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IoT for commercial fruit production

Sailakshmi S.* and Uma Maheswari T.

Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar – 608 802

Abstract

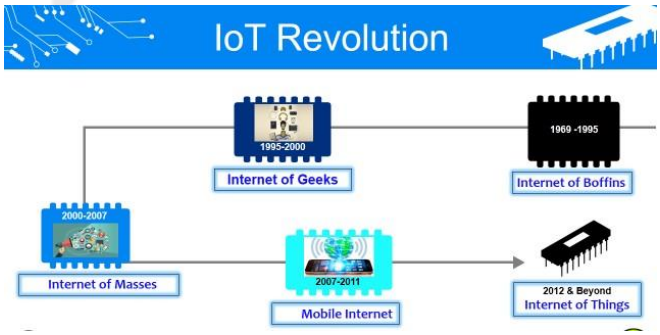
Fruits and vegetables are highly prone to a variety of pests and diseases. There is an increased trend in the use of pesticides and agrochemicals during its production to overcome this adverse situation. As a result, due to the extremes of levels in the humidity and temperature, the quality of the fruit as well as the yield gets affected. To mitigate this battle, the concept of IoT was introduced as a means to connect the internet to people and devices to facilitate easier access to data and information for users. This review article is focusing to address various IoT based systems to predict the various pests and diseases, on tree fruit monitoring systems used, smart farming and precision horticulture technique and supply chain management of fresh horticultural produce.

Keywords: Internet of Things, temperature, pesticides, humidity.

Introduction

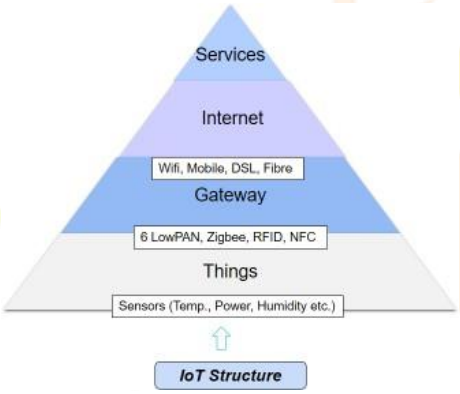
Internet of Things, in short, denotes the combination of people, internet and external devices. The term IoT was coined by Kevin Ashton in the year 1999. IoT uses various machines, drones, robots, sensors along with computer learning and cloud computing tools for analyzing and monitoring crops as well as for disease prediction. IoT in combination with image processing favours a great potential in the field of smart farming owing to its integration of data and sensor output (Chandra and Malaya, 2011). By this technology farmers can be able to monitor the on tree fruit status and adverse environmental conditions viz., temperature, relative humidity, soil moisture, etc., by means of cameras and sensors (Mavridou *et al.*, 2019). Various sensors such as rain sensor, soil moisture sensors, humidity sensors are used for accessing the data from the field and compare it those with a set of data to evaluate their effect on the fruit (Garcia *et al.*, 2020). To transform the labour intensive, experience based decision making to a more automatic, data driven precise prediction approach in horticultural production is a key for an automated monitoring system at a high spatiotemporal resolution. Most importantly, IoT deployment in the field of crop, microclimate and soil sensing has transformed traditional experience based crop monitoring system into a more quantitative and data driven task.

Timeline of IoT



Why IoT for Horticulture?

- ✓ To enhance the quantity and quality of the produce at a reduced cost with added precision.
- ✓ IoT based methods provide improved ways in irrigation techniques and help farmers to decide the optimum quantity and right time for water.
- ✓ It gives a major leap to this with direct benefit of technology and information.
- ✓ IoT drives automation to next level with sophisticated decision making



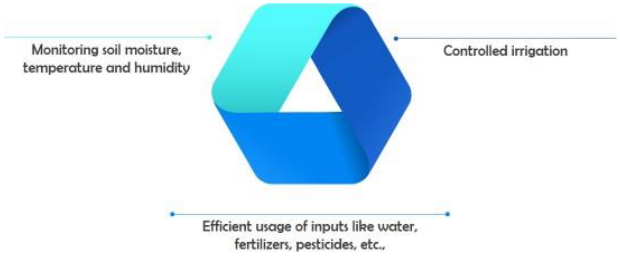
by the use of connectivity and data.

Structure of IoT

Applications of IoT

Constraints of IoT

Various constraints of IoT include 1. Small and dispersed land holdings. 2. Complexity, scalability and affordability of the technologies. 3. Privacy and security concerns. 4. Internet connectivity and availability. 5. Lack of awareness,



investments and capital. 6. Environmental impact.

IoT for Mango

India is the leading producer of mango production. Various pests that attacks mango include spiraling whitefly, Thrips, leafhoppers, etc. The major diseases of mango are powdery mildew, bacterial canker and Blossom Blight. In recent years, mango thrips pose a serious issue in many parts of India. Starting from the vegetative stage, thrips feed on the petals, pollens, anthers and various floral nectaries resulting in both vegetative and floral malformation (Gundappa and Shukla, 2016). Jawade *et al.*, (2020) conducted a survey of five villages in Devgad Taluk to predict the trend in the outbreak of thrips in that area. They proposed an architecture which consists of data acquisition, training by means of algorithm and prediction using a trained machine learning model. In this disease prediction, Random Forest Algorithm was used owing to its mean absolute error.

Data on temperature and humidity was given as input to the algorithm for prediction. The predicted attack value of algorithm ranging from 0.9 to 0.3 for each day. The outbreak of pest for next five days was predicted using the average value of five days. By this module, farmers were alerted two days prior to the predicted pest outbreak. They found that those farmers who were alerted in advance have an average feedback of 0.35 to 0.4 after taking preventive measures. Shiro Tamaki *et al.*, (2019) aimed at developing an IoT based mango production system to combat the problems of output yield and quality influenced by adverse environmental conditions.

IoT for Banana

Ponni and Vijayakumar (2018) developed a Raspberry Pi model for Banana Tree Monitoring system using IoT. This model facilitates farmers with time to time prediction by alerting farmers by providing data on temperature, relative humidity, moisture level, pH of the farm. Deshmukh *et al.*, 2022 developed an IoT based solar banana dryer monitoring and control system to automate solar dryer and monitor dryer air velocity, humidity and temperature at optimum drying level. To monitor and control the dryer an ESP8266 Node MCU and three DHT22 Digital Temperature and humidity sensors were used which can be done using a smartphone.

IoT for Guava

Slamet *et al.*, (2017) proposed an IoT based Growth monitoring system of guava fruits using a low cost optoelectronic sensor. The principle behind the operation was to detect alternating black and white narrow bar printed upon reflective tapes, which is installed to follow the radial growth of the fruit. As a result, the infrared sensor would response to the reflective movements of the tape. The data which were collected from the sensors were compared in real time. The sensors have the capacity to measure the radial growth of fruits with a maximum error of 2 mm. The success rate with these sensors was found to be 97.54%.

Daudi Samson (2022) conducted a study on the IoT based early identification of Guava leaves and fruit diseases. He deployed this using ESP32 CAM for collection of images of guava leaves and fruits. The data acquired were compared with the set of data and hence used for diagnosis of plant diseases by means of leaves and fruits. This system is found to be best for estimation of guava fruit diseases viz., Canker, Mummification, Rust and Dot.

IoT for Apple

The quality of the fruit is highly affected due to the attack of a wide range of pests and diseases. The major reason behind this issue is that the appearance of the disease remains hidden. As result, this fruit face a huge loss during its post harvest operations. Due to the variations in temperature and humidity, various diseases like Scab, Canker, Powdery Mildew, Sooty mould, Core Rot, etc.,. To overcome this problem, Karuna Sheel and Anil Sharma (2020) developed an IoT system to predict the emergence of diseases and to provide a prompt solution that would be helpful for the farmers. They used DHT11 for predicting the temperature and relative humidity with an Arduino Uno Board and a Raspberry Pi minicomputer board.

IoT for Grapes

Grape cultivation has been increased rapidly over the past few years with the introduction of greenhouses and wide scale availability of enormous fungicides and pesticides thereby providing better returns to farmers. Zhang Weifeng and Li Zengyuan conducted a detailed study on improving the Yield and Quality of Grape production in China with IoT by means of deploying IoT sensors to measure the various factors of impeding production such as irrigation, temperature, humidity and fertigation. They installed IoT devices such as those used for monitoring light intensity, soil conditions (temperature, humidity, CO_2 concentrations) and leaf moisture. To obtain more accurate information on the environmental data, collecting data on temperature, pressure, humidity, air velocity, light intensity, wind direction and speed and rainfall, a connected weather station was installed.

IoT for Strawberry

Strawberries are highly sensitive to various pests and diseases. Hence, there is an enormous use of pesticides and fungicides during the vegetative and reproductive stages. As a result, the quality of the fruits gets adversely affected. To mitigate this problem, Mateus Cruz *et al.*, (2022) developed an IoT model for smart strawberry farming using edge computing. They combined Yolo v5 architecture to combat diseases in real time with accuracy of around 92% efficient disease detection. This system also supports LoRa communication for long distance data transmission. The CV application is provided to cater the basic needs, 1. To implement and use high accuracy model in remote locations without the need of internet connectivity. 2. Detection of strawberry diseases in real time. 3. To identify the major diseases in strawberry farming.

IoT for Citrus

Sindhu and Indhrani (2020) depicted a set of sample images in contrast with citrus fruit diseases. The model consists of 1000 images of different citrus fruit diseases like Anthracnose, Scab, Canker, etc. The dimensions of the test images of fruits and leaves is around 100 x 150 pixels with 96 dbi. The chosen disease undergoes its validation process with help of data sets and classified them into respective classes. The accuracy value was found to be 94.50% with Enhanced Bat Algorithm and Decision Tree. The simple methodoly involves capturing the fruit images initially from the farming land by the use of camera sensors. Then it is connected to an IoT device called Raspberry Pi3 which serves as a mediator in receiving the image and transmits it to the cloud and finally testing and training takes place.

Conclusion

The IoT based disease and pest prediction, On Tree monitoring system can be used on horticultural farms with a high degree of accuracy. Autonomous sensor devices plays a key role in gathering a set of data as input for monitoring system and then they send signals to the actuators in the control unit. The interesting role played by IoT is to connect devices via internet and provide access information to users. IoT enables its users to operate its system and monitor the predictions without the need of internet connectivity. This system enables farmers to achieve cost reduction, savings in inputs and to monitor the production process of horticultural produce.

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