Application of image processing to calculate the number of fish seeds using raspberry-pi

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Abstract. Many fish cultivator in Indonesia who suffered losses due to the sale and purchase of fish seeds did not match the agreed amount. The loss is due to the calculation of fish seed still using manual method. To overcome these problems, then in this study designed fish counting system automatically and real-time fish using the image processing based on Raspberry Pi. Used image processing because it can calculate moving objects and eliminate noise. Image processing method used to calculate moving object is virtual loop detector or virtual detector method and the approach used is "double difference image". The "double difference" approach uses information from the previous frame and the next frame to estimate the shape and position of the object. Using these methods and approaches, the results obtained were quite good with an average error of 1.0% for 300 individuals in a test with a virtual detector width of 96 pixels and a slope of 1 degree test plane.

1. Introduction

Many fish farmers in Indonesia who suffered losses as the result from the sale and purchase of fish seeds which does not correspond to the amount agreed. Losses occur due to calculate fish seed, count manually. It is by counting the fish seeds one by one, the possibility of errors is very large such as human error. Maybe the amount of the loss is not great if the amount of the purchased fish seed is not too much. But if the number of fish seed purchased in great numbers, the losses will greatly impact. In addition, the manual counting methods takes quite a long time, It takes approximately 1 hour to the sorting and counting of 500 fish seeds with a size of 1-3 cm, While once a sale range up to 1000 to 3000 fish seeds [1]. In fact there have been many studies that have been conducted on fish seeds count automatically. As an example of research done by [2] and [3]. The sensors used in research [2] using phototransistor. When there is a bubble of air which passes through the pipe, the air bubbles also detected by the sensor [2]. While the sensor is used in research [3] i.e. using LED (Light Emitting Diode) and photodiode problems on the research of [3] similar to that performed [2] i.e. not able to calculate fish seeds with small size accurately and also not able to distinguish between the seed of the fish with the other objects which enter into tools such as air bubbles.

To get the accurate data, then image processing sensor is developed. the sensor that is used in this method is the sensor of the camera. The camera will capture images of fish seeds that pass through the camera sensor. Then the information in the form of an image of the camera is processed to be able to be counted. Pre-launch stage processing function to improve the quality of the image prior to further processing. Improvement of the quality of the image can be through the process of smoothing and
sharpening to eliminate noise in the image [4]. Smoothing technique used to smooth the image, while sharpening technique was used to sharpen the image. After a pre-launch stage processing, the next step is the image segmentation. The purpose of image segmentation is to distinguish objects to its background. Once separated from the background object, the object is detected will be calculated automatically. The system is expected to be able to calculate the fish seeds of various sizes and also more accurate compared to systems that use sensors and photodiode-LED phototransistor.

2. Methodology

In order for research purposes can be achieved, then there are several stages of research to be done, as can be seen in Figure 1. The main stages that must be done in this research is the image segmentation, filtering, image morphology, and fish seeds calculation.

![Flow diagram of fish seeds calculation.](image)

Based on Figure 1, the experimental setting of the fish seed counter begins with the fish seed inserted through the inlet mixed with water. The purpose of water use is to prevent the fish from returning or turning around. After that the fish seed passes through the area highlighted by the camera.
In the area highlighted by the camera is used then as image processing to calculate the number of fish seeds entered. At the end of the fish seed has been calculated out through the outlet.

![Figure 2. Experimental setting or fish seeds counter.](image)

### 2.1. Segmentation

Segment object is one of the processes, in the system of image processing which is used to separate objects with the background. Background subtraction were the first stage or also we known as pre-processing, the main thing in the vision based-Application. Technically, a moving foreground extracted from a static background. The background subtractions done in absolute terms where the difference every pixel of both images will be acquired and is always positive. Because this technique will notice the difference for every pixel in the image, so that the two images must have the same size of data type and it sizes. [8]. As for the background of the process of subtraction algorithm is to use the method model in every pixel background with a mixture of Gaussian distribution of $K$ ($K = 3$ to $5$). Mixed weights represent the proportion of time with these colors remain on the screen. By using this algorithm, the background color of the possibility last longer and are more static.

Background Subtraction adaptive is almost the same as background subtraction methods, It's just a background image constantly updated due to altered conditions, for example in the morning with the daytime then it will causes different intensity. The Intensity differences will affect the threshold value of each pixels. So in need the Background subtraction adaptive methods to do as follows. Soon after you have the original background, then filter the image frame to be more subtle using Gaussian filter, and convert RGB image color type, into grayscale [9].

### 2.2. Filtering

After image segmentation stage is done, then the next step is to reduce noise. Because the system uses research on image processing then the possibility of noise is very likely to happen. Noises may caused by due to lack of lighting or too dark. It also can be caused by the shadows of the water because of the water undergo the turbulence. Therefore do a filter process, due the noise reduction of the image before the next step of the process. Thus the filter that is used in this research is Median Filter.

### 2.3. Morphology

To refine the shape of the object detected by the morphological operations in this research, the morphological operations that is needed to is as it follows: opening morphol ogy operation, closing morphological operation, dilation operation. Opening morphology operation to smoothen the contour object and reduce pixels beside the smallest pixel outside the object identified, thus it will not affect detection process of moving object. In addition the operation is used as the size of the object is relatively the same after the surgery compared to using morphological erosion. Closing morphology operation which is used in this research able to smoothen the object contour and vanish small hole in
the object, in case could fill up the contour wholly, therefore the operation system able to define the centroid point from the moving object. Dilation operation used to combine an object which is separated that caused by imperfect segmentation process.

2.4. Fish Seeds Calculation

The object detection by finding the centroid points objects. For the centroid points could see in the Figure 3 as follows:

![Figure 3](image)

**(a)** Centroid point, **(b)** Frame, **(c)** Blob tracking.

After centroid points is obtained, the next stage is make a frame object. It is intended to display the objects that are being processed and the large dimensions of the frame are the same as the process for seeking centroid points. To track a moving object with detect the object motions, the quantity of the object and the trajectory of the objects. The methods used in this study adopts the blob tracking technology, which is used to count every vehicles in a roadway in a camera or video which is recorded perspectives.[9].

After the process of finding the point of the centroid, create frames and blob tracking is done, then the next step is to create virtual detector. Virtual detector that will be used represented as a normal line, where is the line will be the part of the region of interest (ROI) itself. Which will calculate the amount of fish that pass through the normal line, in the absence of error calculation.

The weakness of virtual loop detector traditional methods is the wrong calculation from the object which is not moving, or the object that move more slowly or an object which runs adjacent. [5]. For it is required an additional algorithm which is consists of frame differencing. Traditional Frame differencing contour of the moving object acquired by using the information differences between two frames in a row, and is widely used in segmentation movement because The characteristic of the object detection process its easy to handle. Besides the traditional frame differencing is less sensitive to changes in lighting or dim lighting condition. So it suited to systems with unstable lighting. But this approachment is also have a shortage of such sensitive to the object speed and frame rate of the video. [5].

To overcome those problems [6] we suggest to variation between these two methods, which is named as “the double difference” methods. The difference between the threshold applying frae at time t, t-1, and t+1 thus combined it with AND logic proposing a techniques which is utilize between two frames, which is frame difference and background subtraction [7]. The differences between actual frame and the prior frame, merged with the differences between actual frame and the actual model of the background to detect moving objects. The first image of the sequence of frames used as an initial background model and dynamically renewed with the new frame which is appropriate with the segmentation moving objects. This approachment promised an object motion, in case the background model gave the appropriat and up-to-date information.

2.5. Double Difference Methods

Double-difference methods applied to get motion regions from video frames and a pose partially on the region where the motion regions is detected. The motion a region where a pixel value changes. A double-difference image is obtained by and operation between successive two difference images. It is assumed that the video frames do not include any moving object except for a fish seed. The double differences images made by three successive frames in an video stream. First, two differences images enerates from corresponding two successive images (’t-1’ and ‘t’, ‘t’ and ‘t+1’). Then binarize the
difference images and execute. Operation on these two images, called a resultant binary image a double-difference image.

As a double-difference image is a product of two differences images. It tends to include isolated noise pixels. Therefore, each 4 by 4 pixels in the double-differences image is grouped into one square block. A block is marked true if more than half of the pixels in the block is true. This process not only prevents noise but also reduces the computation cost in the image processing. Then the system removes isolated blocks to get rid of slight changes in the video frames. The motion regions consists of the pixels whose value is true in the remained blocks [10].

3. Analysis and Discussion

The position and the shape of the object in a correct position is a key factor when calculating an accurate object using the methods that is given (virtual loop methods), since it is depends on pixel value. The contour difference in a normal image does not represent the object shape clearly, because it was a coherency of the shape object in different two times. The “double difference image” approach, apply the information from the previous information, in a prior image sequence, and the next frame merely predict the shape and the position of the objects, which gives a more accurate position information.

To get the image of the object is “double the difference” by distinguishing two images resulting from two consecutive images that match. (frame in the sequence time as beside, ‘t-1’, ‘t’, and ‘t+1’), thus from the differential object binerization is conducted and logical operation AND execute in these two graphic images. The object from the graphic generated, retaining shape and its position at time ‘T’. At the same time, to reduce noise in pixels, using opening, closing, dilate morphology operation in binary graphic which have been executed. Virtual wide variation detector used in this research can be seen in Figure 4 below.

![Virtual Detector Width Images](image)

**Figure 4.** Virtual detector width (a) 480 pixel, (b) 240 pixel, (c) 160 pixel, (d) 120 pixel, and (e) 96 pixel.

In this chapter will be explained about the data analysis at each test specification. Testing has been done include: double difference testing, slope field testing and acrruation testing.
3.1. Double Difference Testing
The program used for software testing by using marbles turned out to be unsuitable to calculate fish seeds, because the program uses full virtual detection. So when used to calculate the fish seeds, there is an error such as the amount of the fish were counted twice. It is therefore necessary the program corresponding to the character of the object in the form of fish seeds using double difference methods. The test aims to determine the width of the virtual detector, and the number if the fish seed used in this test is 50. The testing process conducted by as much as 5 times a wide virtual detector tested. Thus the virtual detector width that is used in this tests is about 480, 240, 160, 120, and 96 pixels. Following are the results of the testing of the virtual width detector, as shown as in Figure 5.

![Figure 5](image)

**Figure 5.** (a) Original frame, (b) Results of the morphological operations, (c) Results of the virtual detector width 96 pixels.

| Virtual detector width testing |
|--------------------------------|
| Width of Virtual Detector | % Average Error |
| (pixel)           |               |
| 480               | 61.2          |
| 240               | 15.2          |
| 160               | 8.0           |
| 120               | 4.4           |
| 96                | 2.8           |

Based on Table 1, the average of the smallest error in virtual detector width 96 pixels obtained around 2.8%.

3.2. Slope Field Testing
This test aims to find out the slope of the field trials that yield the smallest error so on the accuracy testing using only one type of slpe field test course. The amount of the fish examined is 50. Testing process conducted by as much as 5 times each tilt of the field test. The slope of the field test to be tested is about 1°, 2°, 3°, 4°, and 5°.

| Slope field testing process |
|----------------------------|
| Tilt (°) | % Average Error |
|         |               |
| 1        | 5.6           |
| 2        | 8.0           |
| 3        | 12.8          |
| 4        | 18.0          |
| 5        | 16.4          |

Based on Table 2, the average error is obtained the smallest 0 test fields 1-degree slope, with an average error is 5.6%. The slope field is 1-degree which is used in accuracy testing.
3.3. Accuracy Testing

The accuracy testing comes to find out the accuracy of tool in calculating fish seeds, where based on the experiment that have been done the average calculation time takes 5 minutes for 500 fish seeds. This test done to know the tools accuracy in calculate the fish seeds. Based on the previous testing the tilt of the field and the width of virtual detector, used to perform the accuracy testing namely 1° and 96 pixel. Thus the amount of the fish which is used is as the statement follows : 100, 150, 200, 250, 300, 350, 400, 450, and 500 fish seeds. Table 3 perform the average value of error in accuracy testing.

The use of the virtual detection is not suitable if applied to the moving objects such as fish, because of the fish seeds is not stable, will make the calculation of fish seeds for twice or more. So if necessary, there is an additional methods. I.e the double difference methods, to prevent the calculation of the amount of the fish will be counted twice or more. Based on the experiment that has been done, the use of virtual detector with a width of 96 pixels is suitable on this research, because the average errors obtained its small, which is about 2.8 %.

After the virtual detector width is obtained, then the next step is to determine the rate of fish seeds that is suitable for use with the frame rate 25 frame/second. Because if the rate of the fish seeds pace quickly, then the camera is not able to calculate fish seeds that pass through the camera. So to determine the rate of fish seeds with how to set-up the slope of the field test. Based on an experiment that is conducted before, the uses of the slope in 1° does very well on this research, because the average error obtained small i.e 5.6%.

| Amount of Fish Seeds | % Average Error |
|----------------------|-----------------|
| 100                  | 3.2             |
| 150                  | 2.4             |
| 200                  | 1.1             |
| 250                  | 1.2             |
| 300                  | 1.0             |
| 350                  | 4.7             |
| 400                  | 3.5             |
| 450                  | 4.4             |
| 500                  | 4.5             |

Table 3. Accuracy testing with various fish amount

In order the accuracy of the tools were acknowledged, then the testing accuracy is performed. Testing is done using the amount of fish seeds which is 100, 150, 200,and 250. With the slope field 1° and the use of virtual detector with 96 pixels width. The results obtained are quite good on testing, with a number of 300 fish seeds, and an average error of 1.0 %

There is a lot of factors affect the value of the error in this research, include the presence of fish seeds pace that return to the field test, which causes bounding will break and binding again, so the calculation of the fish seeds will be counted twice. Besides due the two fish seeds attached one to another, it will account for only one fish seeds.

4. Conclusions

Based on the results that have been obtained as well as revisiting problems with constraints and objectives, then it can be formulates some conclusions obtained, namely:

- The automatically fish seeds counters and real time based image processing, hve successfully designed.
- Based on width testing of virtual detector, the best results are obtained on the use of virtual width detector 96 pixels with the value of the average errors of 2.8 %
• Based on the slope testing of the field tests, the average error is obtained the least on the slope of the field test in 1° with the average value of error of 5.6%
• Based on the accuracy testing, a tool that has been designed able to produce the smallest average value of error 1.0 % in 300 fish seeds.

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