PRELIMINARY STUDY ON REAL-TIME FISH CLASSIFICATION

Yeffry Handoko[1*], Yul.Y. Nazaruddin[1], Edi Leksono[1], Bambang Riyanto[2]

[1] Department of Engineering Physics, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung, Indonesia
[3] School of Electrical Engineering and Informatics, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung, Indonesia

yeffry@unikom.ac.id, yul@tf.itb.ac.id, edi@tf.itb.ac.id, briyanto@lskk.ee.itb.ac.id

Abstract- There was a lot of researches about classifying some pattern of living objects. Researcher tried to get some special patterns which appear in natural life, such as sound, marks, color, shape. etc. In this research, the fish-classification tool is investigated by using pattern recognition algorithm. Fish type is classified from its agility and swimming direction which measured indirectly from its ultrasonic reflectance pattern. Ultrasonic reflectance produced by schooling fish is extracted to some features and subsequently those features will be used to classify and determine the type of a fish

Keywords- Fish classification , ultrasonic, pattern, behavior

I. INTRODUCTION

In the last few years, many researches dealing with animal behavior study have been conducted. Some behaviors are unique and perform similar pattern for same type of animal. Quite often, classification of animal was obtained based-on their behaviors. On the other side, the behavior of some animals is derived and generalized based-on that pattern which is referred to a science called ethology. In ethology, common and specific behavior of animal is represented as ethogram.

Simple fish ethogram explains common behavior of fish such as locomotion, feeding, and social behavior [10]. From its locomotion behavior, some unique patterns can be derived such as swimming mechanism, swimming gait and agility.

Swimming mechanism of fish is based-on its body and fin. Fish which swims with its body and tail as propulsion mechanism is called Body and Caudal Fin (BCF), i.e. like tuna and banded fish. Fish with BCF type is a type of fish with high agility. This agility is extremely shown when the fish swims forward or turning. Stimulation agent of the agility can be an intention to escape or finding food or just playing around when they meet their mate.

In schooling fish, the agility becomes the most important phenomenon. Timing of changing direction in group swimming is an amazing phenomenon. Diponegoro [1] has made fish classification based on their agility in group swimming. Ultrasonic transmitter is transmitted to schooling fish and subsequently, its reflectance wave is recorded to be analyzed later as classification input. He applies Hidden Markov Model as classification tool which is suitable to interface with a personal computer. However, this technique might be not suitable to be applied in a microcontroller. Compact, smart and small algorithm must be found and adequate enough to be downloaded into a microprocessor.

* On leave from Universitas Komputer Indonesia, Jl. Dipatiukur 112 Bandung, Indonesia for doctorate study at Institut Teknologi Bandung

II. DESIGN

A. Sensory system

Ultrasonic sensor is mounted onto a water proof pipe. The pipe consists of a microcontroller and other electronic components. Ultrasonic range of this sensor is 50 cm in frontal direction. This range is suitable according to the size of aquarium. Microcontroller will send a clock signal to RX channel of the sensor and get serial data from its TX channel as described in Fig. 1.

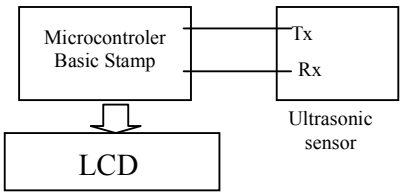

Fig. 1. Sensory System

Ultrasonic reflectance is represented as serial signal as an output from the ultrasonic sensor. This serial signal represents also the fish agility because the ultrasonic reflectance depends on the direction change of the fish. Then the serial data is sent to a microcontroller to have subsequently procedures. The LCD will show the result of classification.

B. Feature extraction

Data reflectance signal should be passed to some signal conditioning procedures. The procedures are some preparation procedures to gain meaningful data to be extracted later.

Firstly, data reflectance will be filtered by a digital filter which performs smoothing of the data following the equation

$$y(k) = \frac{x(k) + x(k-1) + x(k-2)}{3} \quad (1)$$

After filtering process, filtered data is grouped into 3 (three) classes of filtering. This class of filter works as final feature extraction procedure with each filter has some coefficients (a_{ik}) with exactly the same number to number of data. The equation for the class filter is shown in equation (2) below

$$\underline{\hat{y}} = \sum_{k=1}^{K} y(k) a_{ik} \quad (2)$$

with $\underline{\hat{y}} = [\hat{y}_1 \quad \hat{y}_2 \quad \hat{y}_3]$

and $\sum_{k=1}^{K} a_{ik} = 0$

Each class of filtering represents the direction and the schooling/solitary of the fish. The coefficient has been found experimentally in [8]. The results from a class of filter are a single number and the classification of a fish is based-on this result. The procedure for classification is a simply table matching procedure. The value of $\hat{y}_i$ as a result of class filtering is matched to the range value in the classification table. The range value in the classification table is obtained by clustering method with min-max and minimum Euclidian distance. The overall algorithm of the classification is demonstrated by a flow chart shown in Fig 2.

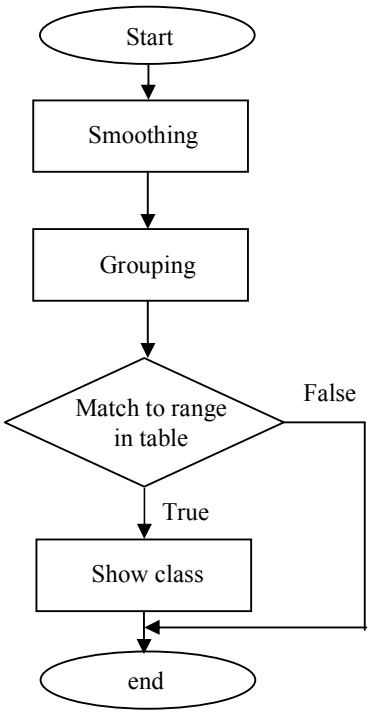

Fig. 2. Algorithm of Fish Classification

III. EXPERIMENTAL PROCEDURE

Experimental procedure began with two types of fish (see Table 1) and placed them into an aquarium. The experiments were divided into three conditions. The two types of fish were exactly the same as five types of fish chosen by Diponegoro [2] Condition A and B where each type of fish was placed separately. Both conditions involved 3 fishes with the same type. For the condition C, both type of fish were placed together in the same aquarium simultaneously.

The sensory element was put in the water. Position of the sensor was not being observed.

Table 1
Fishes Classification that be observed in the experiment

Fish name	Species	Length	Qty
Banded grunter	Therapon Theraps	12 cm	3
Bannerfish	Heniochus acumeratus	10	3

The microprocessor controls the serial data communication from the sensor. Each classification was obtained from 512 data with time sampling of 1 ms. Listing of serial data in basic stamp language is:

```
' {$STAMP BS2}
' {$PBASIC 2.5}

 pMaxRecv PIN 15
 pMaxClock PIN 14

xDist VAR Word
 xPulse VAR Word
 xX VAR Byte

' ============ Main ================
 DO GOSUB sSerial
    DEBUG CR, CR
    PAUSE 50
 LOOP
 END
sSerial:
    FOR xX = 1 TO 512
        SERIN pMaxRecv\pMaxClock, 16468, [WAIT
("R"), DEC xDist]
        DEBUG DEC5 xDist, " "
        PAUSE 50
    NEXT
    DEBUG CR
RETURN
```

With Basic Stamp microcontroller, data could be send directly to PC to obtain plotting image. Easily with program names MaxSonar®-EZ1™ made by Richard Grier [11] the signal could be plotted in a PC via serial port in order to have oscilloscope effect.

IV. RESULTS

Using MaxSonar®-EZ1™, the sequence of the reflectance signal are shown in Fig. 3 to 5.

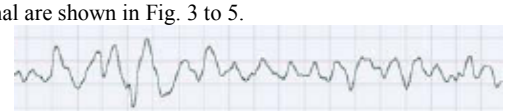

Fig. 3. Experiment with Banded Grunter Fish (Condition A)

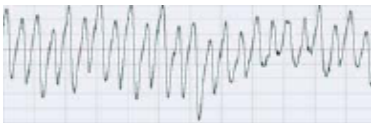

Fig. 4. Experiment with Bannerfish (Condition B)

Fig. 5. Experiment with two fishes placed together into an aquarium (Condition C)

The classification results from 20 tests for each experiment are shown in Table 2. The successful criteria of the classification are represented in percentage from total test.

Table 2 The result of classification

No.	Condition	Percentage of Successful Classification
1	A	40
2	B	25
3	C	15

As observed from the table, inferior result of classification has been obtained. This is due to the interference and noise in the water, which should be overcame intensively. The method of classification and the data processing should be investigated further to give an fruitful performance. In the future, obtaining suitable class of coefficient will be the priority to gain better classification

V. CONCLUSION

The result shows that an inadequate classification still occurs, however at least, a basic concept has been thought and an improvement of the idea can be explored in the future research. Interference and noise in the water should be considered more thoroughly as important factors for determining more accurate classification results.

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Yeffry Handoko received the S.T (Ir.) degree in engineering physics and M.T (M.Eng) degree in instrumentation and control from Institut Teknologi Bandung, Indonesia in 1996 and 1999, respectively, and since 2004 he has been pursuing doctoral degree in Institut Teknologi Bandung. His research interest is in artificial of nature-sensor and robotics control.

Other topic related to his research:

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All can be download at : http://www.fishrobot.zoomshare.com