Smart Crop Protection

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1)Topic: **Ontologies and Artificial Intelligence Systems for the Cooperative Smart Farming Ecosystem**

Authors: Sai Sree Laya Chukkapalli; Sudip Mittal; Maanak Gupta; Mahmoud Abdelsalam; Anupam Joshi

Abstract: Large amounts of data are produced by Cyber-Physical Systems (CPS) and the Internet of Things (IoT), which encourages the development of AI-based smart applications. To balance the rising need for food supply, the agriculture and farming sector is moving toward an IoT connected ecosystem, driven by the quick improvements in technology that support smart devices. A cooperative (co-op) farming level can now include AI supported systems once the number of smart farms reaches a critical threshold. There are currently 1,871 co-ops servicing 1,890,057 member farmers in the United States alone. Therefore, when such cutting-edge infrastructure and technologies are integrated into the co-op farming ecosystem, small member farmers who run and manage these autonomous co-op entities can greatly profit.

2) Topic: **Design, Development and Evaluation of an Intelligent Animal Repelling System for Crop Protection Based on Embedded Edge-AI**

Authors: Davide Adami; Mike O. Ojo; Stefano Giordano

Abstract: By bringing processing and storage capabilities close to end devices, edge computing has recently emerged as a crucial technology for the development of real-time applications. This reduces latency, boosts response times, and ensures secure data transfer. In this study, we concentrate on a Smart Agriculture application that intends to build virtual fences using computer vision and ultrasound emission to protect crops from ungulate attacks and thereby drastically minimise output losses. This paper presents a thorough explanation of the design, development, and evaluation of an intelligent animal repulsion system that allows to detect and recognise the ungulates as well as create ultrasound to drive away the ungulates and protect crops from their attack. The suggested solution is built on IoT platforms that offer a reasonable trade-off between performance, cost, and energy consumption. These platforms take into account the limits arising from the rural setting in terms of energy supply and network connectivity. In order to determine the best animal recognition HW/SW platform to be integrated with the ultrasound generator, we deployed and tested various edge computing devices (Raspberry Pi, with or without a neural compute stick, and NVIDIA Jetson Nano) running real-time object detector (YOLO and Tiny-YOLO) with custom-trained models. Through the use of animal detectors on energy-efficient edge computing devices, experimental results demonstrate the viability of the intelligent animal repelling system while also satisfying real-time requirements.

3) Topic: **Semantically Enriched Crop Type Classification and Linked Earth Observation Data to Support the Common Agricultural Policy Monitoring**

Authors: Maria Rousi; Vasileios Sitokonstantinou; Georgios Meditskos; Ioannis Papoutsis; Ilias Gialampoukidis; Alkiviadis Koukos

Abstract: Massive volumes of satellite photos have recently become accessible, and they can be enhanced with semantic annotations to produce earth observation products with added value. In order to enable quick and precise judgments of a spatiotemporal nature in a real operational environment, it is challenging to extract knowledge from the raw satellite data in an automated manner and to efficiently handle the retrieved information in a semantic fashion. In this work, we provide a system for the implementation of rule sets by the European Common Agricultural Policy that blends supervised learning for crop type classification on satellite imaging time-series with semantic web and linked data technologies (CAP). The system compiles georeferenced data from the internet as well as Sentinel-2 satellite photos. We associate each parcel with a particular crop through the analysis of image time-series that span the whole cultivation season. Additionally, we add a semantic layer to help with knowledge-driven management of the information that is already available. This layer leverages ontologies for knowledge representation and semantic rules to identify potential farmer noncompliance with the CAP's Greening 1 rule (crop diversification) and SMR 1 rule (protection of water against nitrate pollution) rules. In three different scenarios for crop type monitoring and consistency checking for noncompliance with the CAP rules—smart sampling of on-the-spot checks, automatic detection of the CAP's Greening 1 rule, and automatic detection of susceptible parcels in accordance with the CAP's SMR—experiments demonstrate the effectiveness of the proposed integrated approach.

4)Topic: **Finer Resolution Land-Cover Mapping Using Multiple Classifiers and Multisource Remotely Sensed Data in the Heihe River Basin**

Authors: Bo Zhong; Aixia Yang; Aihua Nie; Yanjuan Yao; Hang Zhang; Shanlong Wu; Qinhuo Liu

Abstract: For studies on eco-hydrological processes and earth system modelling, land-cover records are essential. Remote-sensing data have been used to create a variety of land-cover databases. However, they typically have limited spatial resolutions and insufficient classification accuracy, which makes them unsuitable for land surface modelling. As a result, a thorough approach for high-resolution monthly land-cover classification in the Heihe river basin (HRB) is created. Additionally, the main crops grown in the HRB are identified. The suggested approach combines data from several sources and multiple classifiers. The use of MODIS, HJ-1/CCD, Landsat/TM, and Google Earth photos constitutes three different forms of data. Multiple classifiers, such as thresholding, support vector machines (SVM), and object-based methods, as opposed to a single classifier, A thorough validation reveals significant improvement in the accuracy. The classification differences and benefits of the proposed method are first demonstrated by a visual comparison of the land-cover maps created using the proposed method and the conventional SVM method. The confusion matrix is used to assess classification accuracy, and results show that the HRB has an overall classification accuracy of over 90%, which is significantly greater than that of earlier methods. Additionally, a field campaign was run to assess the crop classification's overall accuracy. The crop classification was found to be 84.09% accurate overall.

5)Topic: **Evaluation of Multiorbital SAR and Multisensor Optical Data for Empirical Estimation of Rapeseed Biophysical Parameters**

Authors: Aubin Allies; Antoine Roumiguié; Jean-François Dejoux; Rémy Fieuzal; Anne Jacquin; Amanda Veloso; Luc Champolivier

Abstract: In order to determine rapeseed biophysical characteristics, this paper will assess the possibilities of multitemporal and multiorbital remote sensing data collected in both the microwave and optical domains (crop height, dry mass, fresh mass, and plant water content). The normalised difference vegetation index (NDVI), green fraction cover (fCover), and green area index (GAI) were derived from dense temporal series of 98 Landsat-8 and Sentinel-2 images, while the backscattering coefficients and radar vegetation index (RVI) were derived from 231 images acquired by synthetic aperture radar (SAR) onboard Sentinel-1 platform. Physical interpretations of the temporal fingerprints of these remote sensing indicators (RSI) were made using ground measurements of biophysical parameters collected over 14 winter rapeseed fields over the 2017–2018 growing season. The predictive value of the new indicators, which were based on the cumulative sum of each RSI, increased significantly. Results in particular show how SAR and optical data complement each other for monitoring rapeseed crops throughout their phenological cycles. The potential of the recently developed indicator based on the VH polarised backscatter coefficient to predict height (R 2 = 0.87), plant water content (R 2 = 0.77, from blossoming to harvest), and fresh mass (R 2 = 0.73) as well as RVI to estimate dry mass (R 2 = 0.82) is highlighted.

6)Topic: **Evaluation of Efficacy of Fungicides for Control of Wheat Fusarium Head Blight Based on Digital Imaging**

Authors: Dongyan Zhang; Zhicun Wang; Ning Jin; Chunyan Gu; Yu Chen; Yanbo Huang

Abstract: One of the most significant diseases of wheat in the world is fusarium head blight (FHB). For the control of FHB, evaluation and selection of efficient fungicides are crucial. To assess the effectiveness of fungicides, traditional approaches based on a manual disease severity evaluation are time-consuming and labor-intensive. In this work, we created a brand-new technique for quickly determining the extent of FHB and assessing the effectiveness of fungicide application regimens. A random forest classifier was used with features of colour, texture, geometry, and vegetation index for fine segmentation of disease spots in wheat ears. Enhanced red-green-green (RGG) images were processed from acquired raw red-green-blue (RGB) images of wheat ear samples; the images were transformed in colour spaces through K-means clustering for rough segmentation of wheat ears; The findings demonstrate that a wheat ear might be separated from a complicated field background using a segmentation technique. And the adhesion and blockage of wheat ear could be efficiently solved by the counting algorithm. With coefficients of determination (R 2) of 0.90 and 0.98 and root mean square errors (RMSE) of 10.56 and 7.52, respectively, the average counting accuracy of all and infected wheat ears was 93.00% and 92.64%, respectively. The six fungicides under consideration and the diseased levels of wheat eat groups affected by FHB could both be reliably determined using the novel approach.

7)Topic: **Machine Learning Based Prediction of Reference Evapotranspiration (ET_0) Using IoT**

Authors: Zhiming Hu; Rab Nawaz Bashir; Aqeel Ur Rehman; Salman Iqbal Iqbal; Malik Muhammad Ali Shahid; Ting Xu

Abstract: Correctly estimating the Reference For effective irrigation water management and conservation, evapotranspiration (ET 0) is crucial. The current ET 0 rate calculation techniques are difficult for farmers to use. A number of data-driven soft computing methodologies were also presented to compute the ET 0 with a small amount of data, in addition to the conventional methods of doing so. In order to determine the ET 0 rate based on directly observed environmental conditions in the agricultural field, we presented a temperature and humidity-based ML technique. The proposed Internet of Things (IoT) architecture senses crop field environmental factors for (ET 0) rate determination. Pakistani crop field environmental conditions from 2015 to 2021 are utilised to train and test the suggested model. For training and predicting the ET 0 -rate of crop fields, crop fields' directly detected temperature and humidity are passed to the model. The proposed strategy is evaluated using the 10-fold cross-validation method. In order to determine the ET 0 rate, the Food and Agriculture Organization (FAO) recommends using the Penman-Monteith method, which is compared to the proposed solution's correctness. With 92% accuracy, the KNN model outperforms the SVM, GNB, and ANN models when it comes to ML-based models. In comparison to the state-of-the-art method, the KNN model of ET 0 is more effective in reducing the Mean Absolute Errors (MAE) by 3% and the Root Mean Squared Errors (RMSE) by 16%.

8)Topic**:** An Improved Watermarking Technique for Copyright Protection Based on Tchebichef Moments

Authors**: Ferda Ernawan;Muhammed Nomani Kabir**

Abstract: A approach for preserving ownership of digital multimedia is watermarking. The majority of currently used watermarking methods accomplish good levels of robustness and imperceptibility. The difficulties of achieving greater resistance and invisibility with less processing time drive academics to develop novel watermarking systems. To increase the watermark's resistance capacity, JPEG2000 compression and robustness against noise attacks must be increased. We describe a block-based Tchebichef watermarking method for copyright protection in this research. In this method, Tchebichef moments are computed for each block after the host image is first separated into non-overlapping blocks. The blocks with lower visual entropies have the watermarks included into them. Arnold transform is used to scramble the watermark image before it is embedded in the Tchebichef seconds of the chosen image blocks. Watermarking is a method for protecting ownership of digital content. The majority of watermarking techniques in use today achieve respectable levels of resilience and imperceptibility. Academics are working on developing novel watermarking systems because it is challenging to provide better resistance and invisibility with less processing time. Increased JPEG2000 compression and durability against noise attacks are required to boost the watermark's resistance capabilities. In this study, we present a block-based Tchebichef watermarking technique for copyright protection. This technique divides the host image into non-overlapping blocks before computing Tchebichef moments for each block. The watermarks are incorporated into the blocks

with reduced visual entropies. Prior to being included into the Tchebichef seconds of the selected image, the watermark image is first altered using the Arnold transform.

9)Topic: **Solar** Powered **Water Security: An Enabler for Rural Development in Limpopo South Africa**

Authors**: Johan Meyer ;Sune von Solms**

Abstract**: This essay explains how a tiny village's rural growth was made possible by increased water security. The only source of water for the isolated settlement of Gwakwani in South Africa's Northern Limpopo province was a diesel-powered borehole pump. The expense and unpredictability of the diesel supply hindered the village's capacity to develop and grow. A solar-powered borehole pump was erected in the hamlet as a rural community development enabler, improving the community's access to and dependability of its water supply. It was possible to construct small-scale drip irrigation farming thanks to the installation of a second solar-powered borehole pump, which increased economic activity. This study examines the viability of installing solar water pumps in rural locations and demonstrates their advantages over diesel-powered water pumps. It is demonstrated how enhanced output of subsistence crops resulted from the presence of a steady water supply. This essay ends with a defence of the installation of sophisticated solar pumping systems as a spur to the growth of rural towns.**

10) Topic**: Spectral Identification of Stress Types for Maize Seedlings Under Single and Combined Stresses**

Authors : Baodong Ma ; Ruiliang Pu ; Song Zhang ; Lixin Wu

Abstract : **Plants frequently experience a variety of stressors alone or in combination. For the precise management of crops and environmental protection, timely and efficient**

plant stress monitoring is required. Based on spectral feature analysis, hyperspectral remote sensing could assist in demand monitoring. Existing research, including the combined stress type, is currently insufficient for the spectral identification of plant stress types. In this study, drought, copper, and their combined stressors on maize seedlings were used to compare plant characteristics and spectral indices with a control group in order to analyse differences. The outcomes of the experiment show that: 1) Leaf area, relative water content, and chlorophyll content could be used as key parameters to express the differences between different types of stress; in particular, chlorophyll content was the most significant bio-parameter because of its special ability to distinguish between combined stress and drought stress; and 2) red-edge position, the first derivative at the red edge, and the shortwave infrared water stress index were found to be useful for characterising the three plant parameters. The outcomes could be beneficial for agricultural precision management of crops as well as for the preservation and observation of the environment.