Use of Artificial Intelligence to Identify Vocalizations Emitted by Sick and Healthy Piglets

N. Risi[1], K. O. Silva[1], P. R. F. Zulato[2], R.C. Guido[3], G. Borges[1]

[1] Animal Environment Research Nucleus, University of São Paulo, Brazil

[2] Electrical Engineering, University of São Paulo, Brazil

[3] São Carlos Physics Institute, University of São Paulo, Brazil

Abstract. *Pork consumption grows every day, and to serve this demand, swine farmers try to optimize their production by increasing the number of pigs without increasing the physical space that would be necessary to achieve welfare. However, increasing the quantity of pigs induces diseases in farms, making this an issue of great importance in swine rearing. Among many illnesses, the focus of the present work is about habitual problems in nursing piglets with traumatic arthritis. This disease has the characteristic to cause a great weakness in piglet locomotion. Breastfeeding piglets stop eating as a result of pain and present a great consequence for weight loss, reaching death. For that reason, the aim of this work was to evaluate the vocalization of healthy piglets and sick ones (affected by traumatic arthritis) through the use of expert systems, which are intended to find specific characteristics from a signal. In the experiment, 6 healthy piglets and 6 sick piglets were used, with ages between 10 and 15 days. A recording was made of each animal; however, each call has many screams. The acoustic behavior of the two treatments studied was different considering the visual aspect of the intensity noise. Evaluating these two conditions, the calls were compared to verify the presence of significant differences in the vocalization of sick and healthy animals.*

Keywords. *Swine, diseases, Bioacoustics, Precision livestock science, Animal*

Introduction

The term vocalization was defined by Grandin in 1998 like the generation of active sounds by specific structures, like larynx, which can also be defined as the most top of trachea (Gardner, Gray and O 'Rahilly, 1995). The vocalization issued by animals can express an inner state that can occur spontaneously or can be the result of an external event (Grandin, 1998), allowing make this form of expression an easy way to assess the animal welfare (Dawkins, 1998). The analysis of vocalization front of the pig's behavior can assist in the understanding of the depth of pain, stress and discomfort which animals can be submitted (Puppe et al., 2005). Similarly, some authors say that the crying of a child up to one month of life, which has not yet mastered the forms of communication, may reflect several psycho physiologic states such as hunger, suffering and pain (Wermek et al., 2002).

During the breastfeeding, in intensive system pig's production, occurs a high piglet's death rate, bean that for various causes, and among these, death by arthritis affects 6.44% of the dead piglets (Abrahão et al., 2004). The traumatic arthritis usually occurs in piglets because of the type of floor used in maternity. Studies aimed to assess the risk factors associated with the occurrence of arthritis could see that with the warehouses absence of lining provide a higher rate of arthritis in animals because of this apparatus is directly related to thermal quality offered to animals in the environment (Morés et al. 2003).

Once the animals born, a fragile skin cover your joints, which when in contact with a abrasive floor can cause eruptions, forming a port of entry for microorganisms, thereby, compromising the articulation of animals (Sobestiansky et al., 1999). However, few studies have been able to verify that the vast majority of the pig's joints with arthritis are aseptic, showing injuries not characterize an infectious (Turner et al., 1991).

By this time, most studies related to pig's vocalization, only use measure conditions of welfare and behavior of animals (Manteuffel, Puppe and Schön, 2004), few studies objective to relate the vocalization with animal diseases that may be affecting them. However, from the pathological view, some researchers concerned themselves to interpret the swine cough to distinguish it from other sound effects, trying to develop an intelligent system through artificial neural networks, capable of holding early identification of respiratory diseases that may be affecting the rearing pig (Chedad et al., 2001; Moshou et al., 2001).

The tools used for sound analysis, departed from sonograms, however, the processing of digital signals by using Fourier transformed (Cooley and Tukey, 1965) has a better interpretation of the data. From this, the analysis of the calls of animals could have also in the processing of signals from numerical descriptions and statistical analysis (Hopp et al., 1997). Working with functions able to decompose other functions that are in the field of time for the field of frequency, it is processed task performed by the Wavelet. These functions have advantages as the ability to return the frequencies in the original function as well as where they are located such frequencies, which does not occur in Fourier, for example, that only returns frequencies, but not their position in the original function (Graps, 1995).

Material and Methods

The experiment was conducted in a commercial swine production farm, located in Elias Fausto city, in the State of São Paulo.

Animals from the Study.

For carrying out this experiment, 12 piglets were used (Large White X Landrace) being breastfeeding, of both sexes, with ages ranging between 10 and 15 days of life. The animals were chosen from clinical evaluation prepared by a veterinarian, selecting by this way, sick and health animals. So were selected 6 sick and 6 healthy animals.

The animals were kept in pen farrowing with their mothers and other animals of the litter, with free access to creep area.

The sick animals showed clinical signs similar, like difficulty moving around, limping, increased size and temperature in one or more joints of the limbs, systemic temperature increased, prostration and wounds in the skin that cover the articulation. Unlike this, the animals classified as healthy showed no clinical signs of these.

Sound Collection.

The sound emitted by animals was collected by a directive digital recorder Panasonic® RR-US395, which was positioned at a distance of about 15 cm from the animal's mouth. The sounds were recorded with a sampling rate of 22050 Hz and resolution of 16 bits.

Pigs that had arthritis were held by their bodies. The sounds emitted or vocalized from the pigs were recorded. Holding and touching the pig's body acted as a stimulus for vocalizations. After recording the vocalizations, the pig was marked with a non-toxic paint for later identification and was placed with the rest of the litter. The 6 piglets without clinical signs of arthritis also had their vocalizations recorded using this same procedure. Several sequential cries or screams were recorded for each of the 12 piglets.

Separation of Sounds.

Sound tracks that were collected in the field contained several pig screams. These sound tracks were transferred from the digital recorder to the computer for analysis. The various screams in each track were extracted so that each individual scream could be analyzed. The Audacity 1.3 Beta software was used to separate the screams and analyze each individual scream. A total of 570 individual screams were analyzed; 295 were from sick piglets and 275 were from healthy piglets. Some screams from both sick and healthy piglets were randomly selected to train the Artificial Neural Network. The rest of these collected screams were used to test the network.

Sound Analysis.

From samples gross (screams) concerning signs of audio captured, a vector of energy was created based in the 23 bands criticism of the human ear. The conversion of the sound signals in numbers was made by Discrete Wavelets Transform of the input signal, drawing it the following parameters:

I-23 values of energy, each corresponding to a sub-band criticism;

II- 22 values of the derivatives of discrete energies previous

The union of these values gives us the opportunity to know the 45 points available within each sample. The aim of this phase is to process a sample of sound, or load the file in the sequence of audio and proceed with mathematical logic enough to change the behavior of the original signal.

Artificial Neural Networks.

The 45 previously calculated values of each call, were sent to an artificial neural network type Radial Basis Function (RBF - Radial Basis Function; Guido, 2007), developed by researchers from the physics institute of the University of São Paulo (USP) in São Carlos city, which makes the interpretation of results obtained in the previous step to recognize the pattern's vocalization. The information of 248 cries of sick animals and 237 cries of healthy animals were sent to neural network, trying to make it able to recognize patterns of a sound whatsoever. Once trained, were passed by the Network, to test the sounds and verify the absence of similarities between the screams in the two different situations, 47 cries of animals patients and 38 healthy cries of animals and they will not entered the training of the same, order to verify the efficiency of training and recognition of standards.

Results and Discussion

For some sounds the network returned a satisfactory result, clearly recognizing patterns. But in some other sounds the network had some difficulties of recognition, yielding results beyond the expected, which may have occurred by a lack of training or examples of the standards may be coming, which would impede the work of the network.

In the case of sick animals, the network was able to recognize 21 screams on 47 attempts, giving a rate of 44.68% for hits. During the interpretation of the healthy animals, the network was able to recognize 15 screams on 38 attempts, giving a rate of 39.47% for hits. In general, we evaluated that the use of the network had an efficiency of 42.35%.

A clearly way to distinguish the sound emitted by the two different kind of treatments is to use the same software that was used to separate the sound of the track sound that was collected in the field. The Figure 1 and 2 shows, respectively, the visual relationship from a scream emitted by a healthy animal and a sick animal.

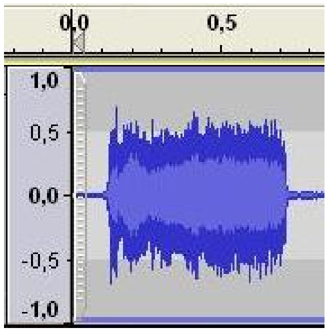

Figure 1. Sound spectrum by a healthy animal.

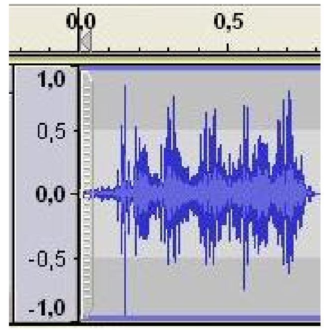

Figure 2. Sound spectrum by a sick animal.

The training of an artificial neural network is very sensitive and susceptible to errors of standards interpretation. So it will require the separation of more "screams" of new sound files, in order to have a wider range of examples to the network recognize between these patterns of a more elaborate and precise way. Another point that should be taken into consideration on this occasion is the adjustment of the transform coefficients, thereby generating greater accuracy of the data.

Conclusions

The network test has not responded so excellent to identify different cries, but this does not exclude the veracity of the percentage obtained from the existence of differences among the calls issued by sick animals and healthy animals.

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