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IoT-Based Plant Monitoring and Automated Irrigation: Transforming Agriculture for Sustainable Growth and Resource Efficiency

As the global population continues to expand, the demand for increased food production places substantial pressure on agriculture to optimize resource use and mitigate plant stress. Modern technologies, such as IoT-based plant monitoring and automated irrigation, offer vital solutions. These systems utilize sensors and technologies to continuously monitor soil moisture, environmental conditions, and plant health, alleviating plant stress. Real-time data optimizes irrigation, conserving water, and improving yields. These systems also regulate greenhouse conditions for various crops. In this context, IoT-based solutions represent a transformative advancement in agriculture, crucial for regions with limited water supplies or impractical manual watering.

This work focuses on an IoT (Internet of Things)-based plant monitoring system. It collects real-time data on soil moisture, ambient temperature, and humidity using a capacitive soil moisture sensor from Xcluma and the DHT11 temperature and humidity sensor. This data is processed, activating instruments to maintain optimal parameters essential for plant growth. The system also alerts users when unfavorable conditions arise, such as low soil moisture, high temperatures, or insufficient humidity. To achieve these goals, we employed a capacitive soil moisture sensor from Xcluma and the DHT11 sensor. The data acquisition system utilized an ATmega 328P-based Arduino Uno development board, while an ESP8266 microcontroller served as the IoT module, transmitting data to the cloud. Calibration involved drying soil to remove humidity, followed by systematic increments of water up to 80 ml while recording data. The DHT11 sensor recorded ambient temperature and humidity readings every 5 minutes. A web application with a smartphone dashboard was created for remote monitoring. An algorithm autonomously controlled and monitored the irrigation supply.

In summary, the fusion of IoT technology with agriculture represents a frontier of agricultural innovation. The IoT-based plant monitoring and automated irrigation system exemplify technology's capacity to transform farming practices, optimize resources, increase yields, and promote sustainability. These systems showcase our ability to use technology to enhance agriculture and preserve natural resources.

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