Statistical_and_Spectral_Feature_Extraction_of_Oryzias_Celebensis_Heart_Rate.pdf

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Statistical and Spectral Feature Extraction of Oryzias Celebensis Heart Rate

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***Abstract*—Due to its unique characteristics, the heart rate of Oryzias Celebensis can play an important role in the observation of the health of the aquatic environment. Unfortunately, due to its tiny size, the process of scanning the heart rate of these fish fry requires sophisticated device engineering. The purpose of this study is to extract cardiac signal characteristics of Oryzias Celebensis seeds based on statistical and spectral aspects. We performed the extraction of statistical and spectral characteristics of heart rate using five statistical formulas namely mean, variance, standard deviation, skewness and kurtosis. As for spectral characteristic, we analyze the magnitude value of the discrete Fourier transformation from the color intensity that appear in the video view. The results of this study showed that statistical characteristic has much better result with 50% accuracy of pulse calculations while spectral characteristic that use fourier transformation only shows 0.2% accuracy.**

Keywords—Oryzias Celebensis, Heart rate, Video Processing, Feature Extraction

I. Introduction

The unique characteristics of Oryzias fish seeds have make this species own an advantages for the benefit of research and experimentation on the health of the aquatic environment. Aside from having a complete genome sequence, Oryzias also has a high fecundity, a transparent body, and is adaptive to various temperatures. That's why these fish are often used as a marker of the health of the surrounding environment. Healthy aquatic environment, characterized by the preservation of the state of health of these fish and vice versa [1].

One of the vital organ that indicate the health of fish seeds is heart rate. The heart pumps bloodstream in the body, pulsates in a certain range of values per minute. The range of its pulsation will depend on the state of health of the seeds which strongly connected with the situation of surrounding aquatic environment[2].

Unfortunately, due to its tiny size—approximately 2 millimeters long— the process of heart rate scanning of these fish seeds requires sophisticated device. This heart rate monitoring has been done by many researchers indeed. Heart rate can be observed by the installation of sensors inside the fish body [3][4], anesthesia [5], based on radar antennas [6] and non-boxed camera-based[7]. The calculation of the pulse is performed based on the calculation of the electrocardiogram signal and the extraction of the digital image signal which contains variations in the intensity of light when the pulsation occurs.

Observation of digital image signals in order to extract a feature mostly done using signals in the time or frequency domain. It is not uncommon that in its processing, the statistical analysis is also involved as a series of feature observations[8][9][10][11][12]. Spectral feature-based feature extraction typically uses frequency spectrum processing in signals [12] [13][14][15][16][17].

This study is focused on making observations to extract heart signals of Oryzias Celebensis seeds based on statistical and spectral aspects. The extraction is performed using 5 statistical characteristics: mean, variance, standard deviation, skewness and kurtosis. We observed spectral feature extraction using discrete fourier transformations to see the magnitude of the fourier coefficients of 256 color classes, ranging from white to black and the color classroom between the two.

II. Research Method

The study was conducted in several stages. We started by taking a video showing footage of the heart rate of Oryzias Celebensis seeds. The recording process uses a camera of Vivo 7 with Octa-core 1.8 GHz Cortex-A53 Qualcomm SDM450 Snapdragon 450 processor and 4 GB RAM. This smartphone is attached to the microscope and video has been enlarged 6 times and 40 times from microscope.

The video views of this recording are processed frame by frame. We only use the color intensity of pixels in the image to observe the characteristics of the heart rate. The color intensity of every pixel is taken and collected together to be extracted into characteristic of a pulsation. This extraction process use the provisions of statistical theory includes mean, variance, standard deviation, skewness and kurtosis.

The mean needs to be calculated because it can show the average texture surface of the object. The surface aspect can be strengthened by the distribution of data of variance in a data center indicated by the standard deviation value. The distribution of these data centers can also be shown in terms of membership based on skewness and kurtosis.

In addition to statistical features, we also extracted spectral features in each frame using the fourier transform as described by the equation (1).

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$$A_k = \sum_{m=0}^{n-1} a_m \exp\left\{-2\pi i \frac{mk}{n}\right\} \; ..... \qquad (1)$$

where,

A_k	=	Value of discrete fourier transformation
n	=	amount of data
a_m	=	m^{th} pixel
m	=	index of pixel
k	=	observation frequency

Based on this transformation, the image of the heart rate in the frame was studied from the point of view of the frequency of color intensity per pixel using the fourier transformation magnitude value of each pixel. The expectation is that with this magnitude value, when a pulsation occurs, there will be a distinctive pattern of the pulsation heart chambers based on the intensity of the overall frequency of pixel colors in the image in the frame.

Based on the characteristics that have been extracted, we mark the presence and absence of a pulsation that occurs. If there is a pulsation, then the statistical feature is represented in a different sign than when there is no pulsation. Simultaneously with this process, calculations of the accuracy and precision of pulsations are also carried out. The calculation of the pulse and matching of the representation of this pulsation mark is performed using hands and eyes without the help of a computer.

III. Results And Discussion

We have record this seed heart rate and taken a string of frames in size 240x240 pixels, as shown in figure 1. The area of the heart chambers appears on the pixels shrouded by a green box. The situation when the chambers that the heart is in a deflating state appear in figure 1.a, and vice versa in figure 1.b the chambers of the heart are in an expanding state.

These frames are initially loaded in the RGB color space, then converted into grayscale. Then, this grayscale image is calculated the statistical values of mean, variance, standard deviation, skewness and kurtosis for the overall intensity of the color that appears in the frame. This value calculation is applied to 300 frames in a recorded heart of the seed. The characteristics of the data, shown in figure 2.

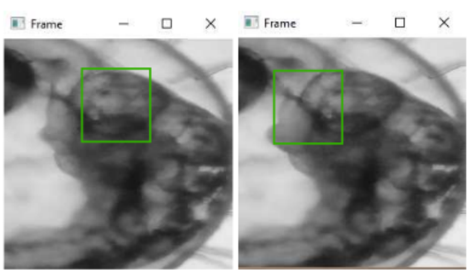


Fig. 1. Heart Chamber when (a) Deflated and (b) expand

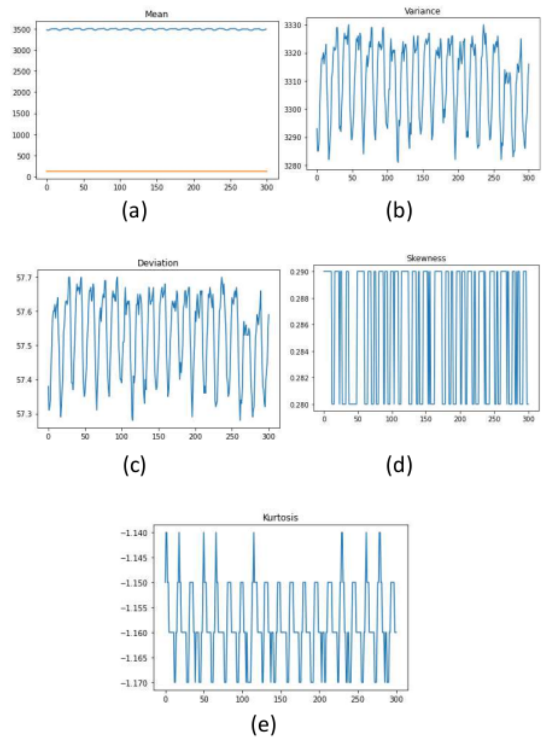


Fig. 2. Statistical data characteristic based on (a) Mean, (b) Varians, (c) Standar Deviasi, (d) Skewness dan (e) Kurtosis

Referring to figure 2, the dynamics of the color intensity values in the frame is wide-ranging. Variance values that show variations in intensity values along the frame strands is fluctuating. This condition also looks the same as the standard deviation, skewness and kurtosis values. However, it is the opposite with a mean value that tends to be flat/fixed. The mean value in the frame strand tends not to be able to indicate the movement of the object of the heart organ in the frame.

The movement of the heart chambers during the process of pumping blood in the pulsation record is strongly indicated by the presence of standard values of deviation, skewness and kurtosis, compared to the mean. Although the focus of the study was only on the chambers, but because the blood was also recorded moving, both are integrated into a single set of statistical characteristics that indicate the presence of chamber movements.

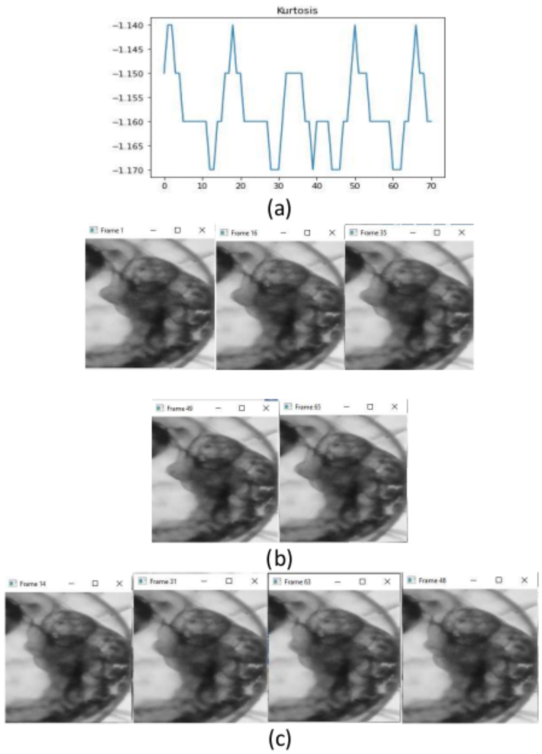


Fig. 3. The simultaneity between chamber pulsation and the formation of kurtosis peak shows by (a) Kurtosis graph with 5 peak when the chamber expand; (b) chamber expantion in frame 1, 16, 35, 49 and 65; (c) chamber deflation at 2-3 frame before the expansion in frame 1, 16, 35, 49, 65.

Intensity data in the frame that fluctuated is in line with the occurrence of pulsations when blood was flowed. Indications of the presence of pulsations arise clearly along with fluctuations in the value of kurtosis. Whenever the chamber expands, the kurtosis value forms the peak of its value graph, and begins to slowly form a slope as the heart chamber deflates. The simultaneity between the expanding chamber and the formation of graph peaks is not visible in other statistical characteristic: mean value, skewness, variance and standard deviation. An illustration of this incident appears in figure 3, which records the strings of frames number 1 through number 35. In this strand, there are 5 expansions of the heart chambers, which is accompanied by the generation of 5 peaks of kurtosis.

In the same strand, the variance value and the standard deviation show the formation of peaks similar to kurtosis. There are 5 peaks on the chart, just like what happens on the kurtosis chart. Thus, when viewed visually, variance and standard deviation seem to give the same response as kurtosis when expansion and deflation of chambers occur.

However, if you look at it in more detail, there are differences that need to be considered. By the time the peak of kurtosis begins to be maximum, it turns out that no peaks are formed at standard deviations and variances. Then, when the peak of kurtosis begins to fall, the standard deviation begins to prepare for the formation of the peak. This condition shows that standard deviations and variances are less dominant in indicating the presence of a heart. An illustration of the peak position in the kurtosis chart, standard deviation and variance in the frame strands related to this condition is shown in figure 4.

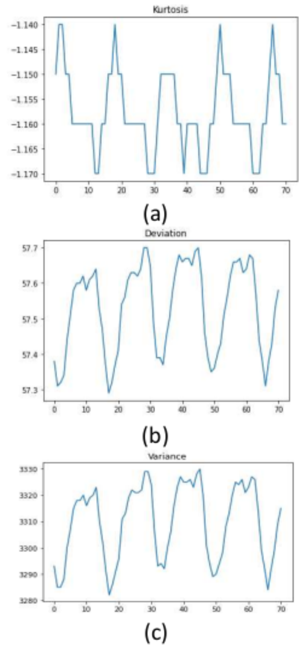
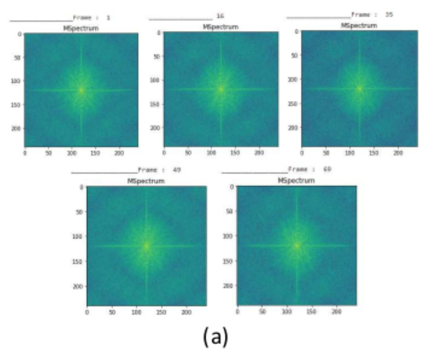
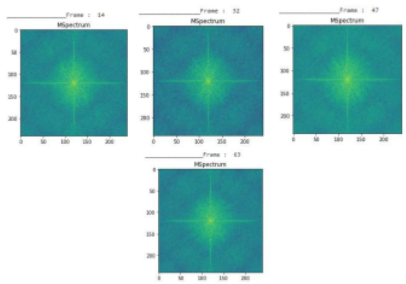


Fig. 4. The position of peak appearance in first 70 frame; (a) Kurtosis Graph, (b) Standar deviasi, dan (c) Variansi

When viewed from a spectral aspect, the presence of heart rate in the magnitude of the image frequency resulting from the fourier transformation has distinctive characteristics that are different from the statistical aspect. Based on the results of the fourier transformation, the variation in the magnitude in image pixels in frames 1, 16, 35, 49 and 65 appears to be variative. An illustration of the image resulting from this fourier transformation can be seen in figure 5.





(b)

Fig. 5. Image of heart rate based on Fourier Transform, (a) chamber expansion in frame 1, 16, 35, 49 and 65; (b) chamber deflation at 2-3 frame before the expansion in frame 1, 16, 35, 49, 65.

Based on figure 5, it can be seen that there is a variation in the diameter of the distribution of low-frequency intensity, which is described in light green areas in a blue circle. Although it varies, this tinge of color does not significantly give a distinctive difference in characteristics. At the time of expansion of the heart chambers and during their deflation, there is no difference in the diameter of the coverage area of the burst which can be used as a strong reference marker of the expansion or shrinkage of the heart chambers.

Based on the accuracy of the calculation of the pulse based on statistical and spectral characteristics, the results of the heart rate calculation are more accurate using statistical characteristics than the spectral characteristics based on the fourier transformation. Heart rate measurement using statistical characteristics using kurtosis as a reference for calculating the pulse for 4 video recordings of heart rate in this study showed an accuracy of 50%. Meanwhile, the accuracy of pulse calculations using spectral characteristics based on the magnitude of the light intensity frequency shows an accuracy of 0.2%.

The percentage of 50% using statistical features appears to decline when the footage appears dark and tends not to have a rough texture over the surface of the object in the image. Video views with a lot of pixel fluctuation activity tend to be more likely to evoke adequate kurtosis to signal a heart rate. The accuracy value using this kurtosis feature visually appears much better than the spectral feature using the fourier transformation, because it tends not to have a distinctive distribution pattern at the time of the deflation transition to the expansion of the heart chambers.

IV. CONCLUSION

This study has succeeded in showing the characteristic in statistical and spectral characteristics of Oryzias Celebensis heart rate. Statistical characteristics that can be used as pulse markers are standard deviation, variance and kurtosis. Of the three, kurtosis shows strong evidence that can be used as the main marker of a pulsation. On the other hand, the mean and skewnes have not found strong evidence to be used as a pulse characteristic. Same thing happen as the magnitude characteristic of the frequency of light intensity in pixels in the image resulting from the fourier transformation.

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