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INTELLIGENT MONITORING OF PAPAYA TREES USING IOT-BASED SENSORS

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ABSTRACT

The boom of IoT Technology emphasizes its significance in various applications like Smart Farming and Manufacturing. In India Agriculture is an important sector since it is a major contributor to the Nation's economy. In India, there are certain factors as hurdles to growing well in agriculture. The aim of this work is to employ smart farming of Papaya Trees using IoT. This smart system monitors the growth of the Papaya tree as well as the weather conditions like moisture, humidity, and temperature through sensors. The main component of this proposed system is to control the watering of crops using mobile application with a help of smartphone. This paper also discusses the design and development of the system which uses sensors in the crop field and the data administration using smartphone and web technology. This will reduce human intervention and increase the productivity of the crop.

Keywords: Irrigation, IoT, Machine Learning, Precipitation

1. INTRODUCTION

Agriculture is act as a backbone of the Indian economy. More than 60 % population of India depends on agriculture. Indian agriculture has had remarkable growth over the last few decades. India is the largest manufacturer of wheat and rice and several dry fruits, roots, pulses, sugarcane coconut, and vegetables. India turns into the most populated country in the world and the UN report says that it is estimated to be about 164 billion by 2050.Increasing population and food demand always remain the most important challenges Rangappa & Chetan (2022), Mandyck & Eric (2015). Nowadays, challenges in the agriculture sector are getting global attention and require feasible solutions in all parts of the world Mandyck & Eric (2015).

The infiltration of technology in agriculture leads to sufficient food requirements. Recently, the Internet of Things (IoT) plays a crucial role in agriculture. So much research is carried out using the IoT and Wireless communication. It is the tool for developing smart city, smart healthcare, smart schools and wearable, and is also used in agriculture, and so many industries. Agriculture is one of the most investigated components of IoT and acts as a breakthrough in the modern agriculture field. Due to the increase in global population, it is essential to ensure food security Hadolikar et al. (2021).

In India, the economy of Fruits and vegetables contribute 3.7 trillion Indian rupees in the fiscal year 2019. During the fiscal year 2019, fruits and vegetables were the most significant contributors among crops. Papaya is a tropical fruit that has high nutritive and medicinal value. Every year India produces 3 million tonnes of papaya Dinesh et al. (2022), Kumar (2021). It is important to boost the productivity of papaya with cost-effectiveness by using IoT. This work aimed to reduce human intervention and increase the production of papaya through automation. Three major components are used in this work. First, the sensors sense the data about crop and weather conditions. Second, manipulate data about the growth of the crop and field information and transfer it through web applications. Finally, the crops are watered by the control of a mobile application. This research work is prepared as follows: Section 2 explains the related work, Section 3 describes the proposed system, and Section 4 concludes this research work.

2. RELATED WORK

In this technical era, IoTs have been used in agriculture as a modern tool to improve production and management, as discussed in Ojha et al. (2015), Shenoy & Pingle (2016), Brewster et al. (2017), Farooqet al. (2019). The use of IoT in agriculture improve crop production with reduced cost. The use of WSN (Wireless Sensor Networks) in precision agriculture helps the farmers to get statistical data about the field and make well-informed decisions Kodali et al. (2014).

In 2014 Fang et al. (2014) set up a new integrated information system (IIS) based on IoT for environmental monitoring and management. This IIS merge IoTs, Cloud Computing, Geoinformatics (RS, GIS, and GPS), and e-Science for environmental monitoring and management for improving the efficiency of complex tasks like regional climate change and its ecological responses. This shows the greatest benefit that not only collecting data with the help of IoTs but also using web applications with cloud computing and e-Science platforms. Monitoring and management were improved effectively.

The agro-industrial production chain also adopted IoT Medela et al. (2013), Ruan & Shi (2016), Capello et al. (2016). They discovered an architecture that uses IoTs which combines wireless and distributed sensors for climatic conditions, to track the growth of grapes for wineries. Xiangyu et al., introduced embedded IOT-Radio Frequency identification, GPS, and smart sensors to transfer data from the field. This data is recorded using RFID Xiangyu & Qian (2011).

In agriculture, so many sensors are used and they are reported in Rehman et al. (2014), Farooq et al. (2020). Sensors used in the field of agriculture are classified into three main classes: physical property type sensors, biosensors, and micro-electro-mechanical system (MEMS) sensors Placidi et al. (2021), Shi et al. (2019). Remote sensing techniques use IoT sensors for monitoring various parameters, like soil water content, temperature, pH level, air humidity, light, and pressure Shi et (2019), Sagheer et al. (2020), Shafi et al. (2019), Messina & Modica (2020). An integrated soil analyzer is used to estimate the pH value of the soil. The analyzer analyses the different values for various soil nutrients. This Embedded Based Soil Analyser system combines a signal conditioning unit, a processing controlling unit. This method predicts the nutrients like potassium, phosphorus, and nitrogen in soil Sivachandran et al. (2014). The real-time monitoring system monitors agricultural fields' humidity, temperature, wind direction, water level, and climate. The problems found in wired communication system can be solved with the help of wireless communication Pusatkar & Gulhane (2016).

Real-time sensors are used in soil and broadcast data without the help of human. In this technological era, implement lot of low-cost sensors to change over physical quantity and also perform post-processing of raw data to extract helpful information Danita et al. (2018), Gnecchi et al. (2008), Ruiz-Garcia et al. (2009).

Precision Agriculture (PA) is the process of integrating information and control technologies in the process of agriculture. To achieve optimized and profitable PA, apply different technologies like micro-electro-mechanical Systems, enhanced machinery, Wireless Sensor Networks (WSN), and computer systems Erickson & Fausti (2021). Wireless Sensor Networks (WSNs) have widely been adopted in agriculture and livestock farming Pawlowski et al. (2009), Germani et al. (2019) due to installation flexibility. The Internet technology is act as a data-intensive industry for agriculture. Farmers can retrieve huge amount of information from physical sensors to improve production Haseeb et al. (2020).

The data collected by sensors and Remote Sensing are used for a smart farming system with environmental factors. Data processing act as a significant role in IoT-based applications. After collecting the data from the server, they are analyzed by analytics techniques. Different types of analytics are used such as real-time analytics, offline analytics, memory level analytics, business intelligence level analytics, and massive level analytics. The decision-making take place with the help of this data analysis. Vermesan et al. (2009).

3. SYSTEM ARCHITECTURE

This research work employs IoTs in Papaya farm that helps the farmers to improve the production. Moreover, the farmers can save time and increase production and profits. The real-time information about the field from IoTs sensors is managed to automatically control the on-off button of drip irrigation. At the start, the data was collected from IoT devices for 8 days and yield analysis can be done with these data. The temperature, moisture and humidity was collected every1 hour. The daily averages were used for analysis.

3.1. ARCHITECTURE OF THE PROPOSED SYSTEM

The design of the proposed work consists of sensors in the field of Papaya crop, and the data collected by sensors are managed with a smartphone with a help of the web enabled application. There are three main elements were used namely sensors, web enabled application and smartphone application, as described in Figure 1. In the architecture Control box is the first component, it is planned to supervise the IoT sensors and receive information from the crop field.

Figure 1

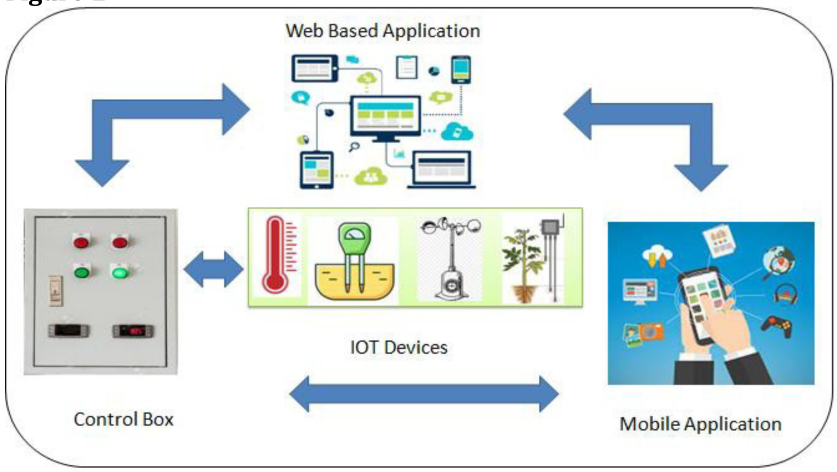

Figure 1 Design of the Proposed System

The next component of this architecture is a web application that manages the information from IoT devices. The web-based application intimates the administrator about the water requirement of the crop. The third component is the mobile application, which provides two types of services such as watering manually by former or automatically. This research work can automatically turn on/off motor for irrigation based on IoT information.

The proposed working model is shown in Figure 2. It has three levels namely the Data acquirement level, Communication level, and Application level. In the data acquirement level, the environmental factors are collected by using sensors. In communication level, the gathered data is deposited in the server. In application level, the data is accumulated and monitored/ controlled the Papaya. By analyzing the data we can say the water requirement of the crops in future. The summarization of the proposed mechanisms is displayed in Figure 3 and also the

Figure 2

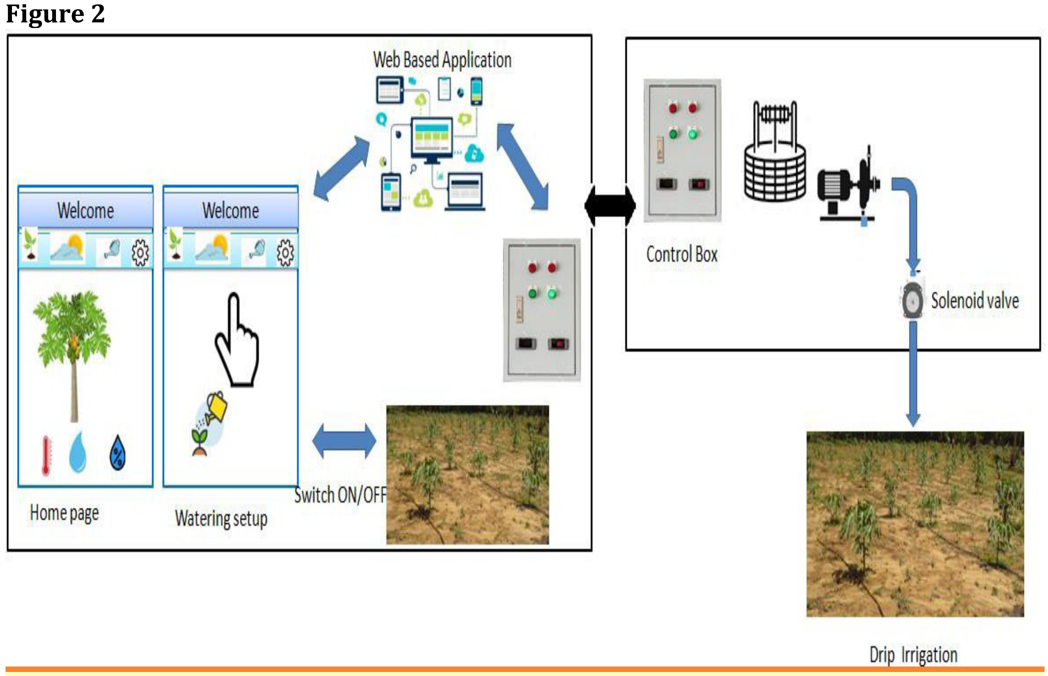

Figure 2 Design Model of the Proposed Work

Data mining is a technique of learning knowledge from large raw data. The first step is Data pre-processing. In this step data organization, data incorporation, and data conversion take place. The proposed work uses a large amount of data which are collected from IoT devices such as temperature, humidity, and soil moisture. This data is converted into a distinct format to hold data modeling. The next step is Data reduction: Here the data is encoded into a smaller reduced representation. The Data Cube Aggregation technique is used for data reduction. The third step is Data modeling/discovery. Here the knowledge is extracted from the equipped data. Association rules are used to discover relationships between the collected data. The SETM algorithm is used to extract association rules from data.

Figure 3

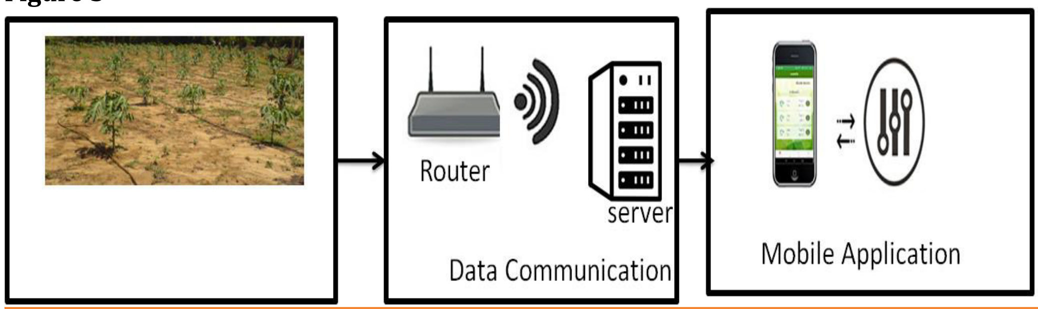

Figure 3 Formal Mechanism of the Proposed System

3.2. IMPLEMENTATION OF THE PROPOSED WORK

As discussed earlier the proposed system has three parts namely sensors, a web enabled application, and smartphone application. Electronic devices are kept in a waterproof control box, and they can be placed anywhere in the farm. The soil moisture sensors, DHT22 sensor, and solenoid valve are connected to the control box. In this proposed work, the soil moisture sensor is applied to calculate the moisture level in the crop field. The solenoid valve is used to manage on/off function of the motor. The web application gathers agriculture information from NodeMCU. WiFi connection is used to accesses the internet.

The web application is applied to control watering in crop field. The last part was an interface to communicate the farmer. The smartphone application controls the on-off function of the motor. By two ways the farmer can watering the crops; automatic and manual. The automatic watering function was operates when it receives the defined value from the sensors. Using mobile application, the farmer can control the watering.

4. DISCUSSION

The proposed system utilizes IoT sensors to gather data like humidity, and soil moisture levels which are obtained from the DHT22 sensor and soil moisture sensor. This data can be viewed by the farmer which is displayed on his mobile phone with the help of the mobile application. The farmer can enable the automatic on/off control of watering. The status of on-off switching can be informed via the LINE Application. Maintaining soil moisture is important in papaya irrigation. Extend moisture level will reduce the growth and support the production of several male or sterile flowers. This will cause poor fruit set on the papaya tree. Maintaining the fruitfulness of papaya depends on managing proper soil moisture. Whenever the soil moisture level reduced a message will be automatically forward to the farmer's mobile via app. The obtained sensor data such as the moisture level, temperature, and humidity data shown in Figure 4, Figure 5 and Figure 6.

Figure 4

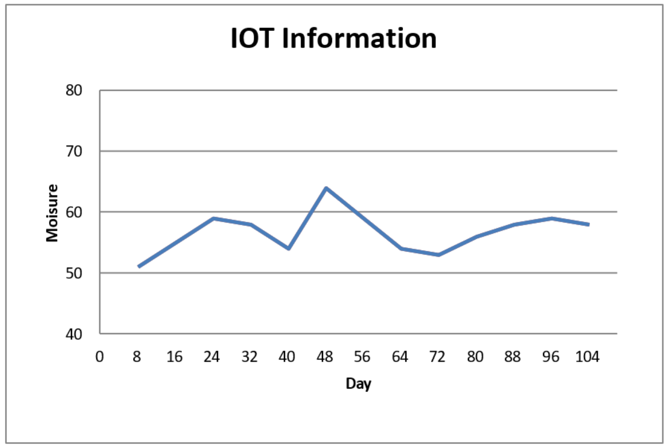

Figure 4 Moisture Level Obtained by IoT Sensor

Figure 5

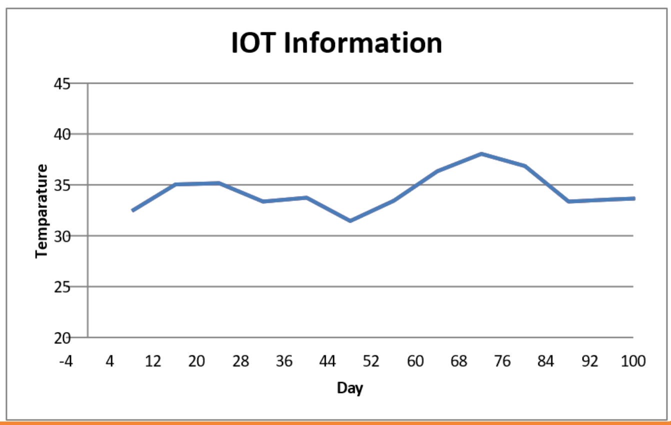

Figure 5 Temperature Level Obtained by IoT Sensor

Figure 6

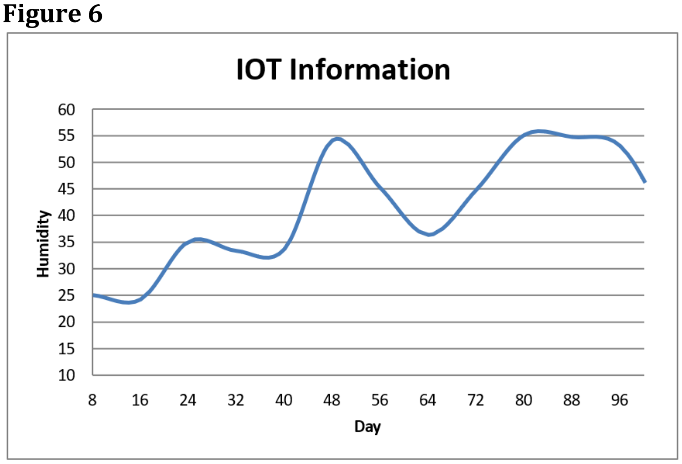

Figure 6 Humidity Level Obtained by IoT Sensor

5. CONCLUSION

IoTs are utilised in the field of agriculture to upgrade crop yields with low cost. This paper proposed a WSN application for watering papaya crops. Fruitfulness in papaya depends on maintaining proper soil moisture. This work is designed and implemented to observe the environmental factors such as humidity, moisture and temperature in the crop fields. This proposed design is used to receive field information using sensors. The farmer can use the WSN to receive crop and field information through sensors. This proposed work monitors the soil moisture and controls the watering of papaya automatically with a help of a mobile application on a smartphone. It is found that through drip irrigation a plant need 6-8 liter per day gives better yields. This work shows high potential benefits in agriculture using digital technology applications.

CONFLICT OF INTERESTS

None.

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