Utilization of IoT-Based Devices for the Implementation of Smart Farming Concept in Greenhouse Environments

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Abstract

Given the current problem of global food shortages, which are escalating due to climate change, the use of smart greenhouse systems is becoming increasingly important. These controlled environments allow for precise control of the microclimate, resulting in higher crop yields per square meter compared to traditional outdoor farming. This project aimed to improve existing manual systems by developing a smart greenhouse monitoring system using IoT technologies using low-cost IoT devices powered by solar energy. The system enables continuous monitoring of the natural environmental parameters in the greenhouse and integrates various sensors such as DHT11, YL-69, BH1750, MQ135, MQ2 and MQ4 sensors with microcontrollers such as Arduino Uno and NodeMCU ESP8266. The system's architecture enables continuous data transmission into the IoT cloud platform, with a SIM900A GSM module sending messages to the user when adverse conditions occur. Thorough testing confirmed accurate measurements of temperature (DHT11), humidity (DHT11), soil moisture (YL-69), light intensity (BH1750) and air quality parameters (MQ135, MQ2 and MQ4) and there were significant differences between units, particularly in temperature and humidity as indicated by the mean absolute error values, and soil moisture was different compared to manual readings (±8%), proving this system accuracy and reliability for on-farm and off-farm monitoring. Innovative features include the use of solar energy and the development of an IoT monitoring system. Future research could also focus on system optimization, additional sensor integration, mobile application development, and integration of real-time actuator feedback and these efforts would contribute to advances in smart greenhouse monitoring and IoT technologies.

Keywords: Arduino, Automation, IoT, NodeMCU, Sensor integration, Smart greenhouse systems

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