A REVIEW OF ARTIFICIAL INTELLIGENCE BASED RESEARCH RESULTS IN AGRICULTURE AND LIVESTOCK INDUSTRY

Lu Sijie, Du Yongxing, Zhouli Yong, Kou Yan

Inner Mongolia university of science and technology, China

Supervisor Li Baoshan

In recent years, China's agricultural and animal husbandry industry has gradually developed towards scale and intelligence, a process that cannot be achieved without the progress and implementation of scientific research. This article takes the Grassland Animal Husbandry Traceability Big Data Inner Mongolia Autonomous Region Engineering Laboratory of Inner Mongolia University of Science and Technology as an example, and introduces four research results related to agriculture and animal husbandry in this laboratory.

Keywords: deep learning, grass production prediction, livestock weighing, individual livestock identification.

Introduction. As the population increases and the economic level rises, the people's demand for food is growing. The production of ordinary free-range scale has long been unable to support Chinese people's demand for meat products, and large-scale and intelligent breeding plants began to appear under the market demand and the guidance of the state. There have been some relevant studies internationally: the study by Herinaina et al [1] in 2016 was to use wearable biosensors to transmit information for the purpose of analyzing individual livestock behavior such as the location information of livestock, the posture of livestock, and the movement of livestock. Hertem et al [2] designed a 3D vision system to automatically monitor cow movement to diagnose cow heat and health.

In recent years, China has been developing rapidly in "smart animal husbandry" and has achieved fruitful scientific and technological achievements as well as application results. The Grassland Animal Husbandry Traceability Big Data Inner Mongolia Autonomous Region Engineering Laboratory of Inner Mongolia University of Science and Technology is one of the representative units, which combines the advantages of the development of animal husbandry in Inner Mongolia Autonomous Region, and integrates modern information technology such as Internet of Things, Big Data, Artificial Intelligence, etc., and implements further technology for the relevant demonstration area。 This paper introduces four representative research results of this laboratory, these research topics focus on practical problems and are closely related to the development and needs of agriculture and animal husbandry.

Research Content

Grassland yield prediction. Grassland livestock farming is dependent on the good or bad ecological decisions of grasslands. The productivity of grasslands can determine the productivity of pasture and thus directly affect livestock production and efficiency [3]. In order to accurately predict pasture yield, we designed a deep learning-based method for pasture yield prediction. The data affecting pasture yield mainly include NDVI (Normalized difference vegetation index) and meteorological data (including precipitation, temperature and sunshine, etc.), both of which meet the requirements for time-series characteristics, so a BiLSTM network is used as a research benchmark and an attention mechanism is introduced. A bi-directional long and short term memory neural network (BiLSTM-attention) based on the attention mechanism is proposed for NDVI prediction model. The attention-weighted feature vectors are input into BiLSTM to train the model, thus improving the prediction accuracy of the model. Comparing with the real data, the prediction results of the BiLSTM-attention model were most similar to the fluctuation of the real NDVI values [4].

Sheep non-sensory weight monitoring system. The change of animal weight is one of the important indicators to measure the health status of animals. In order to solve the difficult problem of sheep weight monitoring and to realize the daily monitoring of sheep weight in the natural state without affecting the normal passage of sheep, i.e., multiple sheep can pass the scale at the same time [5], we designed a sheep non-sensory weight monitoring system. The hardware system consists of a power supply module, STM32 microcontroller core processing module, RFID reading module, data transmission module, and weighing module.

The core of the software part is the data processing algorithm, the purpose of which is to remove the abnormal data and calculate the weight of each sheep, mainly including the random forest algorithm and the mean difference coefficient method. Experiments show that the data classification accuracy based on the random forest algorithm model is 93.4 % and the accuracy rate is up to 95.7 %. Using the mean difference coefficient method to monitor and analyze the weight of single sheep, the error of sheep weight monitoring gradually decreases with the increase of monitoring time, and the absolute error of sheep weight monitoring is less than 1 kg, and the relative error of weight monitoring is less than 1.5 % [6], which can meet the practical requirements.

Individual dairy cow identification. Individual cow identification can help farmers to detect the health condition of cows and analyze their milk production. To address the problems of traditional cow identification methods, we designed a study of individual cow identification based on deep learning and feature fusion. The network is based on the VGG-16 network model, and combined with the application consideration, the VGG-16 model has large parameters, so improvements are made in three directions: running speed, number of parameters, and convergence speed. Firstly, we add overlapping pooling layers with pooling kernel of 3 and step size of 2 after the first and third convolutional layers of the VGG-16 network model, and change the first, second, third, and fifth maximum pooling layers of the original network model to overlapping pooling layers with pooling kernel of 3 and step size of 2.Secondly, the traditional Flatten layer of the VGG-16 network model is replaced by the Global Average Pooling (GAP) layer, and the fully connected layer with 1024 nodes is used instead of the two fully connected layers with 4096 nodes in the original network model; last but not least, the fully connected layer of the VGG-16 network model is replaced by the Batch Normalization (BN) instead of Dropout layer in the fully-connected layer. The number of parameters of the improved VGG-16 network model is about 1/10 compared with that of VGG-16. Meanwhile, in order to improve the recognition rate of the network, we proposed fusion of shallow and deep feature maps using single convolutional neural networks, specifically, fusion of feature maps obtained from the second, fourth, fifth, and seventh layers in VGG-16. Finally, improved model can achieve 98.96 % recognition rate for individual cows [7], which effectively solves the identification problem of individual cow identity in large-scale dairy farming and solves one of the key problems in building a smart farm.

Individual beef cattle identification. As one of the main sources of meat products, beef cattle are in high demand in the market, and there is the same problem of individual cattle identification as dairy cattle in the process of large-scale farming. Carcass-based individual beef cattle identification is easier to apply in practice compared with other ways. Therefore, we designed a deep learning based beef cattle body side recognition method. For individual beef cattle without obvious features, SOLOv2 segmentation is used in the data preprocessing part to extract the cattle from the complex farm environment, the InceptionV3 network with the highest recognition rate was selected as the benchmark network for beef cattle recognition [8]. Firstly, ImageNet was used to pre-train the

InceptionV3 model, and its pre-training weights were obtained to build an InceptionV3 network model combined with migration learning, which improved the recognition accuracy by 1.2 percentage points over InceptionV3 and took 5 s faster per round of iteration on average. Then, the global average pooling layer is used to replace the spreading layer after the convolutional layer in the InceptionV3 network, and the reduced dimensional 1, 3, 5, 6, 7, 8, 9, 10 layers feature information is fused using concat, and the relu activation function and Dropout layer are used to reduce the degree of network overfitting. model. Separation experiments show that the recognition rate of individual beef cattle with the improved InceptionV3 model is improved by 4.1 percentage points.

Summary and Prospect. Agriculture and animal husbandry are the basic guarantee of China's people's livelihood and an important area of China's development. This paper summarizes four research results of the Grassland Animal Husbandry Traceability Big Data Inner Mongolia Autonomous Region Engineering Laboratory by means of modern technologies such as artificial intelligence and Internet of Things.

References

1. Reference: a review on the use of sensors to monitor cattle jaw movements and behavior when grazing. [J] / Andriamandroso Andriamasinoro [et al.] // Biotechnologie, Agronomie, Société et Environnement. – 2016. – N 20 (7). – P. 141–145.
2. Implementation of an automatic 3D vision monitor for dairy cow locomotion in a commercial farm. [J] / Tom V. Hertem [et al.] // Biosystems Engineering. – 2018. – N 173 (14). – P. 166–175.
3. .Stakeholder Perceptions of Climate Extremes'Effects on Management of Protected Grasslands in a Central European Area. [J] / Malatinszky Ákos // Weather Climate and Society. – 2016. – N 8 (3). – P. 209–217.
4. 李倩. 基于深度学习的草地产草量预测方法研究. [D]. – 内蒙古科技大学, 2022.
5. Niedźwiecki, M. System identification based approach to dynamic weighing revisited. [J] / M. Niedźwiecki, M. Meller, P. Pietrzak // Mechanical Systems and Signal Processing. – 2016. – N 80. – P. 582–599.
6. 陈凯东, 杜永兴, 周李涌, 肖俊生,李宝山. 羊群无感知体重监测系统的设计. [J].– 黑龙江畜-牧兽医, 2022.
7. Individual identification of dairy cows based on deep learning and feature fusion. [J] / Y. Du [et al.] // Animal Science Journal. – 2022. – N 93 (1). – P. 13789.
8. Individual identification of dairy cows based on convolutional neural networks. [J] / W. Shen [et al.] // Multimedia Tools and Applications. – 2020. – N 79. – P. 14711–14724.

STUDIES ON VORTEX SAR IMAGING ALGORITHMS

Xiao Tang, Yong Xing Du, Zong Jun Tong

Inner Mongolia university of science and technology, China

Supervisor Yong Xing Du

Vortex electromagnetic waves carrying orbital angular momentum (OAM) have a spiral phase wave front and can be used to obtain more dimensional information in radar imaging. The introduction of vortex electromagnetic waves into synthetic aperture radar (SAR) imaging can break the traditional SAR imaging performance bottleneck problem and obtain higher resolution SAR imaging imagesvedvortex SAR imaging.

Keywords: orbital angular momentum, vortex electromagnetic waves, SAR imaging, BP algorithm, CS algorithm.