88.0 |
| Medium Gaussian | 71.9 | 58.7 | 90.2 | 88.0 | 88.2 | 62.4 | 61.5 |
| Coarse Gaussian | 69.0 | 56.6 | 89.2 | 81.7 | 85.4 | 59.1 | 59.3 |

## 4. Conclusion

It could be concluded from the present investigation that the Fine Gaussian variation of SVM is able to provide a reasonably accurate classification of fish feeding behaviour with regards to the abovementioned parameters examined viz. centre of gravity and school fish density. Further study could be carried out by considering other relevant parameters that may explain the hunger behaviour of *Lates Calcarifer* as well as the effectiveness of other forms of classification techniques.

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