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Popular Article

Use of artificial intelligence in precision farming

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Abstract

Artificial Intelligence (AI) is one such technology which needs immediate implementation in the livestock industry. AI has emerged as a tool that empowers farmers in monitoring, forecasting, optimizing the farm animal growth, tackling parasites, bio-security, and diseases, monitoring farm animal along with farm management are some of the thrust areas in livestock industry where the use of AI technology can pay rich dividends. Artificial Intelligence will help livestock farms accumulate and analyse data to accurately predict consumer behaviour, like buying patterns, leading trends, etc. With increased investments, farms will be enabled to automate processes, reduce major costs and improve the quality of livestock products. Traditional identification of animals based on morphometric spots, ear notch, ear tag, branding and tattoo have serious drawbacks on the part of readability, loss, tampering and other animal welfare issues which can be addresses by biometry-based identification system. The present study of this paper is to review various intelligence applications-based identification of animals and their pros and cons.

Key words: Artificial intelligence, precision farming, Behaviour detection, Sustainable production.

1. Introduction:

In the intensive animal farming, Artificial Intelligence (AI) is an emerging technology takes importance role on supporting a smart farming in the field of animal health and welfare enhancement, so as to achieve good economic benefit. Identification of animals is of immense importance in scientific and profitable animal husbandry practice. Individual animal identification not only allows producers to keep records of animal's parentage, birth, production records, health history but also useful for precision farming system and implementation of different government plans and policies. To improve the efficiency and sustainability of livestock farming, new technologies such as smart sensors, internet of things (IoT) and artificial intelligence (AI) have been gradually used in the livestock industry. Precision livestock farming (PLF) technology enables the management of livestock herds using technologies such as AI and IoT. The PLF combines sensors and devices with intelligent

software to extract key farming information and then provides management strategies that enable famers to monitor animals automatically to improve animal health, welfare, yields and environmental impacts. In the framework of PLF, sensors (e.g., microphones, cameras) are used to monitor the animal appearance prototypes and then utilize engineering techniques to automatically recognize animal behaviour or growth situation for the final decision-making of livestock farming. In the modern smart livestock industry, PLF is becoming increasingly important because it is difficult to achieve intensive agriculture and single animal care without the help of technology

2. Precision farming

Precision farming aims to improve the ability of farmers to manage large livestock herds and enhance the effective monitoring and management of each livestock health and welfare.

Precision pig farming uses technologies such as IoT and AI to continuously monitor animal health and welfare with the following main functions:

i) The IoT is mainly used in the design and layout of temperature, humidity and other sensors, as well as associated networking equipment and data collection. The industrial Internet is mainly used to transmit the data to the server, AI and cloud computing are mainly applied to feature extraction, data analysis, modelling and decision-making.

ii) The intelligent analysis system transforms the data of animal response characteristics measured by cameras and microphones into key indicator information and analyzes them through AI and machine learning methods for the final decision of animal management.

iii) Optimize the production process to avoid over-feeding, reduce farming waste and costs and make livestock farming more sustainable in economic, social and environmental aspects.

3. Identification of animals:

3.1 Facial Recognition:

Animal identification such as ear clips, ear notches, ear tags, microchips, electronic identification devices (EID), and numbers on pig skin labelling or marking has been carried out. EID-based radio frequency identifiers (RFID) are common for pig identification. RFID is an advanced version of numbered ear tags; passive electronic tags consist of a radio frequency identifier (RFID) that transmits a signal to a reader via a microchip and a coiled copper antenna. Low frequency (LF: 125 kHz or 134.2 kHz), high frequency (HF: 13.56 MHz) and ultra-high frequency (UHF: 860-960 MHz) are the three main frequency ranges for RFID systems. Although RFID has advantages such as simple mechanism, low cost, and reliable correlation for identifying objects, it is not suitable for pig identification due to the following characteristics.

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a) **Readability**: Most of the methods have a problem of readability as the identification marks remain invisible due to distance from object, growth of hair on the marking area, soiling, wear and tear, breakage of the tag and pigmentation.
b) **Range**: RFID has a limited range (even long-range readers state a maximum distance of 120 cm) at which the tags can be activated and read successfully. In addition, multiple tags cannot be read concurrently; therefore, the data may not be reliable since pigs are playful and bunch together.
c) **Welfare**: The methods of identification have serious concern over animal welfare issue. Poor application could result in infection or mild sepsis. In addition, many common marking procedures also involve tissue damage and therefore cause pain, such as branding (heat, cold or chemicals), tattooing, toe clipping, ear notching and tagging.
d) Loss: Tags may be lost due to ear tearing during fighting or playing. This is possible since the pig barn has metal objects; in addition, pigs are playful with plastic objects.

3.2 Live weight estimation:

Liveweight is used to assess the health and developmental performance of livestock. Liveweight monitoring is an indicator for assessing reproductive quality and growth rate, reproductive time, feed conversion efficiency, and disease incidence, as well as due to feeding uncertainty.

3.3 Individual identification:

Individual identification enables the farm managers to treat animals as individually tailored diets and environmental control for an optimal productivity. Behavioural identification, which includes aggression, posture, and locomotion thus, it is necessary to have an accurate method of identifying individual pigs. Initially ear tags and RFID technology are commonly used for individual identification of pigs, ruminants and poultry. Camera-based computer vision techniques have proven to be a more promising solution for identifying a pig.

3.4 Behavior monitoring:

Animal behavior is constantly monitored using cameras, microphones and accelerometers to ensure animal health and welfare. To monitor pig behavior, the eYeNamic system has been used to monitor pig behavior in both pig and poultry farming.

3.4.1 Feeding behaviours

Among most behaviors, the feeding behavior of an individual animal is an important indicator reflecting its health status. Water meters provide accurate information about water usage and are considered a simple and effective way to monitor drinking performance. We automatically

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monitored the individual eating and drinking behavior of pigs and ruminants using RFID tags, video surveillance, or video recorders.

3.4.2 Aggressive behaviours

Pigs tend to exhibit aggressive behavior in closed and intensive housing systems. Aggressive behavior in pigs causes problems such as uneven feed distribution, skin damage and wound infection, leading to poor welfare and economic loss in pigs. Therefore, there is a lot of interest in using computer vision and AI technology to detect aggressive behavior in pigs. Traditional machine learning models based on feature extraction have problems such as too few feature types, complex artificial feature selection, and weak generalization ability.

3.5 Live weight estimation:

Live weight is used for assessing the health condition and growth performances of farm animals. Traditionally, the live weight was measured by pass-over scale. To avoid injury and stress caused by the direct weighing, non-contact weighing methods using cameras of RGB, depth or binocular for pig size or volume calculation based on images have increased.

3.6. Health monitoring and detection:

In the process of pig farming, in addition to vision for monitoring abnormal pig behaviors, sound is also the most obvious external manifestation for pig diseases. Pig's coughing sounds could be used as a feature to identify pig respiratory diseases. For monitoring and recognition of pig coughs and estrus sounds, data pre-processing and sound recognition models are two important aspects. Sound recognition models such as support vector machine model, decision tree, double threshold algorithm, dynamic time warping, the sparse representation classifier and fuzzy c-means clustering also play an important role in the recognition of pig cough sounds.

4. Challenges and future research needs:

The images or impression of animal biometric have to be collected in a stable and controlled environment. Different external effect like intensity of light, movement of animal, behaviour of animal in front of camera are different environmental factors which can affect the quality of image In the past few years, some technologies for data collecting and processing, modelling algorithms and tools have been developed and integrated for assessing animal health and welfare states. In modern farming, temperature sensors, weight sensors and RFID sensors are used to obtain data about the pigsty environment or pig, and 2D and 3D cameras are used to obtain data about the pigs.

5. Conclusions:

According to the literature review, this paper systematically summarizes the current research progress of the main sensor devices used in pig farming and the AI-based vision and sound for

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detection and tracking, behavior, etc. In modern farming, temperature sensors, weight sensors and RFID sensors are used to obtain data about the pigsty environment or pig. On this basis, combined with AI techniques, the deep learning algorithms for pig detection and tracking, pig drinking, aggression, and other behaviors are expounded. In addition, the deep learning algorithm for recognizing respiratory diseases through pig sound is described. Much has been achieved so far in the real-time monitoring of pigs, but further improvements to the practicality and stability of the farming systems for automatic and sustainable pig industry development are needed.

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