Estimated RV/TV Based on Empirical Mode Decomposition of Heart Sound

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Abstract—**In the poultry industry we have problems like Ascites and SDS (Sudden Death *Syndrome)* that they are dependent on weak vascular system. Analysis of the heart sounds could be a way to estimate the heart's strength. Estimating the heart strength with the RV/TV (ratio of the right ventricle weight to total heart weight) index, could help to diagnose chickens with low RV/TV in high genetic stocks (*Broiler Breeders*) and decline these problems in the next generations.**

In this paper, we applied the EMD method for decomposition of the chicken heart sounds to compare their RV/TV. We have chosen to use the global maxima of 5th IMF as extracted feature. The results presented a linear relationship between extracted features of the chicken heart sounds and RV/TV ratios.

Index Terms—**Broiler, ascites, heart sound, RV/TV, empirical mode decomposition (EMD), intrinsic mode function (IMF).**

I. Introduction

In the past few years, rapid development of poultry industry has caused problems like Ascites and SDS (Sudden Death Syndrome) [1]. One of these reasons is a weak vascular system. Ascites syndrome is a functional hypoxia caused by the high oxygen requirement of rapid growth and the inability of the heart and lungs to deliver sufficient oxygen to the tissues. The physiology of this syndrome has been studied extensively [2-4]. Estimating the heart strength with the RV/TV (ratio of the right ventricle weight to total heart weight) index [5], could help to diagnose chickens with low RV/TV in high genetic stocks (*Broiler Breeders*) and decline these problems in the next generations. Analysis of the heart's sound could be a way to estimate the heart's strength. This method could be the best practical way for estimating heart sound on-farm. Also aim study don't effect to growth broiler. Zhou *et al.* [6] report the Experimental method and they can detect right ventricular hypertrophy. But using this method impassible in long farm because ECG (Electrocardiogram) needs gel and steady birds for desirable results.

Time-scale methods like wavelet transform have been successfully used to analyze the heart sounds [7]. However, the main drawback of this method is that a mother wavelet has to be defined. Huang *et al.* [8] proposed Empirical mode decomposition (EMD), a novel signal decomposition method which in contrast to wavelet transform doesn't decompose the signal in terms of basic atoms like the mother wavelets. The essence of the method is to identify the intrinsic oscillatory modes by their characteristic time scales in the data empirically, and then decompose the data accordingly. Both EMD and wavelets decompose the signals into different frequency bandwidths. However, Empirical mode decomposition is data-driven ,adaptive and makes no assumptions about the input time-series. As a result of the sifting process, intrinsic mode functions (IMFs) are yielded . An IMF is a signal that satisfies two conditions: [1] in the whole time-series, the number of zero crossings and the number of extrema must either equal or differ at most by one; and [2] at any point in the time-series, the mean values of the envelopes are zero. The first condition is obvious; it is similar to the traditional narrow band requirements for a stationary Gaussian process. The second condition is a new idea; it modifies the classical global requirement to a local one; it is necessary so that the instantaneous frequency will not have the unwanted fluctuations induced by asymmetric wave forms [8]. Ideally, the requirement should be, the local mean of the data being zero. For non-stationary data, the local mean involves a local time scale, to compute the mean, which is impossible to define. The details of EMD method are described in [8]. In this work, we applied the EMD method for decomposition of the chicken heart sounds to compare their RV/TV.

II. Materials and Methods

A. Signal Acquisition

A total of 100 day old male broiler chicks (Ross 308) were contributed for the study. These chickens have relative (Billy) and chickens hatch in hatchery machine. Therefore, chickens have normal environment after hatch (uniform humidity and temperature). In a quiet place the heart sounds were recorded through a microphone placed into a stethoscope. Each record was 12 seconds in duration (sampled at 4 kHz sample rate, 32 bits/sample).

B. Estimation of RV/TV

After euthanizing of the birds by cervical dislocation, right and total ventricles was weighed. After estimating these two factors, normal heart strength is estimated by RV/TV. The chickens were assigned by RV/TV. They were also assigned by features after that the correlation of these two factors was

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estimated [9].

C. Signal Decomposition

After recording of the heart sounds, signals were decomposed using EMD method to their IMF. The process of applying EMD method for decomposition of x(t) is as follows:

(1): Splines are fitted to the upper extrema and the lower extrema of x (t).

(2): The average envelope of m is calculated as the average of upper and lower envelopes.

(3): A candidate IMF, h, is estimated as the difference between x and m.

(4): If h doesn't fulfill the criteria defining an IMF, it is assigned to the variable x and the steps (1)-(3) are repeated. Otherwise, if h is an IMF then the procedure moves to step (5).

(5): If h is an IMF it is saved as, where k is the k^{th} component. The result of applying this decomposition to a signal is shown in Fig. 1. We have chosen to use the global maxima of 5^{th} IMF as extracted features. The main reason for this selection is that they contain low frequency components of heart's sound, which related to heart beats.

III. Results and Discussion

The result of extracted features of the chicken heart sounds with respect to their RV/TV ratio and fitted regression line are plotted in Fig. 2. As shown in Fig. 2, the features linearly increase with RV/TV ratio. In the other words, larger right ventricular weights cause the increase of the features because larger muscles increase the power of heart sounds.

The heart of birds is different from mammals in LV is thick-walled and RV thin-walled. The right atrioventricular valve is also different and is composed of a muscle flap made up mainly of muscle fibers from the RV wall. The anatomy of this valve makes the bird very susceptible to valvular insufficiency [10-11]. The thin RV responds very rapidly to increased workload by dilation (stretch) and hypertrophy (response to stretch) [12]. When the RV wall hypertrophies the right atrioven-tricular valve also hypertrophies, leading to valvular insufficiency and RVF [10]. Genetic or congenital differences in the RV wall or valve may make some broilers even more susceptible to PH-induced RVF as suggested by structural and electrocardiographic studies [13]-[17].

Ascites mortality has the great variety (%3 to %6) [18]. For example, on the farm with 50000 chickens we have 1500 bird mortality for ascites in the minimum situation. This broiler mostly died after 3 or 4 weeks of breeding. One bird average food intake for 28 days is 2065 grams [19]. All feed intake for 1500 birds is 3097500 g. with early Identification by heart sound analysis, we can providence in Waste feed intake.

The results of this work show that using heart's sound, it is possible to rank the chickens by their RV/TV and with using this method there were wouldn't need to kill the birds. RV/TV in poultry is used for estimating heart's strength and is computable after killing the birds. In this study it has been tried to estimate the RV/TV index by using the heart sound. A larger RV/TV index shows that these birds have a larger right ventricle that causes increases their sensitivity to Ascites syndrome. Mortality caused by ascites syndrome is very variable. From high RV/TV to low RV/TV Calcification of susceptible chickens to these syndromes using heart's strength can help us to diagnose chickens sensitive to Ascites Syndrome and decline detriment in broiler stocks. Due to the fact that highest rate of mortality occur in high ages, therefore elimination chickens susceptible to this syndrome in low ages, will significantly decline the nutrition and management costs. Using heart power for selection in high genetic stocks like *Broiler Breeders*, could be a method for natural genetic selection against this syndrome.

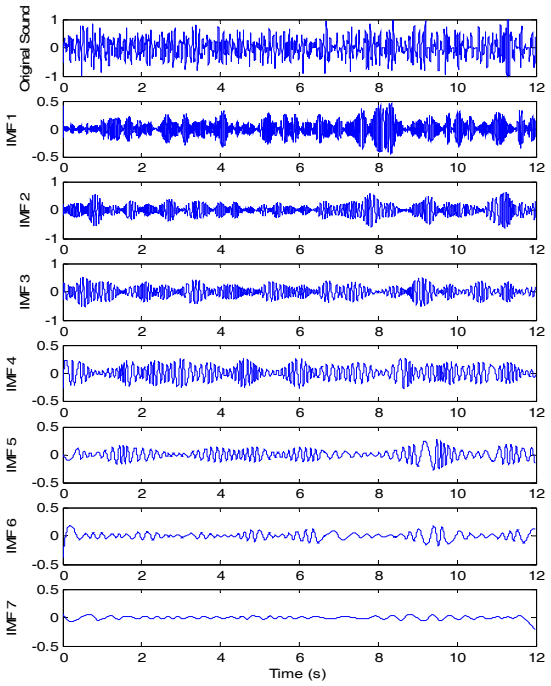

Fig. 1. An original heart sound signal and its constitutive intrinsic mode functions.

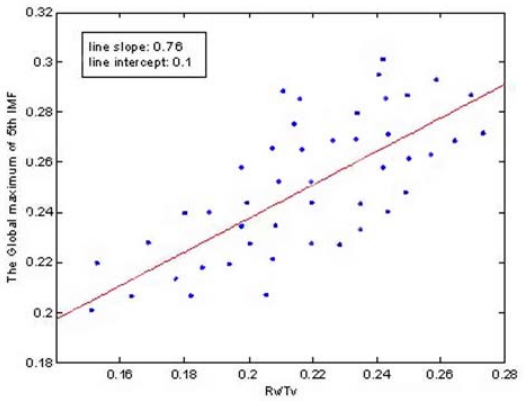

Fig. 2. Fitted regression line

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