

Artificial Intelligence based models

for water management and pest management

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Agriculture needs help in handling the complexity, uncertainty and fuzziness inherent in its nature, and it requires new solutions for all aspects of agricultural production—from better and predictable crop planning, to precision farming, optimized resource application, support of efficient and collaborative processes using modern technology, fully or partially autonomous solutions for tedious work, up to the sustained long-term development of useful knowledge resources. In the recent decade, automated responses to such challenges in agriculture have been made possible with the help of GPS and mobile communication technology, which provide precise location data and offer the basis of all kinds of location-specific support. Making sense from the data that become available now, and using the resulting knowledge for process and operation improvement on all levels, brings into play Artificial Intelligence and their modelling and reasoning capabilities.

Key words: AI, Management, IoT, Pest, Water

FROM the Artificial Intelligence (AI) point of view, agriculture offers a vast application area for all kinds of AI core technologies: mobile, autonomous agents operating in uncontrolled environments, stand-alone or in collaborative settings, allow to investigate, test and exploit technologies from robotics, computer vision, sensing, and environment interaction. Integrating multiple partners and their heterogeneous information sources leads to application of semantic technologies. Further, owing to the complex nature of agricultural production, uncertainty in weather and other production parameters, location and context specific nature of the output demands progress in modelling capabilities. The growing interest in reliable predictions as a basis for planning and control of agricultural activities requires the interdisciplinary cooperation with domain experts e.g. from agricultural research, pathologists, engineers and AI specialists. Consequently, modern

agricultural machines shall use self-configuring components and shall be able to collaborate and exhibit aspects of artificial intelligence. This article presents know how of two digital models namely water management and pest management using AI potential. The presented models are based on various problems floated by ICAR for the event organised by Ministry of Human Resource and Development, Government of India (<https://sih.gov.in/>).

Digital Water Management using IoT and AI

The Internet of Things (IoT) is the concept of connecting any device to the internet and to other connected devices. The IoT is a giant network of connected things and people – all of which collect and share data about the way they are used and about the environment around them. Devices and objects with built in sensors are connected to an IoT platform, which integrates data from the different devices and applies analytics to share the most valuable

information with applications built to address specific needs. These powerful IoT platforms can pinpoint exactly what information is useful and what can safely be ignored using AI. This information can be used to detect patterns, make recommendations, and detect possible problems before they occur.

IoT based applications can be developed to enhance smart irrigation for farmers using microcontroller based Intelligent irrigation system controller which will allow irrigation to take place from remote places where manual inspection is not needed. The amount of soil moisture, humidity and temperature are indicated through suitable sensors. Based on that sensor values, the controller will activate the DC motor or pump by sending the commands to the farmers. Besides, it is possible to develop the irrigation controller through a mobile app where it consists of several parameters that can be selected according to the stage of the crop, climatic condition, and the amount

of moisture content. The temperature sensor is also used to find the climatic change that takes place in the atmosphere. Based on the weather conditions and historic weather data and associated crop and plant stage specific water requirement, irrigation water requirement can be predicted. Researchers as well as farmers can access all the dynamic data that provides insights into yield management.

Working: System contains the IoT for giving notification in the form of call and message about irrigation schedule using soil moisture sensor, temperature sensor and humidity sensor. Soil sensor will sense the moisture of the soil then notify to the farmer. Using android application farmers will be able to On/Off the motor automatically from anywhere to give water to the crops also check weather forecasting (Fig 1). Further analytics of the sensor data will provide insights to the crop yield management.

Technology details: The system use GSM module for sending notification such as call and message. A microcontroller is used for controlling sensors and GSM module. Soil moisture sensor is use for sensing soil quality which helps to use the soil associated water requirement model for the selected crop. GPS based weather forecasting further enable selection of correct scheduling plan. More details of such model is available in Fig 2. This model helps in water conservation, overcoming water scarcity and increase in yield production.

Image processing based Pest Management Models supported by mobile apps

India’s farmers are hard at work. They help to feed a nation that contains 1.3 billion people – one fifth of the world’s population. However, their productivity is threatened by pests that can ruin their crops and their livelihoods. Identifying a disease correctly when it first appears is a crucial step for efficient disease management and various efforts have been developed to prevent crop loss due to plant diseases. However, not much efforts have been observed in

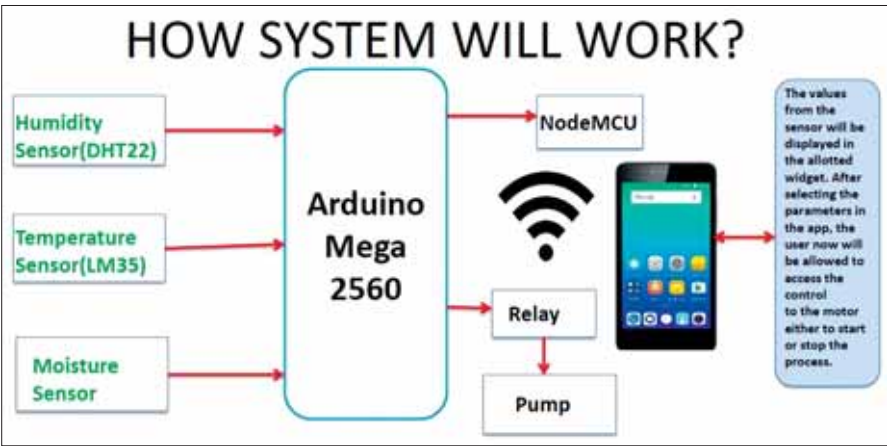


Fig. 1. Working of AI based digital water management

India in this direction even though some research is being done at international level (Table 1).

In more recent times, such efforts have additionally been supported by neural networks, machine learning techniques providing information for

disease diagnosis online or offline to farmers and researchers. In addition to increasing global smartphone penetration, recent advances in computer vision has paved the way for using deep learning for image-based plant disease detection. Deep

Table 1. Some AI based image processing models for disease identification

S. No.	Applications of Deep learning for image processing	References
1.	Banana leaves diseases	Amara J, Bouaziz B, and Algergawy A. 2017. A Deep Learning-based Approach for Banana Leaf Diseases Classification. In <i>BTW (Workshops)</i> (pp. 79-88)
2.	Fruit detection in orchards, including mangoes, almonds and apples	Bargoti S and Underwood J. (2017, May). Deep fruit detection in orchards. In <i>2017 IEEE International Conference on Robotics and Automation (ICRA)</i> (pp. 3626-3633). IEEE.
3.	Classification of 22 weeds	Dyrmann M, Karstoft H and Midtiby H S. 2016. Plant species classification using deep convolutional neural network. <i>Biosystems Engineering</i> , 151, 72-80.
4.	Classification of diseased and healthy plant for apple, cherry, banana, cabbage in different crop stages	Ferentinos, K. P. (2018). Deep learning models for plant disease detection and diagnosis. <i>Computers and Electronics in Agriculture</i> , 145, 311-318.
5.	Diseases and pests in tomato plants	Fuentes, A., Yoon, S., Kim, S. C., & Park, D. S. (2017). A robust deep-learning-based detector for real-time tomato plant diseases and pests recognition. <i>Sensors</i> , 17(9), 2022.
6.	26 diseases of apple, corn, tomato, orange	Mohanty, S. P., Hughes, D. P., & Salathé, M. (2016). Using deep learning for image-based plant disease detection. <i>Frontiers in plant science</i> , 7, 1419.
7.	Septoria rust of wheat in Spain and Germany	Johannes, A., Picon, A., Alvarez-Gila, A., Echazarra, J., Rodriguez-Vaamonde, S., Navajas, A. D., & Ortiz-Barredo, A. (2017). Automatic plant disease diagnosis using mobile capture devices, applied on a wheat use case. <i>Computers and Electronics in Agriculture</i> , 138, 200-209.
8.	Disease recognition model for Caffee	ÿpSladojevic, S., Arsenovic, M., Anderla, A., Culibrk, D., & Stefanovic, D. (2016). Deep neural networks based recognition of plant diseases by leaf image classification. <i>Computational intelligence and neuroscience</i> , 2016.

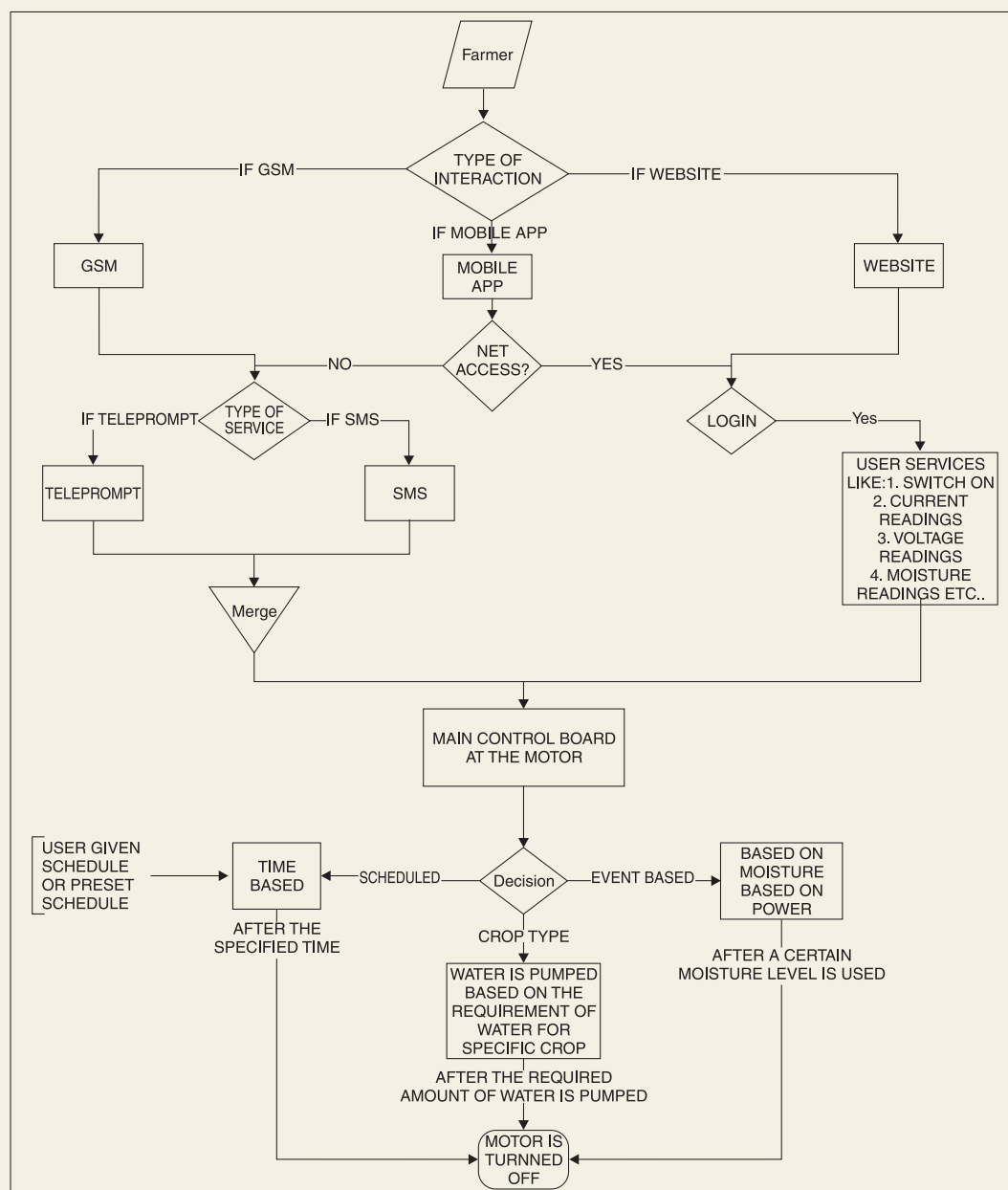


Fig. 2. Model of Digital Water Management for Irrigation Scheduling

learning based algorithms can be applied for image-based plant disease classification. In order to develop accurate image classifiers for the purposes of plant disease diagnosis, a large, verified dataset of images of diseased and healthy plants needs to be developed. AI based image processing models for disease identification as discussed in table 1 have been proved to show an accuracy between 91-99%. Application of such methods is illustrated with following example available at <https://www.intel.in/content/www/in/en/big-data/article/agriculture-harvests-big-data.html>.

A farmer in Texas checked the

direction of the wind and reckoned a swarm of grasshoppers was likely to descend on the southwest corner of his farm. But before he could check his crops, the farmer got an alert on his smartphone from the AI and data company he hires to help monitor his farm. Checking new satellite images against pictures of the same parcel over a five-year period, an AI algorithm detected that the insects had landed in another corner of the farmer's field. The farmer inspected the section, confirmed the warning was accurate and removed the costly pests from his field of nearly ripened corn.

Image processing based models as

discussed above need to be developed for India too. The modellers will require an extensive database of photographs of crops, weeds, other plants, trees, symptoms in the leaves that has been caused by pests, diseases and also typical examples of major and minor nutrient deficiency symptoms. These models can be subsequently used for development of an app for identification of crops, weeds, diseases, pest damage and nutrient deficiency symptoms. These apps will use AI based algorithms for object detection, image classification and pattern recognition algorithms. Once such apps are developed farmers or extension professional can identify the disease and suggest suitable measures to minimize the losses.

CONCLUSION

Artificial intelligence performs fixed and domain-specific tasks with computing capacity, unmatched learning speed, boundless data, and extraordinary efficiency. In a present scenario where India must produce more food with fewer resources, artificial intelligence holds the promise of driving a revolution in Indian agriculture. Moreover, in recent years' rapid adoption of Artificial Intelligence (AI) and Machine Learning techniques has seen increase in terms of agricultural products and in-field farming techniques.

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