Review of Pig Anomaly Recognition Based on Audio Analysis

Xiaoping Gu[1, 2, a], Hao Wu[1, 2,*], Xiaotao Hu[1, 2, c], Jiahao Chen[1, 2, d], Hong Song[1, 2, e]

[1]Artificial Intelligence Key Laboratory of Sichuan Province, Automation and Information Engineering, Sichuan University of Science & Engineering, Zigong, 643000, China;

[2]Enterprise informatization and Internet of things measurement and control technology key laboratory, Zigong, 643000, China.

[a]gxp_will@163.com, [b]wuhao801212@163.com, [c]ray_scqhg@163.com, [d]1309087496@qq.com [e]3452974910@qq.com.

Abstract

The application of voice recognition technology based on audio analysis in the breeding industry is currently a research hotspot. With the development of science and technology, more and more new technologies are applied to the pig breeding process, thereby promoting the transformation of pig breeding methods and voice recognition. The technology is widely used in security systems, with high recognition accuracy, no contact, and strong objectivity. Pig abnormal sound monitoring and recognition includes pig sound extraction, preprocessing, feature extraction, and status recognition. This article starts from the above four aspects. This article introduces the research development status of pig abnormal sound recognition in recent years and the current challenges in this research direction, and makes a brief summary.

Keywords

Audio analysis, Artificial intelligence, Voice recognition, Pig herd.

1. Introduction

Agriculture is the basic industry of a country and the foundation of a country. As one of the core industries of agricultural production, livestock and poultry farming plays a vital role in the daily production and life of the people. As the world's largest pig breeding country, China's pig production volume in 2018 reached 694 million heads, and the scale of China's pig industry was about 1.4 trillion yuan, which contributed more than 2% to China's GDP. China is both a big producer and a big pig consumer. Although China is in the forefront of the world in terms of pork production and consumption, China still has a considerable gap in pig breeding methods and management modes compared with countries in the world with advanced breeding industries.

With the increasing demand of modern humans for meat food, the scale and intensification of modern aquaculture is getting higher and higher. Although there have been great changes in the scale and methods of breeding, as China's pig industry is still in the development stage, there are still many problems. First, the expansion of the breeding scale has led to an increase in feeding density, intensive feeding methods have also caused changes in pigs' living habits, and related pig infectious diseases have become more easily transmitted [1]. Secondly, the daily observation of pigs is more difficult to achieve. Traditional manual observations have serious shortcomings, accuracy and real-time performance are poor, and it takes time and effort. The frequent occurrence of epidemic diseases caused the meat quality problem of farms to decrease, which hindered the development of China's aquaculture industry. Therefore, it is very important to detect and identify abnormal pigs in a timely manner, and it is also an important prerequisite to improve the economic benefits of breeding and avoid losses.

Studies have shown that pigs make unusual sounds, such as coughing, when they are abnormal. Like humans, pig cough is also an uncomfortable symptom of the body. One of the conditions is that when foreign bodies or irritating gases irritate the respiratory sensors, they can cause cough in pigs. For example, when pigs eat feed, feed enters the pig's respiratory tract, and pigs often exclude foreign

bodies through their own cough. But coughing too often may have a deleterious effect on the pig's body and even affect its breathing. In addition, when pigs suffer from respiratory diseases such as cold, pneumonia, rhinitis and asthma, they often show symptoms of cough. Monitoring pigs by sound can simplify the work of breeders and save a lot of labor costs. It is conducive to promoting the large-scale development of modern breeding industry and the establishment of a scientific modern management system. The level of automation and intelligence is of great practical significance.

2. Abnormal sound recognition of pig

Jonguk Lee et al [2] proposed a feature parameter collection method to detect pig wasting diseases. Different models were used for testing in experiments. The results show that the proposed feature parameter collection method is not limited to specific Classification model. Yongwha Chung et al [3] proposed an effective data mining solution for the automatic detection of pig consumable diseases. The method automatically detects and identifies pig consumable diseases. This method automatically collects sound signals and extracts Mel data from sound data. The cepstrum coefficients and the secondary classification structure composed of support vector data field descriptions and sparse representation classifiers are used as early anomaly detectors and respiratory disease classifiers. Experimental results show that the method is effective in terms of economy and practicability. The main work of Sara Ferrari et al [4] was to describe the acoustic characteristics of cough sounds in pigs with lung infections, and to compare the difference between such cough sounds and cough sounds stimulated by inhalation of citric acid. M. Guarino et al [5] recorded the cough sounds of 44 different types of pigs. These pigs belong to the same period and are of equal weight. Feature vectors are extracted from these sound files. Compare and then classify the sound file to get cough and other sounds.

Ma Huidong [6] and others used a 150-order FIR filter band-pass filter with a frequency range of 300 ~ 8000Hz to denoise the original signal, and applied the endpoint detection method to the detection of pig cough sound. The endpoint detection method for pig cough sounds improves the detection efficiency of pig cough sounds, and is conducive to the recognition of late pig cough sounds.

Zhang Zhenhua [7] studied three kinds of noise reduction methods: spectral subtraction noise reduction, wavelet threshold noise reduction method and adaptive filter cancellation method, and used the signal-to-noise ratio of the sound signal as the evaluation standard. Signal noise reduction processing, while analyzing the acoustic characteristics of pig cough sound, extracting feature parameters of it, and using hidden Markov model to realize pig cough sound recognition. The pig cough is pre-processed through pre-emphasis, framed windowing, and endpoint detection. Then, feature parameters are extracted from the sound signal of each frame, and the hidden parameter Markov model is input as the observations of the feature parameter sequence. Initialization; Finally, the initial model is trained by Welch-Baum algorithm, and the trained model is used to recognize pig cough sounds by Viterbi algorithm. Among the characteristic parameters, the commonly used linear prediction cepstrum coefficients, Mel cepstrum coefficients, and their first-order differences are selected. The experimental results show that the hidden Markov model can complete the recognition of pig cough, and the recognition rate is the highest when the Mel cepstrum coefficient and its first-order difference are used as feature parameters. The pigs are analyzed from the time domain, frequency domain, and transform domain, respectively. Cough, fighting, hungry, and twitching sounds of four pigs, compare their characteristics and differences.

Gong Yongjie [8] researched the pig cough sound recognition technology based on sound recognition technology, collected the pig sound signals in the actual pigsty, manually labeled and classified the samples by software, and applied the short-term zero-crossing rate and short-term energy to set double threshold Endpoint detection accurately locates the starting point of pig sound samples. Based on improved MFCC and short-term energy fusion feature parameters, VQ, SVM, and HMM pig cough sound recognition models are constructed.

Li Yi [9] and others proposed a method for identifying pig cough based on deep belief network (DBN) based on monitoring of pig cough for disease early warning. Taking the sounds of cough, sneezing, eating, screaming, humming, and flicking ears of Changbai pig as research objects, the multi-window spectrum-based psychoacoustic speech enhancement algorithm and single-parameter dual-threshold endpoint detection were used to pre-process the pig's sound to achieve De-noise and effective signal detection of pig sound signals. Based on the time warping algorithm, the short-term energy characteristics and Mel frequency cepstrum coefficient feature parameters of pig sounds are extracted. The deep belief network is used to identify pig cough sounds, and after principal component analysis After the dimensionality reduction, the recognition effect is improved.

Han Leilei [10] designed a pig abnormal sound monitoring system using voice recognition technology to monitor pig horror and cough online, using the single classification detection capability of the SVDD model, and constructing a suitable multi-classifier for the SVM model. The SVDD and SVM detection and recognition models were obtained. The model was used to detect and identify abnormal sound signals of pigs in the piggery, and the signal was reduced by improved spectral subtraction. The endpoint position of the sound signal is determined, and the Hamming window is selected as the window function at the time of framing, and then the characteristic parameters are extracted for recognition, and finally the health status of the pig is judged based on the recognition results over a period of time.

Li Yu [11] et al Aimed at the existing cough sound recognition of pigs based on isolated word recognition technology, which had limited types of recognition sounds and could not reflect the continuous cough of actual diseased pigs. This paper proposed a two-way long-term and short-term memory network-connection sequence A classification model is used to construct a pig acoustic model, which is used to identify continuous cough sounds in pig farm environments, so as to provide early warning and judgment of pigs' early respiratory diseases.

Zhang Qiming [12] and others designed a speech recognition method based on support vector machine (SVM). First, the end point detection of short-time zero-crossing rate and short-term energy was used to determine the start and end points of sound signals in different states of pigs. Then extract the Mel frequency cepstrum coefficient of the sound information as the feature parameter, use SVM algorithm to train, establish the classification model of the sound, and finally identify the different states of the pigs being crushed, pigs fighting, pig hungry, pig food, and pig cough.

Liu Zhenyu et al [13] proposed a pig cough sound recognition scheme based on Hidden Markov Model (HMM) for the difficulty in detecting pigs suffering from respiratory or lung diseases. VQ-quantified voice recognition can efficiently use the quantification of voice personality characteristics. The codebook describes the distribution center of the characteristics of each frame in the feature space; HMM sound recognition can describe the dynamic characteristics of the sound signal, and can also describe the statistical step-by-step of the personality characteristics of the sound, combining VQ quantification with HMM recognition To identify pig cough.

Li Boyu et al [14] studied the vocal recognition of piglets in noisy situations, humming for piglets when they were hungry, and two types of background noise: predatory screaming noise and mechanical feeding noise. These three sound characteristics are analyzed through time domain, power spectral density (PSD), and so on. Classification is performed by extracting Mel Cepstrum Coefficients (MFCC) and using vector quantization (VQ). Aiming at the sound recognition mixed with background noise, a recognition method based on VQ-PSD is proposed.

Zhang Sunan et al [15] performed double-threshold endpoint detection and pre-emphasis on sound signals in different states of pigs, and then performed de-noising processing on sound signals by wavelet threshold method through a large number of experimental comparisons to extract Mel frequency cepstrum coefficients MFCC) and its first-order difference are used as characteristic parameters, and then the HMM is used to recognize the sound signals of the pigs to realize the sound monitoring of the pigs in 8 different states.

Xu Yani et al [16] used the cough sound of Meishan sows as the research object, collected and transmitted the sow's sound signals using wireless communication technology, and then pre-processed the collected sound signals, including designing a 5th order The Butterworth low-pass filter implements filter denoising. The overlapped segmentation method is used to frame the filtered sound signal. The double-threshold algorithm based on short-term average energy and short-term average zero-crossing rate is used to sample the signal. Endpoint detection, according to the fluctuation of the power spectral density curve of different sound signals, and then extract the power spectral density feature of the sound signal, and use this feature as the clustering center. An improved fuzzy C-means clustering algorithm is proposed. Clustering to achieve clustering of lines and classification and recognition of cough and scream.

Yan Li et al [17] took the common sounds of lactating Xiaomeishan sows as research objects, and used filter and wavelet threshold denoising to remove environmental noise. The log energy entropy quadratic wavelet packet denoising method can effectively remove the piglet tip. Residual environmental noise such as vocalization and pink noise, white noise, etc., to achieve the lowest possible source sound loss. Using the power ratio as the feature vector, more detailed energy calculations are performed in the frequency domain. Insignificant subbands, reduce the number of feature vectors, and use support vector machines as sound classifiers to monitor the health of sows during lactation in real time.

In order to filter out low frequency noise, Dong Hongsong [18] and others proposed an enhancement method based on the pig cough sound signal. The pig cough sound signal and the fan noise signal were collected separately, and the two signals were analyzed and processed using MATLAB (2016a) to obtain their Time-frequency domain characteristics. Secondly, an enhanced algorithm based on discrete cosine transform (DCT) is used to process the cough sound signal of noisy pigs. At the same time, the enhanced method based on empirical mode decomposition (EMD) and wavelet packet transform (WPT) and the enhanced algorithm of DCT are removed The effect of fan noise is compared, and the DCT enhancement method has better denoising effect.

3. Challenges

Multiple pigs often make simultaneous sounds in the piggery, and the sound signals of the pigs are prone to aliasing. Processing of the aliased pig sound signals is a problem. It is a challenge how to perform signal separation, feature parameter extraction and signal separation after aliasing on live pig sound signals.

As the pig's age increases, its sound signal will also change accordingly, so it will definitely affect the accuracy of the pig's sound signal recognition. During the entire life cycle from pig birth to death, the characteristics of pig sound signals at different periods are studied and analyzed in order to find out the rules of pig sound signals changing with age.

Whether it is pig cough sound recognition or abnormal pig sound recognition, the pig sound signals used by previous people are collected in a single piggery on the farm. How to ensure the recognition rate while expanding the monitoring range and improving the application efficiency of monitoring equipment will be a difficult problem.

4. Conclusion

With the advancement of science and technology and the development of the Internet, more and more new technologies are applied to livestock and poultry breeding, which has injected new vitality into the livestock and poultry breeding industry. In the process of realizing the automation and intelligence of livestock and poultry, voice recognition technology has received more and more attention. The better application of voice recognition technology to the livestock and poultry breeding industry will become one of the main research directions for achieving automated and intelligent breeding. Audio analysis refers to analyzing audio signals of different health levels or different states, obtaining characteristic parameters and establishing a template, and then matching the audio signals collected

by the farm with a template library to finally obtain the status or health of the individual livestock Happening. Using audio monitoring technology to realize real-time monitoring of the health status of pigs, timely detection of ill pigs, control of disease spread, improvement of breeding economic benefits, and realization of welfare and precision breeding.

Acknowledgements

The research was supported by the Artificial Intelligence Key Laboratory of Sichuan Province (Grant No.2019RYY01) and Enterprise informatization and Internet of things measurement and control technology key laboratory project of Sichuan provincial university (Grant No.2018WZY01).

References

[1] Wu Wenbo. Accelerating the transformation and upgrading of the pig breeding industry and promoting the sustainable and healthy orderly development of pig production, 2016 (9): 20-21.

[2] Lee J, Jin L, Park D, et al. Acoustic features for pig wasting disease detection [J]. Internal Journal of Information Processing and Management, 2015, 6 (1): 37-46.

[3] Yongwha C, Seunggeun O, Jonguk L, et al. Automatic Detection and Recognition of Pig Wasting Diseases Using Sound Data in Audio Surveillance Systems [J]. Sensors, 2008, 13 (10): 12929-12942.

[4] Ferrari S, Silva M, Guarino M, et al. Cough sound analysis to identify respiratory infection in pigs [J]. Computers & Electronics in Agriculture, 2008, 64 (2): 318-325.

[5] Guarino M, Jans P, Costa A, et al. Field test of algorithm for automatic cough detection in pig house [J]. Computers & Electronics in Agriculture, 2013, 62 (1): 22-28.

[6] Ma Huidong, Liu Zhenyu. Application of Speech Endpoint Detection Algorithm in Pig Cough Detection [J]. Journal of Shanxi Agricultural University (Natural Science Edition), 2016, 36 (6): 445-449.

[7] Zhang Zhenhua. Pig abnormality detection based on audio analysis technology [D]. Taiyuan University of Technology, 2017.

[8] Gong Yongjie. Research on pig cough sound recognition method based on voice recognition technology [D]. Huazhong Agricultural University, 2015.

[9] Li Yi, Zhao Jian, Gao Yun, et al. Pig cough sound recognition based on deep belief network [J]. Journal of the Chinese Society of Agricultural Machinery, 2018, 49 (3): 179-186.

[10] Han Leilei. Department of abnormal pig sound recognition and monitoring based on support vector machine [D]. Taiyuan University of Technology, 2019.

[11] Li Yan, Zhao Jian, Gao Yun, et al. Continuous cough sound recognition of pigs based on continuous speech recognition technology [J]. Journal of Agricultural Engineering, 2019, 35 (06): 182-188.

[12] Zhang Qiming, Yuan Ruilin, Fan Fan, et al. Research on pig sound recognition based on SVM algorithm [J]. Computer Knowledge and Technology, 2017, 13 (10): 162-164.

[13] Liu Zhenyu, He Xiaoyan, Sang Jing, et al. Research on Pig Cough Sound Recognition Based on Hidden Markov Model [C]. Academic Seminar of Information Technology Branch of Chinese Animal Husbandry and Veterinary Society. 2015: 6.

[14] Li Boyu, Zhao Cuilian, Wu Jiawei, et al. Identification of vocal signals for piglets in noisy environment [J]. Electroacoustic Technology, 40 (7): 44-49.

[15] Zhang Sunan, Wang Fang, Yan Gaowei, et al. Automatic pig state recognition technology based on hidden Markov model [J]. Heilongjiang Animal Science and Veterinary Medicine, 2016 (21): 97-99.

[16] Xu Yani, Shen Mingxia, Yan Li, et al. Research on cough sound recognition algorithm of Meishan sow in labor [J]. Journal of Nanjing Agricultural University, 2016, 39 (4): 681-687.

[17] Yan Li, Shao Qing, Wu Xiaomei, et al. Sound feature extraction and classification recognition of lactating sows based on skewness clustering [J] .Transactions of the Chinese Society of Agricultural Machinery, 2016, 47 (5): 300-306.

[18] Dong Hongsong, Liu Zhenyu, Ma Huidong, et al. Application of speech enhancement in removing pig cough noise [J]. Journal of Shanxi Agricultural University (Natural Science Edition), 2017, 37 (11): 831-836.