Identification Of Asian Green Mussel Perna Viridis' Sex Using Image Processing, Fuzzy Logic And K –Nearest Neighbor

Robie Ann Magbayao, Edwin R. Arboleda, Elbert M. Galas

Abstract: Perna Viridis gender can not be identified in its shell, however, it can be classified by identifying the color of its gonad. The male green mussel has creamy white colors while the female green mussel has reddish gonad. The proponent of this paper will propose an identification technique by image processing, fuzzy logic and K nearest neighbor. The image processing will gather RGB data for each sample and the gathered data will be used to identify the gender of the green mussel using fuzzy logic and K nearest neighbor. Fuzzy logic identified 75.76% of male green mussels and 100% female green mussels, on the other hand, the K nearest neighbor classifies the male and female green mussels on the first trial.

Index Terms: Fuzzy logic, Green mussel, Image processing, Perna Viridis, Sexing

1. INTRODUCTION

PERNA Viridis, commonly known as the Asian green mussel is highly comparable with blue mussel (Mytilus edulis). Blue mussel is extensively spread out in the greater latitude area and serves as the counterpart of Perna Viridis. Both mussels are dominant in near-shore areas of sea or littoral waters and substantially helps the productivity of coastal ecosystems[1], [2]. Asian green mussel is a large mussel considering its length that ranges from 8-16 cm. There is no sexual dimorphism as respects to their length or other physical characteristics. Perna Viridis's shell has concentrical lines and narrows as it prolongs towards the anterior [3]. The innermost part of the shell is even with an opalescent blue tone [4]. Mussel is one of the main species that is highly cultivated in several parts of the world that is why mussel farming is greatly introduced in the industry [5]. Green mussel is one of the mussel types that is grown commercially in the southern areas of China like Guandong. Green mussel is a low-cost source of protein in the region of Southeast Asia. Thailand reached the second leading provider of mussels among all Asian countries next to China. In Thailand, green mussel yields the utmost net income of any Bivalvia creature in their country [6], [7]. Classifying the sexuality of green mussel (Perna Viridis) may be determined in terms of the developmental forms of their gonads. Moreover, the color of female's gonad at its initial stage growth is similar to males [8], [9]. At present, an expert is needed to visually examine the sex of a green mussel, which is sometimes not accessible [10].In solution with this, an identifier of green mussel's sex is proposed using Image processing, Fuzzy logic and K nearest neighbors.

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1.1 The Genus Perna

Four species are commonly characterized in genus Perna. The Perna Viridis, Perna Perna, Perna canaliculus and Perna picta. P. Viridis and P. Perna are widely circulated in many countries and often found on the other hand P. canaliculus are usually exist in New Zealand and P. picta in the sea of Mediterranean [1]. Color pigmentation and patterns of the shell are considered in classifying genus Perna species [7], [11].

1.2 Distribution

The Perna Viridis usually dispersed in the part of the Indo-Pacific area [6], [7], mainly spread on the coast of Southeast Asia and India [1], [12]. It is tending to spread and introduced in the littoral areas of Trinidad and Tobago and other American countries [3]. The Dissemination happens through ballast tanks of ships with larvae and sea currents [13], [14].

1.2 Habitat

Perna Viridis easily occur in coastal areas at 10m depths and below. This mussel is mostly seen in habitats like estuarine, intertidal, and subtidal [3]. They form on stony surfaces and structures like quay and offshore barrier [1]. Green mussels commonly exist on solid surfaces and also can be seen on muddy and sandy substructures. They like better to stay in spaces where there is a great flow of water about 30 cm of depth. Green mussels are euryhaline and able to tolerate conditions in the range of salinities 15–45 ppt. Salinity is an important factor since it affects the growth of mussels in an ecosystem. Green mussels can be able to survive at temperatures between 10°C–42°C. However, high temperatures in water provided more survival rate than the lower water temperatures areas [4], [15]–[20].

1.3 Sexes

Green mussels (P. Viridis) become sexually mature at two to three months and grow approximately twenty to thirty millimeters in length. They have a life span of three years [4]. There are male and female green mussels but it is not easily distinguished by morphology. Male green mussels are identified with milky white-colored gonads; females possessed an orange and red tone gonads [1]. Sexual distinction started at twenty millimeters with the developing shape of follicular. Mussels bigger than twenty-five millimeters had well-built gonads at various levels of maturation [9], [21].

***Fig. 1**. The gonad of male Perna Viridis (Left)*
Fig. 2. The gonad of female Perna Viridis (Right)

2 MATERIALS AND METHOD

2.1 Perna Viridis

The green mussels used in this study are collected from the seawater of Bacoor, Cavite, Philippines. The samples are 3 months old and ready for harvest. These Perna Viridis from Bacoor, Cavite are the ones that the fishermen from the Province of Cavite, particularly fishermen from Cavite City, Kawit and Bacoor, are exporting. The fishermen have pabiyayan. This is where they grow and breed green mussels. The pabiyayan is made up of bamboo which is commonly located at the seawaters of Bacoor and Kawit, Cavite.

2.2 Image Processing, Fuzzy Logic and K nearest neighbor

Image processing can be easily performed using MATLAB software [22]. Image processing is essential in extracting morphological features like describing size or shape and identifying patterns [23], [24]. MATLAB software will be used to process the images of the gathered samples. Coming from the samples, RGB data will be obtained. These gathered data will be the basis of fuzzy logic and the K nearest neighbor. Fuzzy logic is a method for analyzing the "degrees of truth" compared to the standard or computer-based "true or false" or “1 or 0” [23], [25], [26]. K nearest neighbor (KNN) is an approach utilized for regression and classification of certain objects [25]. Furthermore, KNN is used for identifying samples or objects based on the distance in the dimensional space [26], [27]. The proponent took images of the male and female green mussels using the same camera. The camera is maintained at the same height while taking pictures of the sample. The camera from an Ipad Mini first generation was used in this study. The data gathered from the image processing of the samples will be used to classify the sex of the Perna Viridis. Using the same camera, the researcher captured images of the female and male green mussels. The camera is maintained at the same height while taking photos of the sample. The camera from an Ipad Mini first generation was used in this study. The gathered data from the image processing of the samples will be used to identify the sex of the Perna Viridis.

A total of 33 male green mussels and 33 female mussels samples are used by the proponents.

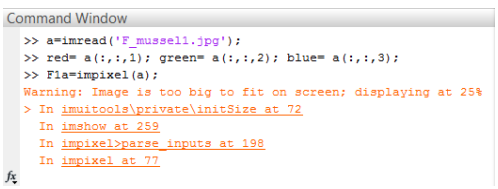

***Fig. 3.** Command Window in MATLAB*

3 RESULTS AND ANALYSIS

The RGB values of the samples will be considered to determine the sex of the Asian Green Mussel. Using MATLAB,

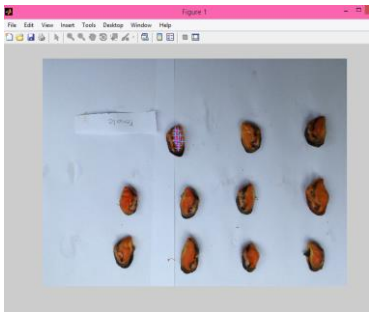

***Fig. 4**. Pixelating the sample image*

the images will be processed. The codes below are used to get the RGB values of the samples. A pixelated image will appear. This is where the MATLAB gets the data. By clicking onto the image, it will save in RGB values of the selected pixel in the workspace. The data gathered shows different values of red, green, and blue from each sample. The proponent gathered RGB values of 10 pixels in each sample, both male and female green mussels. The data showed the difference between the values between female and male green mussels. The values of RGB in male and female green mussel samples are known. The proponents wish to classify the gender using fuzzy logic. The inputs in fuzzy logic are the range of red, green and blue from the data gathered in the image processing. Under that red input, the range is 110 to 210. 20 to 165 and 5 100 for green and blue inputs respectively. The fuzzy logic now has input data which will be the reference for the output- the gender of the Perna Viridis. The fuzzy logic output will be the gender of the green mussels. 0 to 4.99 determines the male green mussels and 5.01 to 1 determines the female green mussels. 0.5 fuzzy logic output value means the gender cannot be classified by MATLAB.

From the data gathered (see tables 1 & 2), the proponents can set the rules for the classification of the sex of the Perna Viridis. Understanding the data is crucial to the accuracy of the result of the fuzzy logic.

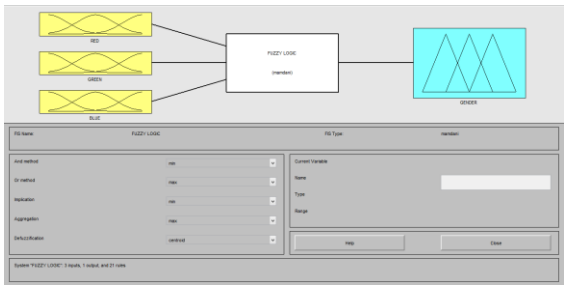

***Fig. 5**. Fuzzy logic toolbox in MATLAB*

The proponent test the accuracy of the fuzzy logic algorithm using the data gathered from the samples. The table below

shows an RGB pixel value of 1 pixel in each sample (male and female green mussels) and the Fuzzy Logic output, which is the gender prediction of the Perna Viridis.

TABLE 1

RGB VALUES OF MALE GREEN MUSSELS

33 MALE samples (RGB value of 1 pixel per sample)				
	Red	Green	Blue	Fuzzy Logic
1	148	109	44	0.486
2	155	119	45	0.395
3	158	116	44	0.395
4	179	150	80	0.38
5	152	109	41	0.486
6	173	133	71	0.353
7	142	103	38	0.531
8	137	102	48	0.5
9	159	110	33	0.476
10	143	100	57	0.5
11	149	132	80	0.341
12	165	121	50	0.398
13	154	115	46	0.428
14	136	114	65	0.44
15	138	103	45	0.578
16	163	135	70	0.335
17	172	130	56	0.371
18	146	111	43	0.466
19	166	132	60	0.35
20	156	109	31	0.486
21	145	105	36	0.526
22	139	105	44	0.5
23	172	127	46	0.36
24	146	101	36	0.563
25	164	121	43	0.382
26	142	90	30	0.594
27	177	141	79	0.368
28	159	129	67	0.345
29	183	143	73	0.407
30	162	121	57	0.391
31	174	129	61	0.364
32	125	114	82	0.364
33	173	141	68	0.349

TABLE 2

RGB VALUES OF FEMALE GREEN MUSSELS

33 FEMALE samples (RGB value of 1 pixel per sample)				
	red	green	blue	fuzzy result
1	160	62	27	0.656
2	125	38	10	0.604
3	162	53	22	0.624
4	175	72	27	0.643
5	157	60	27	0.65
6	159	65	29	0.662
7	174	71	40	0.648
8	179	73	31	0.62
9	150	64	13	0.593
10	172	70	22	0.649
11	160	67	23	0.654
12	197	86	31	0.637
13	179	72	26	0.62
14	181	76	28	0.607
15	169	65	14	0.6
16	110	41	12	0.59
17	136	43	10	0.581
18	151	43	14	0.581
19	185	70	25	0.581
20	148	52	12	0.597
21	132	49	15	0.601
22	155	60	14	0.6
23	158	66	25	0.661
24	139	45	11	0.588
25	158	67	22	0.649
26	160	81	25	0.658
27	127	53	14	0.6
28	143	51	10	0.611
29	174	72	32	0.648
30	159	53	13	0.593
31	151	60	16	0.613
32	144	34	7	0.621
33	163	77	28	0.667

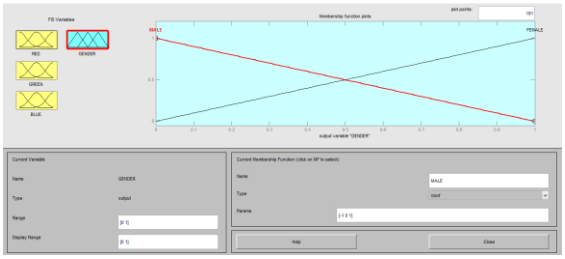

Fig. 6*. Fuzzy logic output*

Eight out of thirty-three fuzzy logic output are correct and shows value for the male gender. In the identification of male green mussel has 75.76% accuracy. Thirty-three out of thirty-three fuzzy logic outputs are correct and successfully identified the female Perna Viridis. The identification in female green mussels using fuzzy logic is 100%.The K nearest neighbor can be able to determine the gender of the green mussel by feeding gathered RGB data to it. The data used in this method is the RGB values of male and female green mussels. 50 male samples and 50 female samples were used in test data and 20 samples were used in training data.\

4 CONCLUSION

In the RGB data gathered, the proponent noticed that the green and blue value of the male Perna Viridis is higher than the green and blue value of the female green mussel. This data are helpful especially in the setting of rules in fuzzy logic. The RGB data gathered from image processing is used for the identification of green mussel's gender using fuzzy logic and KNN. Fuzzy logic shows 75.76% accuracy in identifying male Perna Viridis and 100%% accuracy in identifying female green mussels. On the other hand, the KNN classified the gender of the 50 male mussels and 50 female mussels in just the first training of data with 100% accuracy.

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