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《智慧农业发展战略研究》专题快报

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【动态资讯】

1．江西：智慧农场丰富场景高效生产

【经济参考报】树立在地头的气象监测站、加装了北斗终端的拖拉机、翱翔在田间的无人植保机…… 近些年来，江西智慧农业场景越来越丰富。作为集大数据、移动互联网、物联网、云计算为一体的高效生产模式，智慧农业近年来发展迅速。

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN46teAVQhUAADID4TWMgQ269.pdf

2．江苏宿迁：擘画乡村振兴美丽图景

【光明日报】走进宿迁市宿城区蔡集镇田洼智慧农业园，滴灌、吊蔓、岩棉无土栽培、蔬菜生产分段施肥等农业生产新技术让记者应接不暇。“依托大数据，运用智慧物联传输系统平台，我们能实现对农作物的‘全天候’监控，确保作物在‘温光水气肥’合适的环境中快速生长。通过这种智慧化管理模式，园区综合效益达到传统种植的 50 倍以上。”田洼智慧农业园负责人潘海燕指着放在土里的传感器介绍，“你看，通过这个传感器，我们就可以获取大量环境数据，并实时上传到我们的智慧中心、大数据中心，并根据数据迅速作出调整。比如，如果监测到棚内二氧化碳超标，天窗就会自动打开进行换气。”

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfPn5GAPBE3AAEp3w5Mxcw834.pdf

3．“农业装备的智能化是实现农业现代化的必由之路”?

【农业科技报】用于农作物规模化生产的智能农业装备，是农业生产中的一个重要生产资料。那么，智能农业装备如何在农业农村现代化建设、助力乡村振兴战略中发挥重要作用？为此，记者采访了陕西省农业机械产业技术体系首席

专家、西北农林科技大学教授陈军，他长期致力于这方面的技术理论基础研究和作业装备开发，建树颇丰。据他介绍：“智能农业装备是融合自主感知、智能决策、精准控制等技术为一体的现代化农业装备，也是提高农业生产率、解放农村劳动力的关键要素，对缓解老龄化带来的农业劳动力短缺、支撑农村劳动力转移具有重要意义。”

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN47DWAESwKAAFc6GP7Vcc159.pdf

【文献速递】

1．Throughput optimization in backscatter-assisted wireless-powered underground sensor networks for smart agriculture

文献源：ScienceDirect,2022-11-12

摘要：Wireless underground sensor networks (WUSNs) using wirelessly-connected buried sensors enable smart agriculture through real-time soil sensing, timely decision-making, and precise remote operation. Energy harvesting technology is adopted in WUSNs, implying wireless-powered underground sensor networks (WPUSNs), to prolong the network lifetime. In addition, the backscatter communication (BSC) technology seems promising for improving the utilization of resources and network throughput according to preliminary studies in terrestrial wireless-powered communication networks. However, this technique has not yet been investigated in WPUSNs, where channel impairments are incredibly severe. In this work, we aim to assess BSC’s performance in WPUSNs and evaluate its feasibility for sustainable smart agriculture. For this, we first conceptualize a multi-user backscatter-assisted WPUSN (BS-WPUSN), where a set of energy-constrained underground sensors (USs) backscatter and/or harvest the radio frequency energy emitted by an above-ground power source before the sensed data are transmitted to a nearby above-ground access point. Then, we formulate the optimal time allocation to maximize the network throughput while assuring real-world users’ quality of service (QoS). Our analysis considers the non-linearities of practical energy harvesting circuits and severe signal attenuation in underground channels. By simulating a realistic farming scenario, we show that our proposed solution outperforms two baseline schemes, i.e., underground harvest-then-transmit and underground BSC, by an average of 12% and 358% increase in network throughput (when USs are buried at 0.35 m), respectively. Additionally, several trade-offs between the network throughput, time allocation, network configurations, and underground parameters are identified to facilitate the practical implementation of BS-WPUSNs.

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GNzbKGAZBaVAB0JUfMFIWo210.pdf

2．喷雾机药罐液体纵向晃动等效力学模型建立与应用

文献源：农业机械学报,2022-11-08

摘要：针对高地隙自走式喷雾机在复杂工况下，药罐液体发生的纵向晃动对整机平顺性及作业质量影响难以探明的问题，基于液体晃动动力学特性及机械模型等效准则，建立了可描述药罐液体纵向晃动的弹簧—质量—阻尼等效力学模型，并利用力学等价原则，对模型参数进行了求解。应用Fluent流体仿真软件建立罐内液体晃动仿真模型，并通过台架实验验证了其仿真结果能够反映真实的液体晃动冲击作用。应用Matlab/Simulink软件，建立等效力学数值解析模型，结合Fluent仿真结果对比分析了充液比为0.1、0.5、0.9时液体纵向晃动作用在容器壁的力矩变化规律，验证了所建等效模型的准确性。将所构建的等效力学模型应用于喷雾机垂向动力学特性分析，得到药液晃动和药液质量变化对整机行驶平顺性有较大影响且充液比为0.8时整机行驶平顺性较差的结论。

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GNzZWyAdgTfABQt5iHc8zk544.pdf

3．Recent trends of smart agricultural systems based on Internet of Things technology: A survey

文献源：ScienceDirect,2022-11-04

摘要：Internet of Things (IoT) technology can be used to enhance traditional approaches by combining advanced technologies with sophisticated methodologies aiming to boost agricultural production quality and quantity. The global population is rapidly growing, and the demand for food is rising accordingly. Thus, traditional agriculture will be unable to fulfill the demands of the crops. This paper aims to review the state-of-the-art contributions of smart IoT-based agriculture system design including IoT technology which presents the core framework of present and future agricultural development. Also, the basic structure of the IoT agricultural system is highlighted including the hardware and the software along with the data processing components. The potential issues systems are also investigated. The results of previous works show that the developed agricultural based-IoT systems can provide higher accuracy for making the best decision to structure a healthy farm environment. Consequently, crop production can be increased many folds.

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfKIlCAPApqAB2zTgBVHYM631.pdf

4．地下滴灌加气技术研究进展

文献源：灌溉排水学报,2022-10-15

摘要：地下滴灌加气技术是通过对地下滴灌管网加气来改善根区土壤通气条件，避免低氧胁迫对作物造成不利影响，促进作物增产提质的一种新型灌溉技术。明确不同条件下地下滴灌加气技术的实施效果，确定适宜的加气灌溉模式与配套设备是推动该技术规模化应用的关键。通过总结近年来地下滴灌加气技术的相关研究进展与成果，全面总结了作物生长适宜的根区土壤氧气条件以及地下滴灌加气技术对土壤环境与作物生长的改善效果，并重点探讨了加气模式与加气设备的应用现状、存在的问题和发展趋势。目前，地下滴灌加气技术在作物产量与品质提升方面效果显著，但仍存在需进一步研究和解决的问题，首先是作物需按时、按需加气，其次需要从“气源-灌溉系统-土壤环境-作物生长”全过程提升加气综合利用效率并研发实用、高效的地下滴灌专用加气设备。

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GNx5DOAX6ilABZQCCpf-lc476.pdf

5．果实目标深度学习识别技术研究进展

文献源：农业机械学报,2022-10-08

摘要：机器视觉技术是果实目标识别与定位研究的关键。传统的目标识别算法准确率较低、检测速度较慢，难以满足实际生产的需求。近年来，深度学习方法在果实目标识别与定位任务中表现出了优良的性能。本文从数据集制备与果实目标识别模型两方面进行综述，总结了数据集制备相关的有监督、半监督和无监督3种方法的特点，按照深度学习算法的发展历程，归纳了基于深度学习的果实目标检测和分割技术的常用方法及其实际应用，轻量化模型的研究进展及其应用情况，基于深度学习的果实目标识别技术面临的问题和挑战。最后指出基于深度学习的果实目标识别方法未来发展趋势为：通过弱监督学习来降低模型对数据标签的依赖性，提高轻量化模型的检测速度以实现果实目标的实时准确检测。

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfImVmABXagABI7u0crBq4663.pdf

6．A CNN-based image detector for plant leaf diseases classification

文献源：ScienceDirect,2022-09-27

摘要：Identifying diseases from images of plant leaves is one of the most important research areas in precision agriculture. The aim of this paper is to propose an image detector embedding a resource constrained convolutional neural network (CNN) implemented in a low cost, low power platform, named OpenMV Cam H7 Plus, to perform a real-time classification of plant disease. The CNN network so obtained has been trained on two specific datasets for plant diseases detection, the ESCA-dataset

and the PlantVillage-augmented dataset, and implemented in a low-power, low-cost Python programmable machine vision camera for real-time image acquisition and classification, equipped with a LCD display showing to the user the classification response in real-time. Experimental results show that this CNN-based image detector can be effectively implemented on the chosen constrained-resource system, achieving an accuracy of about 98.10%/95.24% with a very low memory cost (718.961 KB/735.727 KB) and inference time (122.969 ms/125.630 ms) tested on board for the ESCA and the PlantVillage-augmented datasets respectively, allowing the design of a portable embedded system for plant leaf diseases classification.

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfM05eALi8EAA-OOHUqjaQ481.pdf

7．Comparative performance of four CNN-based deep learning variants in detecting Hispa pest, two fungal diseases, and NPK deficiency symptoms of rice (Oryza sativa)

文献源：ScienceDirect,2022-09-09

摘要：Crop production can be significantly increased if stresses are detected at the earliest possible time to facilitate the implementation of necessary mitigation measures. This present study aims to evaluate the comparative performance of the Convolutional Neural Network (CNN) and four pre-trained deep CNN models, for automatic and rapid detections of Hispa, brown spot, leaf blast, and NPK deficiency symptoms from public and real field images. Deep learning models were trained using different public and field datasets combinations. Best accuracy was achieved for mixed public and field datasets rather than solely field or solely public datasets, with VGG19 models achieving 91.8% accuracy. Relatively simple structured CNN was found to predict phosphate deficient leaves with better performance (96% accuracy) than the other four advanced models, while VGG16 performed better for leaf blast and N deficiency identification. Likewise, ResNet50 could be recommended among the five models for the Potassium deficient leaf identification, while for the Hispa pest, VGG19 outperforms the InceptionV3, ResNet50, and VGG16 models, and was slightly better than the basic CNN. The implication of the study is enormous considering practical application as it deals with the complex dataset of pest, disease and nutrient deficiency. This non-invasive way of detecting different stresses of rice could help farmers in practicing precision agriculture. The findings from this study could be used to develop a user-friendly interface for the rapid and inexpensive detection of diseases and nutrition status by farmers, in a non-destructive way. Similar to rice, various biotic and abiotic stress symptoms in

other economic crops could also be captured and identified by deep learning algorithms.

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfMy42AE-_hAGsJkWQP0hg737.pdf

8．防飘喷头在植保无人飞机水稻病害防治应用研究

文献源：中国农业大学学报,2022-09-08

摘要：为了解植保无人飞机应用文丘里防飘喷头对水稻病害的防效影响。利用植保无人飞机搭载文丘里防飘喷头的方法，分析雾滴沉积特性及水稻纹枯病、稻曲病的防治效率。结果表明：应用文丘里防飘喷头雾滴在冠层上部与下部以及总体沉积量均超过应用常规扇形喷头的雾滴沉积量，相对于小雾滴，植保无人飞机采用大雾滴可以改善雾滴在冠层中的穿透性及喷幅范围内的雾滴分布均匀性；不论是粗雾滴还是细雾滴，植保无人飞机均可以有效防治稻曲病，而且防效优于传统的背负式喷雾器；纹枯病植保无人飞机应用文丘里防飘喷头施药后，其防效达到80%，与背负式喷雾器防效相当，较常规扇形喷头防效提高30%。因此，水稻叶部病害应用文丘里防飘喷头能够达到病害防治要求。

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GNzY5KANctdAAe8BeQYv14825.pdf

9．Enhancing classification capacity of CNN models with deep feature selection and fusion: A case study on maize seed classification

文献源：ScienceDirect,2022-08-20

摘要：Developing computer-assisted agricultural analysis systems using machine learning methods is a focused area in recent years. As in every field, it is aimed to improve the production process and product quality in agricultural applications with computer-assisted systems. The maize plant is a very important species in terms of providing sufficient food to the world’s population. The separation process of the haploid and diploid maize seeds is a critical issue in terms of maize breeding time and production efficiency. In this study, a haploiddiploid maize seed classification method is proposed using deep features obtained from convolutional neural networks (CNN). In the first stage, deep features were obtained from fully connected layers of different CNN models. Then, the best 100 features were selected by using the MRMR (Max-Relevance and Min-Redundancy) feature selection method for 1000 features obtained in each CNN model. These selected features have been fused according to different combinations of the CNN models. These fused features have been used in the training and testing stages of a conventional classifier method in the last stage.

Eventually, according to the experimental results, it was determined that the general accuracy performance has been around 96.74%. It has been observed that the proposed approach exhibits high performance in the classification process of maize seeds.

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN2Hk2ATrP_AAzT4z1aHq0364.pdf

10．Data quality assessment and analysis for pest identification in smart agriculture

文献源：ScienceDirect,2022-08-17

摘要：Deep learning has played a crucial role in the field of smart agriculture and been widely used in various applications. However, the deep learning models are constrained by data quality, which means poor data quality and unreliable data annotation will seriously restrict the performance of smart applications. In this paper, we proposed two methods to assess data quality, named Bound-DE and Multi-Branch. In experiments, the IP06 dataset and the ResNet-18 backbone network were adopted. The results show that the redundancy of the used public dataset is so large that about 50% of the data can achieve the similar test accuracy. Furthermore, we also analyzed the high contributive samples and summarized the rules of those selected informative samples, which is significant for the design of high-efficiency datasets. In summary, this study guides and promotes the following data-centric research in the field of smart agriculture.

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfPnYSAYPkdAFWxMKM4uZg971.pdf

11．Anomaly detection in smart agriculture systems

文献源：ScienceDirect,2022-08-05

摘要：This work proposes a new approach for Anomaly Detection in smart agriculture systems. Through the use of multi-sensor systems and Decision Support Systems, it is possible to collect, analyze, and process huge amounts of data on agriculture. This supports the farmer in the decision-making process to optimize the results in terms of quality and quantity, to avoid waste, and to maximize profits. However, the use of IoT and intelligent communication technologies can introduce a number of intentional and unintentional weaknesses and flaws in data and information management. The research proposes an Anomaly Detection System (a multi-layered architecture) to mitigate the infrastructure threats in a pro-active way in

the Smart Agriculture domain. The design of the proposed architecture is based on a machine-learning algorithmic approach by a multivariate linear regression (MLR) and a long-term memory neural network algorithm (LSTM). The application of the Anomaly Detection System was done on a real dataset coming from a smart agriculture system located in the Apulia region (Italy).

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN41jSAbNy-AIY8VrE9guw780.pdf

12．HOB-CNN: Hallucination of occluded branches with a convolutional neural network for 2D fruit trees

文献源：ScienceDirect,2022-07-26

摘要：Orchard automation has attracted the attention of researchers recently due to the shortage of global labor force. To automate tasks in orchards such as pruning, thinning, and harvesting, a detailed understanding of the tree structure is required. However, occlusions from foliage and fruits can make it challenging to predict the position of occluded trunks and branches. This work proposes a regression-based deep learning model, Hallucination of Occluded Branch Convolutional Neural Network (HOB-CNN), for tree branch position prediction in varying occluded conditions. We formulate tree branch position prediction as a regression problem towards the horizontal locations of the branch along the vertical direction or vice versa. We present comparative experiments on Y-shaped trees with two state-of-the-art baselines, representing common approaches to the problem. Experiments show that HOB-CNN outperform the baselines at predicting branch position and shows robustness against varying levels of occlusion. We further validated HOB-CNN against two different types of 2D trees, and HOB-CNN shows generalization across different trees and robustness under different occluded conditions.

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN2Ff-AKCwtAiW57lfbZr8118.pdf

13．基于RGB-D相机的脐橙实时识别定位与分级方法

文献源：农业工程学报,2022-07-23

摘要：为实现脐橙采摘机器人对脐橙果实进行实时识别、定位和分级采摘的需求，该研究提出了一种基于RGB-D相机数据的脐橙果实实时识别、定位及分级的OrangePointSeg算法。首先利用微软最新消费级深度相机（Azure Kinect DK）采集脐橙果实的RGB-D数据，建立脐橙果实实例分割数据集及增强数据集。然后通过改进YOLACT算法对脐橙果实进行实时分割并生成实例掩膜，与配准后的深度图裁剪得到果实深度点云，再利用最小二乘法进行脐橙果实外形拟合，

得到其相机坐标系下质心坐标及半径。试验结果表明，在果实识别阶段，改进YOLACT算法在该数据集上的检测速度为44.63帧/s，平均精度为31.15%。在果实定位阶段，1 400～2 000点云数量时的拟合时间为1.99 ms，定位误差为0.49 cm，拟合出的半径均方根误差为0.43 cm，体积均方根误差为52.6 mL，在大于800点云数量和拍摄距离1 m以内时，定位误差均在0.46 cm以内。最后通过引入并行化计算，OrangePointSeg的总体处理速度为29.4帧/s，能够较好地实现精度与速度的平衡，利于实际应用和工程部署。该研究成果可推广至其他类似形态学特征的果实识别中，为果园的智能化管理提供行之有效的技术支撑。

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfKGlaAS8vXACGldwoHnjk524.pdf

14．基于云台相机的番茄主茎跟踪控制方法

文献源：西南大学学报(自然科学版),2022-07-11

摘要：为满足番茄整枝和果实收获机器人的需求，设计了一种对番茄主茎主动跟踪的视觉获取系统，提出了一种云台姿态的控制方法.该系统由一个二自由度的云台和Realsense D435i深度相机组成，由安装在云台上的相机获取番茄主茎的三维信息，根据提出的跟踪方案确定跟踪参考点的3D坐标；在完成云台和相机参数标定的基础上，提出了基于主茎图像形态的主动跟踪控制方法，通过实时控制相机姿态实现对番茄主茎自下而上进行图像的跟踪采集.试验结果表明，观测垂直区域在600～1 500 mm的范围且跟踪步长△l≤150 mm时，跟踪的最大水平偏差和最大垂直偏差不超过8个像素，水平像素最大偏差相当于番茄主茎像素宽度的53.3%.该研究可以为番茄授粉、整枝、喷药和采摘等环节的智能化作业提供技术支持。

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfKFl6AXHdaABL4BwiXMhM340.pdf

15．Applying convolutional neural networks (CNN) for end-to-end soil analysis based on laser-induced breakdown spectroscopy (LIBS) with less spectral preprocessing

文献源：ScienceDirect,2022-07-09

摘要：The high variation of raw laser-induced breakdown spectroscopy (LIBS) caused by soil heterogeneity seriously reduces the accuracy and stability of the spectral analysis. Therefore, the conventional chemometrics for spectral analysis requires seeking an appropriate spectral preprocessing by a trial-and-error method before modeling, which resulted in a mutable performance. To settle this problem, the convolutional neural network (CNN), a type of deep learning approach with the advantage of end-to-end, was applied to predict soil type and soil properties based on

the non-preprocessed LIBS spectra. The results indicated, when compared to conventional partial least squares (PLS), that the CNN models presented equal classification accuracy but they decreased the root mean square error in the validation set (RMSEV) by 1.48%, 4.97%, 9.56%, 10.05%, and 2.90% for pH, soil organic matter (SOM), total nitrogen (TN), total phosphorus (TP), total potassium (TK), respectively. In addition, the CNN models performed better in preventing overfitting than the conventional PLS combined with various spectral preprocessing approaches. The multi-task of CNN models also further improved the prediction of TN due to its capacity to learn inherent structures from spectra. The sensitivity analysis of spectral variables revealed that the CNN model with the Inception module discovered both the local and high abstracted features compared with other CNN models. In conclusion, the CNN architectures showed potential to end-to-end deal with raw soil LIBS spectra.

链接:

http://agri.ckcest.cn/file1/M00/10/15/Csgk0GN4mW2AewnhAGOIRpx0xVk657.pdf

16．日本设施农业采收机器人研究应用进展及对中国的启示

文献源：智慧农业(中英文),2022-06-06

摘要：设施农业智能装备是设施农业稳定、高品质、高效生产的必要保障。日本智能采收装备已有近四十年的研发经验，其发展具有一定启发和借鉴意义。本文综述了日本设施农业采收机器人的研究应用进展，分析了基于农机农艺结合的茄科（番茄、茄子、青椒）、葫芦科（黄瓜、瓜类水果）、芦笋和草莓等10种设施农业采收机器人的采收技术，其中详细对比了番茄、草莓等几种蔬菜历代采收机器人的设计理念及其优点与不足。分析了设施农业采收机器人面临的科学问题及解决方案，总结了未来发展趋势及对中国的启发。本文可为加速推进中国设施农业采收机器人的智慧化、智能化和产业化发展提供借鉴参考。

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http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfImjiAfHmxAB10MgeK9jc319.pdf

17．基于机器视觉和北斗定位的小麦变量喷雾系统研究

文献源：农业机械学报,2022-05-19

摘要：针对传统植保喷杆喷雾机作业时各喷头以同等药量喷洒的方式导致农药浪费、利用率低和污染环境等问题，以生长前期的小麦为研究对象，设计一种基于北斗定位系统和机器视觉的小麦变量喷雾作业系统。通过双平面高度投影法完成对感兴趣区域获取，研究了速度、植株密度对喷雾的影响，提出变量喷雾流量的控制方法。在定位系统规划的目标区域内，通过机器视觉处理实现变量喷雾，试验结果表明，相同机组速度下，植株密度稀疏区相对植株密度正常

区的平均雾滴覆盖率平均减少12.06%;相同植株密度下机组前进速度0.75 m/s相对1.50 m/s的平均雾滴覆盖率平均增加3.94%。在满足喷雾标准的情况下，可以在不同速度、不同植株密度下实现变量喷雾。为验证目标区域边界行驶速度对等级变换准确度，进行定位传感器实时判断在目标区域边界喷头相对位置并控制开闭，试验结果表明，在行驶速度为0.50 m/s时准确度最高，区域边界行驶超出量误差平均值为48.72 cm;为验证行驶方式对喷雾等级变换准确度的影响，使用北斗定位系统在目标区域边界开展行驶方式对喷雾等级变换准确度的影响试验，试验结果表明，驶入目标区域超出量误差平均值为7.20 cm。

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfKGI2AW9kgACL8WiiPE-M933.pdf

18．Automatic scoring of postures in grouped pigs using depth image and CNN-SVM

文献源：ScienceDirect,2022-02-13

摘要：Animal posture is a manifestation of animal behavior, and an animal's behavior provides information about their health, welfare, and living environment. In recent years, machine vision and machine learning technologies have been widely used to detect individual or group behavior of pigs. The purpose of this study is to use machine vision and deep learning technologies to recognize and score multiple postures (standing, sitting, sternal recumbency, ventral recumbency and lateral recumbency) of pigs under commercial conditions based on depth images. In this study, the Azure Kinect DK depth camera with a top view was used to obtain the depth image of pigs, and the target pig image was obtained by GrabCut image segmentation and watershed segmentation of target object calibration. Then, based on the characteristics of the image, the convex hull, boundary, and the depth distance of the shoulder and the hip were obtained. The ratio of the convex hull perimeter to the boundary and the ratio of the convex hull area to the boundary, as well as the depth distance of the shoulder and the hip, and the depth distance ratio of the shoulder to the hip were obtained as the input of the Convolutional Neural Network-Support Vector Machine (CNN-SVM) classification model, and the model was trained and tested. In various classifier detection experiments, the performance of our pig posture classifier for standing posture and lateral recumbency posture was better, with the area under the receiver operating characteristic (AUC) values being 0.9969 and 0.9967, respectively. However, the performance of sitting posture, sternal recumbency posture and ventral recumbency posture classifier was slightly worse but still had good performance: AUC values were 0.9790, 0.9355 and 0.9795, respectively. The model in this article was used to detect the average postures of pigs

in one day (taking the average for eight consecutive days), and it was found that the proportion of lying postures was higher than other postures (lying postures were 72%, standing postures were 20%, and sitting postures were 8%). The proportion of standing postures in the daytime was higher than that in the evening, and lying posture was the opposite. The proportion of the three lying postures also changes over time. This study compared the difference of posture recognition accuracy between the model in this paper (CNN-SVM), SVM and CNN; using the same training data and experimental data, the accuracy of posture recognition of the three models was 94.6368%, 92.2175% and 90.5396%, respectively. Therefore, the recognition accuracy of the model in this paper was improved greatly compared with CNN and SVM.

链接:

http://agri.ckcest.cn/file1/M00/03/43/Csgk0YfPWzKAGlBEAE-uU05aYrI550.pdf

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