中国工程科技知识中心
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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．智慧农业有甜头 农民增收有奔头

【河北日报】夏日时节，广袤的京津冀大地生机勃勃。一项项特色产业蓬勃发展，一个个高智装备如虎添翼，一张张幸福笑脸灿烂绽放；京津冀三地智慧农业合作项目，连接京津冀经济命脉与城乡循环，关系着人们的柴米油盐、三餐四季。农业的根本出路在于现代化，数字化、智能化是重要路径。

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZbf-AeWajAAHT1gjSv_g252.pdf

2．智慧农业方兴未艾

【人民日报】随着大数据、人工智能等数字技术在农业领域的广泛应用，智慧农业在许多国家方兴未艾。荷兰、法国、日本等国通过积极运用数字技术，科学精准地管理农田，让农业生产经营更加优质高效。

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLCveSAETBsAAJh3pXrCSA835.pdf

3．大山深处的智慧农业

【商洛日报】6月15日，记者走进镇安县西口回族镇程家川的镇安县水产智慧养殖产业园，在工作人员的操作下，直观地感受到了智慧农业的无穷魅力。地头的植保无人机，代替人力实现自动作业；量身定制的“营养套餐”，通过纵横交错的管道，可以送达每一个池塘水田。

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLCvR-AOZmhAAEm3OHN7QU178.pdf

4．北大荒农业股份八五三分公司 智慧农业让种植户更慧种田

【黑龙江日报】眼下，正是大田管理的好时节，大田里的作物在阳光雨露的滋润下，噌噌拔节。走进完达山北麓、三江平原腹地的北大荒农业股份八五三分公司，一片片绿油油的秧苗长势喜人。八五三分公司围绕北大荒集团32366任务体系，严格落实“藏粮于地、藏粮于技”战略，“走实走深”智慧农业。

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZbciAZmLwAAHa7HbUEZU500.pdf

【文献速递】

1．Improving sugarcane production in saline soils with Machine Learning and the Internet of Things

文献源：ScienceDirect,2022-07-04

摘要：The Indian sugar industry is the second largest in the world. Sugar is an essential domestic grocery item required in India producing over 25 million tonnes per annum. Sugarcane is the root of sugar products that grow in over 5 million hectares all over India. However, nearly 1.5 million hectares of overall farms are saline soil lands (high salt content). This leads to lower yields in sugarcane agriculture than what would be expected. Therefore, tackling the salinity problem is crucial to achieve strong food security as well as tackle the sustainability of farming practices in India that have reach beyond just sugarcane. This research proposes efficient, sustainable, smart farming techniques for sugarcane cultivation in salt-affected lands with the help of the Internet of Things (IoT) and Machine Learning (ML). The proposed model has been implemented in a real-world two hectare sugar cane field cultivated from saline soils using Raspberry PI IoT nodes to control the drip irrigation (water supply). The Naive Bayes model has been used to train and predict the leaching requirement suggested by Food and Agriculture Organization of the United Nations (FAO) and United Nations Educational, Scientific and Cultural Organization (UNESCO) for efficient leaching water requirements. The performance of the proposed model has been evaluated in terms of sugar cane growth, cost of cultivation, as well as water requirements leading to an improved outlook for future use. Moreover, our results have been compared with regular sugar cane cultivation to show their effectiveness.

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC1ueAYhv6ADLFWUBPSfw752.pdf

2．Balancing smart irrigation and hydropower investments for sustainable water conservation in the Indus basin

文献源：ScienceDirect,2022-05-17

摘要：Indus River Basin (IRB) region of South Asia is severely water-stressed with irrigation receiving 90-95% of total surface water allocations and depletion of fossil groundwater reserves of more than 30 km3/year. Simultaneously, many supply-driven hydropower reservoirs, are planned in the basin. The reservoirs constructed upstream inflict severe environmental damages and reduce water availability for irrigation downstream. Policymakers promote smart technologies as a demand-based solution to reduce water consumption in irrigation. However, the effects of such technologies are not yet well understood, and unintended consequences (such as irrigation efficiency paradox and other nexus externalities) have recently begun to appear. Therefore, we use an integrated assessment model to analyze the proliferation of smart technologies in the IRB. The analysis suggests that if the Indus countries adopt a demand-based approach and irrigate their land completely using smart technologies, surface and groundwater withdrawals are indeed reduced. However, this reduction comes with a 33% increase in total expenditures, an increase in consumption across water and energy sectors, and higher withdrawals from fossil groundwater reserves. On the other hand, we find that if the countries were to balance their investments between smart and hydropower technologies it would not only reduce the increment in expenditure to 28%, but would also conserve irrigation water while avoiding the increased multi-sectoral consumption and environmental degradation. Thus, balancing investments between smart irrigation and hydropower projects can significantly reduce the economic and environmental (including conservation of water resources, meeting environmental flow targets, among others) costs of multi-sector water conservation in the IRB.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZhWOAAsR7AJtD9eMTqEg141.pdf

3．Estimating plant nitrogen content in tomato using a smartphone

文献源：ScienceDirect,2022-05-13

摘要：Optimizing nitrogen (N) fertilization is increasingly becoming a key issue to maximize productivity and farmers' income while reducing environmental impact of agricultural

productions. Among the most sophisticated approaches to support variable rate N applications, a central role is played by frameworks that integrate satellite images and smart-scouting driven ground estimates of plant N content (PNC) and critical N concentration. Among the approaches to estimate PNC, the smartphone application PocketN demonstrated its suitability for cereals as well as its great integrability within digital platforms. In this study, we developed genotype-specific calibration curves to derive PNC of tomato crops from PocketN readings and we compared the performance of PocketN with the SPAD ones. Five commercial genotypes were grown in two field experiments in Northern and Southern Italy and four PocketN/SPAD readings and sampling events were carried out along the season. The most reliable relationships between PocketN/SPAD readings and PNC values from the laboratory were obtained for the readings carried out on the apical leaflet of the lower leaves of three plants. Mean R2 for all genotypes was 0.75 and 0.62 for PocketN and SPAD, respectively. This allows considering PocketN as a suitable tool for PNC estimates in light of its adoption within digital frameworks aimed at transferring precision agriculture principles to operational farming contexts.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZjTGADK85ABa5f0j8qb4299.pdf

4．A low-cost approach for soil moisture prediction using multi-sensor data and machine learning algorithm

文献源：ScienceDirect,2022-04-19

摘要：A high-resolution soil moisture prediction method has recently gained its importance in various fields such as forestry, agricultural and land management. However, accurate, robust and non-cost prohibitive spatially monitoring of soil moisture is challenging. In this research, a new approach involving the use of advance machine learning (ML) models, and multi-sensor data fusion including Sentinel-1(S1) C-band dual polarimetric synthetic aperture radar (SAR), Sentinel-2 (S2) multispectral data, and ALOS Global Digital Surface Model (ALOS DSM) to predict precisely soil mois-ture at 10 m spatial resolution across research areas in Australia. The total of 52 predictor variables generated from S1, S2 and ALOS DSM data fusion, including vegetation indices, soil indices, water index, SAR transformation indices, ALOS DSM derived indices like digital model elevation (DEM), slope, and topographic wetness index (TWI). The field soil data from Western Australia was employed. The performance capability of extreme gradient boosting regres-sion (XGBR) together with

the genetic algorithm (GA) optimizer for features selection and optimization for soil mois-ture prediction in bare lands was examined and compared with various scenarios and ML models. The proposed model (the XGBR-GA model) with 21 optimal features obtained from GA was yielded the highest performance (R-2 = 0.891; RMSE = 0.875%) compared to random forest regression (RFR), support vector machine (SVM), and CatBoost gradient boosting regression (CBR). Conclusively, the new approach using the XGBR-GA with features from combination of reliable free-of-charge remotely sensed data from Sentinel and ALOS imagery can effectively estimate the spatial variability of soil moisture. The described framework can further support precision agriculture and drought resilience programs via water use efficiency and smart irrigation management for crop production.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZjA2AXwkBAE2pfCC_ReQ766.pdf

5. A smart agriculture framework for IoT based plant decay detection using smart croft algorithm

文献源：ScienceDirect,2022-03-25

摘要：Internet of things (IOT) is an assuring technology which provides systematic and logical solutions towards the revolution of various realms. Various researches and analysis have been conducted and numerous methods have been incorporated to apply IoT technology on agronomical fields. IoT can play a vital role in timely detection of declining plant health so that appropriate measures can be taken. It is a huge step towards smart agriculture. In this paper we propose a model to build up an automated framework which will recognize the crop decay in the initial phase which is imperceptible to naked human eyes. This model helps in prevention of huge losses and also save a lot of time and labor. The proposed model builds a recognition framework using sensors like humidity, moisture, temperature and color of the plant leaf. The data from the sensors is sent to Arduino to Cloud which then analyzes the data and helps in identifying the plant decay. In the upcoming years, the internet of things will be a crucial bit in the smart farming system.

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC2--AVek9AAymES6C58o422.pdf

6. AI-based modeling and data-driven evaluation for smart farming-oriented big data architecture using IoT with energy harvesting capabilities

文献源：ScienceDirect,2022-02-24

摘要：The use of Internet of Things (IoT) networks offers great advantages over wired networks, especially due to their simple installation, low maintenance costs, and automatic configuration. IoT facilitates the integration of sensing and communication for various industries, including smart farming and precision agriculture. For several years, many researchers have strived to find new sources of energy that are always “cleaner” and more environmentally friendly. Energy harvesting technology is one of the most promising environment-friendly solutions that extend the lifetime of these IoT devices. In this paper, the state-of-art of IoT energy harvesting capabilities and communication technologies in smart agriculture is presented. In addition, this work proposes a comprehensive architecture that includes big data technologies, IoT components, and knowledge-based systems for innovative farm architecture. The solution answers some of the biggest challenges the agriculture industry faces, especially when handling small files in a big data environment without impacting the computation performance. The solution is built on top of a pre-defined big data architecture that includes an abstraction layer of the data lake that handles data quality following a data migration strategy to ensure the data's insights. Furthermore, in this paper, we compared several machine learning algorithms to find the most suitable smart farming analytics tools in terms of forecasting and predictions.

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC4RWAX9KIAD4ujqTwYRo541.pdf

7．Discrete controller synthesis applied to smart greenhouse

文献源：ScienceDirect,2022-02-05

摘要：The popularization of the Internet of Things allowed the emergence of different monitoring and control solutions in different economic sectors. For example, in agriculture, this type of technology has supported the monitoring of environmental variables essential in decision-making, defining when and how much water to use in a given crop. Besides, it made it possible to control various devices to meet each crop type's environmental requirements, increasing productivity. In this sense, there is a need for increasingly improved control strategies to meet crop requirements in real-time, ensuring sustainable production and reliable quality. This work presents Discrete Event System techniques to develop an agricultural greenhouse controller considering self-configuring mechanisms for adapting to dynamic environments and preventing conflicting rules from violating control objectives. The

controller was validated through a simulator based on temperature balance equations, allowing the environment's temperature control. We used accurate climate data from actual Brazilian meteorological stations to evaluate different control scenarios in the year's four seasons, checking the controller's efficiency and the control strategy adopted, guaranteeing the crop's thermal comfort and minimizing water loss. Applying this control technique, we achieved the crop's thermal comfort under 87% of the time, influencing the absolute humidity and evapotranspiration rates over 31 days. Besides, we were also able to reach 66% more energy efficiency than other approaches.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZiS2AXkfgADtxs-FmM8E722.pdf

8．The impact of agroecosystem on ecological footprint: Fresh evidence in the perspective of existing agriculture and green Pakistan

文献源：Web of Science,2022-06-29

摘要：The focus of this research study investigated the impact of agroecosystem on the ecological footprint in Pakistan, using the time series data over the period from 1990 to 2019. The econometric methods of time series were employed to investigate the long-term association between an agroecosystem and ecological footprint. After performing the stationarity tests Johansen approach was employed. Results of the Johansen method imply that long-term co-integration exists between the exogenous and endogenous variables. Moreover, the ARDL model was performed and long-run results were validated by the bound testing approach. The elasticity of the short-run form of the ARDL model reveals that agricultural land, employment, energy consumption, fertilizer use, and biomass burned dry matter in agriculture have a positive relationship with the agroecosystem. In contrast in the log-run form of ARDL agricultural land, employment, energy consumption, fertilizer use in agriculture and temperature have a positive impact on ecological footprint. Results of the impulse response function revealed that employment and fertilizer use in agriculture have positive while energy consumption and livestock in number have a negative influence on the ecological footprint. Thus, rigorous practices of agriculture for higher production put extra pressure on the agroecosystem. As a result, the stability of the agroecosystem deteriorates and reduces. To minimize the ecological ecosystem, modern technology is required to reduce carbon emission, enhance greener production and improve the biocapacity of the land in the country. This study would help the researcher, planner, policymaker and academicians to provide a proper guideline and vision to provide sustainable food and environment.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZc5uACpfZAAmKpERjOjc903.pdf

9．Novel energy management scheme in IoT enabled smart irrigation system? using optimized intelligence methods

文献源：ScienceDirect,2022-06-03

摘要：In recent times, due to the growing global population and increased food demand, smart agriculture is becoming more vital. In this context, Internet of Things (IoT) technologies have emerged as a significant pathway to innovative agricultural techniques. Due to their low capacity, these IoT nodes have faced energy limits and complicated routing methods. As a result, in the sphere of IoT-based agriculture, transmitting data failure, energy consumption, network lifetime reduction, and delay occur. To overcome this problem, this study proposes a novel combination of optimized intelligent smart irrigation systems to improve the energy management performance of the system. Here, the optimal cluster head formation and selection is performed by Hierarchy Shuffled Shepherd Clustering (HSSC) method. Also, the finest energy regulation and routing path are provided by the proposed Emperor Penguin Jellyfish Optimizer (EPJO) method. The simulation of this work is performed on Network Simulator-2 (NS2) software. The simulation consequences from the proposed method are validated and compared with the conventional methods. Thus, the proposed approach results demonstrate that the developed model has much lesser energy consumption and improved network lifetime as compared to the traditional works.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZnsCANpgUAEFiJQNYSyw333.pdf

10．番茄枝叶修剪机械手视觉伺服控制系统研究

文献源：中国农机化学报,2022-06-27

摘要：为解决番茄枝叶修剪机械手无法准确找到番茄侧枝修剪点的问题，保证番茄枝叶修剪机械手工作效率，提出基于不同边缘类型的番茄侧枝特征点识别方法。在粒子群算法优化的神经网络（PSO-BP）的基础上设计“眼在手上”视觉伺服控制系统。通过对番茄植株横纵边缘分割，分别进行横向边缘和纵向边缘的提取，用阈值分割除去番茄叶片的短边缘，并记录其交点横纵坐标，限制交点分别在横向边缘的上边缘和下边缘，得到对偶的番茄侧枝点。试验结果表明，所设计的视觉伺服系统能成功的识别番茄侧枝点，仿真试验测试得到图像特征的实际值和期望值误差在3～5个像素之间，五自由度的机械

手能在4s内移动到期望位置，为农业修剪枝叶机器人进一步研究提供参考。

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC6ECAKGjCABFh8vBKIm0397.pdf

11．基于深度学习模型的种植结构复杂区农作物精细分类研究

文献源：中国农业资源与区划,2022-06-24

摘要：[目的]卫星遥感技术具有覆盖范围广、探测周期短、调查成本低等优势而广泛应用于大区域农作物分类。然而在种植结构复杂区（如城乡结合部），因其地块破碎、同期生长的作物种类多且分布分散，利用传统的统计分类或机器学习方法进行农作物分类时仍存在精度不高的问题。为提高种植结构复杂区农作物分类精度，[方法]研究选取河北省廊坊市广阳区为研究区，以GF-1 PMS全色多光谱融合影像为数据源，采用U-Net、PSPNet及DeepLabv3+三种深度学习模型进行农作物分类研究。分析模型参数对农作物分类精度的影响，评价三种深度学习模型的农作物分类精度，优选农作物精细分类方法。[结果]（1）学习率与3种深度学习模型的分类精度呈正相关关系，较大的学习率（0.01，0.001）下，3种模型收敛速度快，分类精度高。批样本量与模型分类稳定性相关，批样本量设为100时，3种模型的分类稳定性最好。（2）相比PSPNet、DeepLabv3+模型，U-Net模型分类效果最好，总体分类精度为89.32%。（3）GF-1 PMS影像结合U-Net模型可有效提升种植结构复杂区农作物分类精度，大宗作物春玉米、夏玉米的分类精度在80%以上，花生、红薯、蔬菜小宗作物分类精度在60%以上。[结论]该研究可为准确获取种植结构复杂区的农作物类型、面积及空间分布信息提供参考依据。

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZmr-AeRAOABtJjmQmei0988.pdf

12．面向小麦生育进程监测的卷积神经网络精简化研究

文献源：江苏农业科学,2022-04-20

摘要：目前，利用机器视觉进行小麦生育进程监测主要是通过人工来进行特征提取，存在客观性差、效率低等问题，为了解决该问题，把深度学习引入到小麦生育进程监测研究中。卷积神经网络作为深度学习中常用的算法被广泛应用于图像分类任务中，使用深层的特征提取网络能够自动识别和提取图像特征，但常规深度卷积网络带来的大量参数和计算开销使这些算法难以应用到对存储空间和参数量有一定限制的嵌入式设备中。为此提出将知识蒸馏方法用于目标检测网络的特征提取网络，以提升浅层特征提取网络的性能，在降低模型的计算量和模型大小的同时尽可能地保证识别结果的准确性。通过使用ResNet50、VGG-16这2个不同教师网络分别指导学生模型MobileNet进行训练，试验

结果表明，当ResNet50作为教师模型、MobileNet作为学生模型时识别效果最好，学生模型MobileNet的平均识别准确率达到了97.3%,模型大小压缩为仅19.7 MB,相比于ResNet50缩小了88.9%，通过知识蒸馏的方法，使得到的模型能够在提高准确率的情况下还能减少网络模型的参数量和模型运行时间的消耗，大幅降低部署模型的成本，可以为田间小麦智慧化生产提供技术支撑。

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC636APPe0AFZ4e9ljuqA799.pdf

【会议论文】

1．Using NLP to analyze requirements for Agriculture 4.0 applications?

发布源：IEEE

发布时间：2022-06-27

摘要：This contribution describes the use of Natural Language Processing (NLP) methods for the lexical analysis of requirements for control, sensors, and information systems in the Agriculture 4.0 domain. The analysis is presented on an orchard 4.0 concept.The proposed orchard includes a sensor network (containing mainly measurements of hydrometeorological and soil variables), camera monitoring of conditions, and yield, support for autonomous robotic care and harvesting based on machine vision, prediction of appropriate times for interventions, etc. Requirements specification for mentioned system is written in natural language.A sentence splitting, Tokenization, Lemmatization, and POS (Part-of-Speech) tagging methods are applied to the mentioned structured requirements of the system and Use Case description. From these and by means of NLP, the candidates of classes, attributes, operations, and associations of the UML (Unified Modeling Language) class diagram are filtered and the UML model is synthesized. This paper presents the application of software engineering methods to support the development of complex heterogeneous sensors, information, and control systems.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZl5KAXwSmAA_ZwJx1S0Y740.pdf

2．The Computer Farmer Concept:Human-cyberphysical Systems for Monitoring and Improving Agricultural Productivity in Nigeria?

发布源：IEEE

发布时间：2022-06-27

摘要：The emergence of the Internet of Things (IoT) as a new technological paradigm has inspired several research interests in agricultural robotics, cyberphysical systems and wireless sensors networks. This can be attributed to the application of telecommunications and automation to improve traditional mechanized farming methods. This article proposes a viable and attractive technological approach to agriculture, with the aim of revamping Nigerian farms. This involves conceptualising cyberphysical systems that can enable people to do physical farming with computers from remote locations via the Internet. Practical applications and case studies of existing platforms are used to describe the effectiveness of the IoT in automating traditional farming. This is to show the adaptability of the cyberphysical network infrastructure to modern agriculture, in line with industry 4.0. Moreover, a feasible close-loop conceptual model was designed to illustrate its practicability. Therefore, this work is expected to attract smart people, especially in Nigeria, to agriculture and thus improve food production and operational security in the agricultural sector.

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC5eeAWMoKAMcBkZLrJmY624.pdf

3．SMART IRRIGATION SYSTEM: A WATER?AND POWER MANAGEMENT APPROACH

发布源：IEEE

发布时间：2022-06-27

摘要：Energy, water, and agriculture together form a formidable synergy which when properly utilized can achieve national growth and development. Cost effective solar powered irrigation systems can be the answer for all energy and fuel crisis. In this work, a smart irrigation system that considers the available water and solar energy power to determine the performance of its irrigation process is developed. The system adopted solar power such that it could be deployed in places with inadequate or no grid power while providing a means of monitoring the available solar/battery power as well as the water available in reservoir over the Internet on a Blynk user-friendly application. Experiments carried out at 7 am to 8 am, 1 pm to 2 pm, 3 pm to 4 pm and 7 pm to 8 pm reveal the dependence of the irrigation system on optimal utilization of the two essential parameters of water and power for a smooth operation of a smart irrigation system. During this time, system operation is simultaneously

monitored in real-time via a user-friendly interface on an Android mobile device. The adopted approach in this paper provides a convenient way of remote monitoring of solar energy power and water for an irrigation system and enhances effective use of resources (water and power). Optimal usage of resources prolongs lifespan of irrigation facilities such as solar battery and water pumps while making adequate water available for irrigation to achieve bumper crop yield.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZla-ACpZcABHasH1dZ0k953.pdf

4．Decision Support Platform for Production of Chili using IoT, Cloud Computing, and Machine Learning Approach

发布源：IEEE

发布时间：2022-06-27

摘要：The chili crop is largely grown in several regions of the world, especially in Asian and African countries. It is a major source of income for both small- and large-scale farmers. Unfortunately, chili farmers have to contend with the challenge of pests and diseases and the need for timely decisions to have a bountiful production. To solve this problem, this paper proposes a chili-decision support platform (chili-DSP) that can help farmers detect diseases, and nutrient deficiency and make timely decisions. The proposed system integrates the internet of things, cloud computing, and data analytics technologies. The framework and architecture of the proposed chili-DSP are presented in this paper and the preliminary results using the convolutional neural network (CNN) for the classification of chili are presented. The result shows that CNN provides an accurate prediction of the learned data set and can be extended to larger data set for real-time classification of chili diseases. The chili-DSP is expected to provide a comprehensive feature and support that will help the chili farmers enhance the production of chili while minimizing losses.

链接:

http://agri.ckcest.cn/file1/M00/10/08/Csgk0GLC496AXe95ABJ5xMr8otM795.pdf

5．Monitoring of Plant Growth Using Soil Moisture and Temperature Sensor and Camera

发布源：IEEE

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摘要：The digital revolution has made a significant step forward in the application of information technology in monitoring the changes taking place around us. The Internet of Things is widely used to modernize and optimize agricultural processes. Achieving an ideal model of information technology management in agriculture requires data collection that will ensure an adequate range of impact on agricultural cultures. In this paper, the lifespan of one type of ornamental flower will be monitored by several sensors. Monitoring parameters such as soil moisture and temperature are easily performed using various sensors that immediately measure the desired values. Numerous papers report on monitoring and controlling plant growth, but most of them are based only on monitoring values obtained from sensors. Using various sensors and a camera, growers can react promptly and see the change in leaves and/or flowers. Monitoring changes with sensors and cameras provides data that help automate the cultivation of cultures.

链接:

http://agri.ckcest.cn/file1/M00/03/36/Csgk0YcZkzyAE0QIABHJO5OUhiQ333.pdf

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