Fish Eggs Calculation Models Using Morphological Operation

Syaipul Ramdhan
Dept. Of Informatics Engineering
Universitas Budiluhur
Jakarta, Indonesia
syaipulramdhan@stmikglobal.ac.id

Muhammad Syafrullah
Dept. Of Informatics Engineering
Universitas Budiluhur
Jakarta, Indonesia
msyafrullah@budiluhur.ac.id

***Abstract*—Calculations on group objects are the concern of current researchers, to find optimal detection and calculation solutions. One of them is fish eggs in a group. Fish cultivators need precision in calculations, because currently conventional methods often make errors in calculations. If the calculation is wrong, it will have an impact on production and sales that are not balanced (loss). Small and easily broken fish eggs are grouped and it is difficult to do manual calculations. The purpose of this study is to test which segmentation method is the most optimal in calculating these grouped fish egg objects and produce precise and fast calculations. The test model was developed from algorithm of morphological operations, watershed and statistical approaches with the same number of samples. The result shows morphological operation is better than the others with 96.67%, watershed 81.28% and the count statistic is 95.62% with an average calculation process speed of 54.5 seconds for morphological operations, watershed 1 minute 55 seconds and statistical approach 58.9 seconds. As a result. morphology gets the most optimal and fast calculation results.**

Keywords*—*object calculation, HSV, otsu tresholding, morphological operations, watershed, statistics.

I. Introduction

Processing on an image is intended to obtain information and meaning. Through a two-dimensional signal or defined in a mathematical function with F (x, y), an image basically has two x and y coordinates, each of which has values in horizontal and vertical coordinates.

At present there are so many digital imaging models to do automatic calculations [1] that can help humans solve their problems. the image transformation approach has many approaches including morphology, watershed [2][3] and object counting algorithms with statistical approaches [4]. Morphology [5] has an operating variant for image segmentation, erosion, dilation, opening and closing. Morphology is a traditional technique in modeling images that focus on the point or set that forms an image, point vertices that form a region to get image segmentation on a predetermined set. In the image region there are always two trends, namely light and dark, the darker the image, the intensity value goes to 0. While the more white the intensity value is 1. The treshold function is to get the background image and noise from the binary image that has been copied.

Watershed is an image segmentation that divides gray scale or color images in different regions of image representation in the form of topographic reliefs such as the behavior of water in a landscape. When it rains, drops of water fall in different areas, then it will follow a decreasing surface. Water will end at the bottom of the valley so that for each valley there will be an area where all water flows into it.

The statistical approach has general rules that can always be followed to identify the most appropriate concentration measure to use. Each measure of concentration (mean, median and mode) has its own characteristics. In addition, the types of data available must be evaluated and considered. Choosing a concentration size that will be used in a symmetrical distribution is easier because the arithmetic, median and mode mean have the same value.

This paper compares the calculation model of fish eggs with the above methods, namely morphological, watershed and statistical arithmetic operations. Each method will be pre-processed to get the ideal results from each method. In addition, the method is made in one application that allows measuring the accuracy of the number of fish eggs and their speed and counting.

II. Related Work

Fish farmers have a lot of works to do [6] especially egg counting [7] fish that requires accuracy. The right method is needed so that the calculation process takes place quickly and correctly. If the calculation is wrong, it will have an impact on production and sales that are not balanced (loss). Object imaging has two ways to accomplish this task, namely static image and dynamic image. Static image, the image depends on the brightness [8] to be detected maximum.

Gouramy eggs have a tendency to overlap because they are round. The calculation of gouramy eggs by fish farmers is calculated at least 3000 eggs, while the maximum number of eggs [9] that can be sent can reach 60,000 eggs. The farmers experienced difficulties due to the very large number, the manual calculation required about 2 hours to count 3000 eggs, 12 hours to count 60,000 eggs. Not to mention if the calculation is forgotten or missed, a recalculation must be done.

In the previous study [10] the authors used the HSV and watershed methods [11] which were developed to be able to guess the grade of carp eggs with accuracy to test fish eggs to obtain an accuracy of around 70%. Subsequent research [12] proposed to design a fish seed counting technique using image processing by adding image brightness, grayscale process, image binaryization, reversing image color, removing 3000> pixel area, boundary process, label process, boundary area measurement) and using algorithms calculation of objects with mode (.8, 25%) and mode (.9.25%). The author adds statistical parameters in the catfish seed calculation algorithm is able to have an effect on the accuracy of calculations. The average level of accuracy in the sample test of up to 70 catfish seeds is 93%. although his research uses a different sample with the test this time it is very relevant to be tested with with fish eggs because they have the same scope that is related to group objects (clusters).

Furthermore, the author intends to test the two methods above and compare them with the morphological operating method to get the accuracy and speed of calculation of grouped egg objects.

III. METHOD

Morphology [13] recommends erosion algorithms for thinning the output of each object based on line feature extraction techniques. In addition, it is assumed that our model makes optimal thinning detection by first testing the optimal R (erode) value through the looping function. Processing using digital images or static images is chosen because objects have fixed and vulnerable contours (shapes).

The calculation process through several stages of color segmentation into the colors of HSV (Hue Saturation Value) [14], then binaryization of the image before being treshlowed using Otsu. Otsu performs a boundary process on the image to detect the edge of the image and make corrections and cleanup of noise in the pixel set image.

$$V = \max R, G, B$$
$$V_m = V - \min R, G, B$$
$$S = \begin{cases} 0^0 & jika\ V = 0 \\ \underline{V_m} & jika\ V > 0 \end{cases} \quad (1)$$

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$$H = \begin{cases} 0^0 & jika\ S = 0 \\ 60^0 x \left(\frac{G-B}{V_m} \bmod 6 \right) & if\ V = R \\ 60^0 x \left(2 + \frac{B-R}{V_m} \right) & if\ V = G \\ 60^0 x \left(4 + \frac{R-G}{V_m} \right) & if\ V = B \end{cases}$$

A. Otsu Tresholding

Thresholding is the easiest way to segment. This is done through the threshold value obtained from the edge histogram of the original image. The threshold value is obtained from the edge detected image. So, if edge detection is accurate then the threshold is too. Segmentation through thresholding has fewer calculations than other techniques. Thresholding's way of working is to change the image with a degree of gray and then convert it to a binary image or black and white, this is intended to be able to distinguish between objects and background images from the image in detail and clearly.

This Otsu method is based on the histogram. The histogram shows any intensity value of each pixel in the image in 1 dimension. So the x axis usually states different intensity levels while the y axis states the number of pixels that have the intensity value. By observing the histogram of an image, we get 2 information at once namely the number of different intensity levels (symbolized by L) and the number of pixels for each of these intensity levels (symbolized by n (k) with k = 0 ... 255).

$$P_i = \frac{n_i}{N} \quad (2)$$

Information :
Ni : number of pixels at level i
N : the total number of pixels in the image

$$\omega(k) = \sum_i^k P_i$$
$$\mu(k) = \sum_i^k i * P_i \quad (3)$$
$$\mu_r(k) = \sum_{i=1}^k i * P_i$$

Zeroth Cumulative Moment value, and the total consecutive mean values can be expressed by the following equation:

$$\sigma \frac{2}{B} \left(k^*\right) \underset{1 \le k \le L}{Max} \sigma \frac{2}{B} (k) \quad (4)$$

B. Morphological Operation

Morphology has the main function as an image processor to improve segmentation results. In addition to binary some cases of gray images (grayscale) can be used with morphological techniques.

C. Erosion

Erosion [15] aims to reduce or erode the edges of the object or by being an object point (1) which is adjacent to the background point (0) to become the background point (0).

$$A \Theta B = A^c \oplus B^c \quad (5)$$

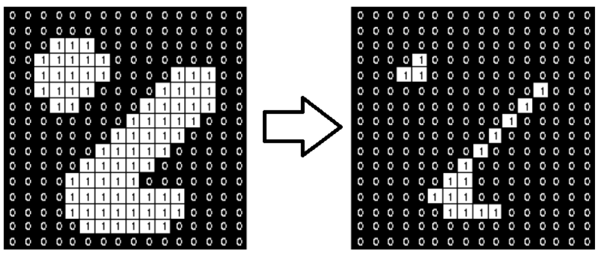

Figure 1 . Morfological Operation – Erosion

Figure 1 above is an operating technique of morphology that will separate objects that coincide with each other to obtain a skeleton (frame) of an object and obtain the shape structure of an object.

D. Watershed

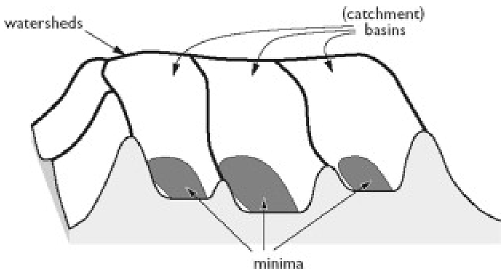

Figure 2. Watershed Illustration

The gradient level of an image is seen as a height level from the topographic surface shape. Water that floods this surface will flow to the lower part of the surface due to gravity. As shown in Figure 2, water will flow to each shelter valley. If water is given in each shelter valley and continues to flood it, then the water from the different shelter valleys will overflow and before it overflows into another shelter area, a boundary will be built. Watershed [16] [17], which works with parts of an image with a high gradient level, will be detected and will be used to divide the image into many regions near the same.

E. Statistical Approach

Calculation of objects through a statistical approach uses Mean, Median and Mode values to get the optimal image mean.

1. Arithmetic Mean

In the practice, the average term often refers to the arithmetic mean.

$$\chi = \frac{\sum_{i=1}^{k} n_i \bar{x}_i}{\sum_{i=1}^{k} ni} \tag{6}$$

1. Aritmatic Median

$$Median = \bar{\chi} = L_i + \left(\frac{\frac{n}{2} - (\Sigma f)_t}{f_{median}} \right) e \tag{7}$$

Where:

L_i = real lower limit of the class of the median class (median class that contains media)

n/2 = amount of data (total number of frequencies)

$(\Sigma f)_t$ = the number of frequencies of all classes is lower than the median class

F_{median} = median class frequency

c = width of the median class interval

2. Arithmetic Modus

$$Mo = L + i \frac{b1}{b1 + b2} \tag{8}$$

With : Mo = Modus

L = The lower edge of the class which has the highest frequency (modus class) i = class interval

b1 = The frequency of the modus class is reduced by the closest closest interval class frequency

b2 =class frequency modus minus the closest interval class frequency thereafter

$$Me = Q_2 = \begin{cases} \dfrac{{}^{x}n+1}{2} & \text{, if } n \text{ odd number} \\ \dfrac{{}^{x}\frac{n}{2} + {}^{x}\frac{n}{2}+1}{2} & \text{, if } n \text{ even} \end{cases} \tag{9}$$

F. Implementation

The implementation of each method has been designed in one application model and the same key input, so that the calculation can be seen simultaneously with only the calculation time difference. We decided to use 10 samples of 25, 50, 75, 100, 125, 150, 175, 200, 225, 250. The sample image was taken using an 8 megapixel smartphone camera. The application is made using the software matlab R2012b.

Table 1. Number of Samples

Number of Samples Eggs	Number of groups
25	0
50	2
75	2, 3
100	2, 3, 4
125	2, 3
150	2, 3, 4, 5, 6
175	2, 3, 4, 7
200	2, 3, 4
225	2, 3, 4, 5, 12
250	2, 3, 4, 21

.

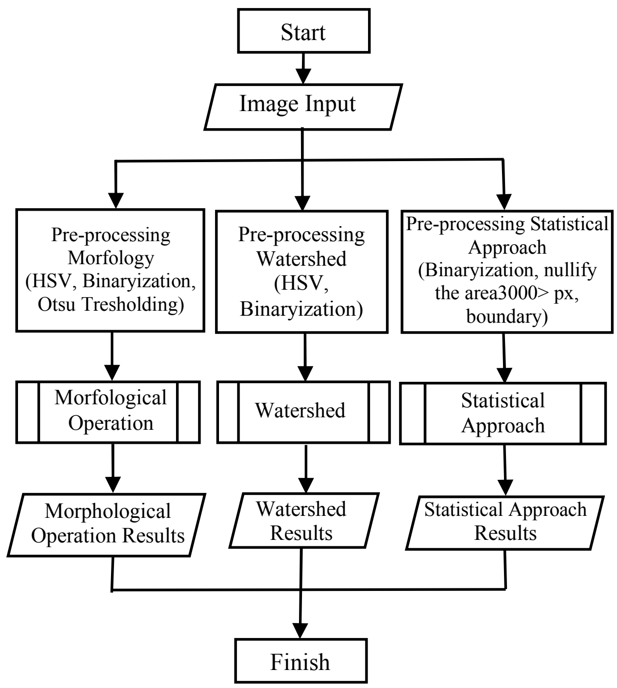

Figure 3. Calculation Flowchart

Figure 3 above is a calculation process flow diagram. First, entering the image will be pre-processed to maximize the calculation process of each method.

In the process of pre-processing the Morphological Operation method: (1) RGB to HSV, the previous RGB image is colored into the value of hue (red) H = HSV (:,:, 1). (2) The second step is binary imagery of dark intensity or value of 0. (3) The third step is cleaning the noise with tresholding otsu, after the pre-processing stage morphology is performed with erosion operations (optimal R value) with an algorithm developed to select pixel sets to separate between eggs, using the looping algorithm at the erode value, the optimal results are found.

Furthermore, the process of pre-processing the Watershed method: (1) RGB to HSV, the previous RGB image is colored yellow to the value hue (red) H = HSV (:,:, 1). (2) Image binaryization to dark intensity or value 0. After the pre-processing stage is done watershed with .... do a calculation so that the results are found.

While the pre-processing process of the Counting Algorithm Approach method: (1) Adjusts the image brightness and makes it grayscale. (2) Image binaryization and reversing it. (3) Eliminate the area of 3000> pixels. (4) Boundary and labeling processes. After the pre-processing stage, the calculation of the statistical counting approach algorithm is calculated, which is to find the Mean, Median and Mode values with the algorithm value .8,25%, .9,25%, .9,15%.

IV. Result And Discussion

In this section we will explain the results of calculating digital imagery using application models that have been developed to test group objects simultaneously.

A. Comparison of Model

Table 2. Comparison of Model Testing

EGG SAMPLES (S)	GROUPING AMOUNT	METHOD (M)					
		MORFOLOGY (EROSI)	S/M (%)	WATERSHED	S/M (%)	STATISTICAL APPROACH	S/M (%)
25	0	25	100	45	55,55	25	100
50	2	50	100	81	93,1	50	100
75	2, 3	80	100	88	85,22	79	94,93
100	2, 3, 4	101	99	141	58,13	103	96,15
125	2, 3	123	98,4	128	97,65	123	98,4
150	2, 3, 4, 5, 6	144	96	149	99,33	150	100
175	2, 3, 4, 7	170	97,14	209	83,73	175	100
200	2, 3, 4	196	98	235	85,1	198	99
225	2, 3, 4, 5, 12	242	92,97	241	93,36	253	88,93
250	2, 3, 4, 21	213	85,2	405	61,72	317	78,86
TOTAL (∑ H1,...H10)			96,67 %		81,28 %		95,62 %

Table 2 shows the results of system testing between methods. It is seen that the results of the calculation of the proposed method are more accurate, namely 96, 67%, while the previous research was 81.28% and 95.62%.

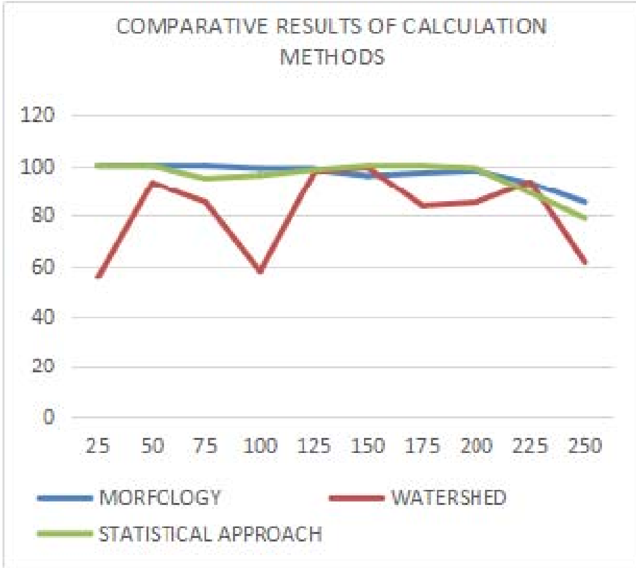

Figure 4. Method Comparison Chart

Figure 4 shows an image comparison method with graph..

B. Speed calculation

Speed testing is performed on the same application by entering a time calculation algorithm, which is displayed through a trace program. Table 3 shows the results of testing the speed of time.

Table 3. Comparison of Calculating Speed Tests

SAMPLE	MORFOLOGY	WATERSHED	STATISTICAL APPROACH
25	5,1	10,1	5,5
50	5,2	10,9	5,5
75	5,3	11,2	5,2
100	5	11,2	5,2
125	5,4	11	6,1
150	5,7	11,8	6,1
175	5,5	12	5,9
200	5,6	12,1	5,8
225	5,9	12,5	6,2
250	5,8	12,5	7
	54,5	115,3	58,5
∑SPEED	54,5 second	1 minute 55 second	58,5 second

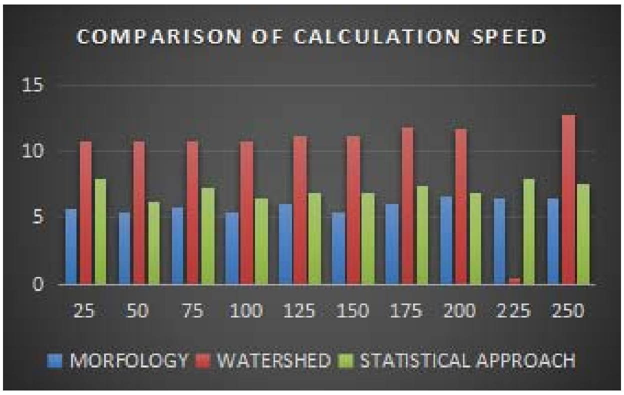

Figure 5. Speed Comparison Chart

Figure 5 above is the result of speed calculations with samples 25 to 250.

C. Testing for User Acceptance (UAT)

The results of testing the application to respondents of fish farmers are as followst.

Table 4. User Acceptance Test

No	Questions	Grade					Count	Analisis	Persentage
		5	4	3	2	1		(count)	Analisis/5
1	The application of gouramy egg counters can be operated easily and effectively.	25	0	0	0	0	25	5	100%
2	The application of gouramy egg counters can count in large quantities?	25	0	0	0	0	25	5	100%
3	The application of gouramy egg counters can calculate grouped egg objects?	5	16	0	0	0	21	4,2	84%
4	The process of inputting the image until the output on the application is running properly?	5	16	0	0	0	21	4,2	84%
5	The number of gouramy egg counts with applications is better than manual?	20	4	0	0	0	24	4,8	96%
6	Application of gouramy egg counting method Morphology is better than Watershed?	15	8	0	0	0	23	4,6	92%
7	Application of gouramy egg counter method Morphology Operation is better than object counting algorithm?	0	20	0	0	0	20	4	80%
8	The gouramy egg counting application can count faster than Watershed?	10	12	0	0	0	22	4,4	88%
9	The gouramy egg counter application can calculate faster than the object counting algorithm?	5	16	0	0	0	21	4,2	84%
10	Applications can be applied to simplify the work of calculating gouramy eggs for fish farmers?	25	0	0	0	0	25	5	100%
	Result							45,4	90,80%

V. CONCLUSION

The image processing algorithm model that can be applied according to the calculation of gouramy eggs is by a combination of HSV methods, Otsu Tresholding and morphological operations resulting in fast and precise calculations in an average time of 59.3 seconds faster than previous studies with a value of 1 minute 42 seconds and 1 minute 11 seconds. The average level of accuracy in the sample test up to 25 to 250 gourami eggs is 96.67%. This has an impact on a better level of accuracy than previous studies with an accuracy of 81.82% and 95.62% with the same sample.

From the test results above, the morphological operating algorithm model is better for calculating group objects. This research is still limited to fish egg samples, so further research can also be tested on other samples that are more complex in size, shape and overlapping objects and adjusted deviations.

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