Design and Construction of a Hydroponic Plant Nutrition Monitoring and Control System Using an IoT-Based Esp32 Microcontroller

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ABSTRACT

The success of a hydroponic system depends heavily on the quality of the nutrient water, including optimal nutrient concentration (TDS) and water temperature. Manual monitoring of these parameters is often inefficient and can lead to delays in addressing suboptimal conditions. This research aims to develop an IoT-based, automated control and monitoring system for hydroponic nutrients and water temperature that can be accessed remotely. The system uses a NodeMCU ESP32 microcontroller, a TDS sensor, a DS18B20 temperature sensor, and an LDR sensor to control LED grow lights. A 12V DC nutrient pump is controlled via a relay module to add nutrients when needed. Sensor data is sent to a Firebase database and integrated with the MIT App Inventor mobile application and the Telegram notification system. Test results show that the system successfully performs automatic monitoring and control. Testing of the TDS sensor (420-1250 ppm) can activate the nutrient pump when the value is below 800 ppm. The DS18B20 temperature sensor (23.5-33.2°C) provides accurate temperature status. The LDR sensor controls the LED grow lights based on a light intensity of 1000 lux. The mobile app displays real-time data with a 2-3 second delay, while Telegram notifications have a 12-hour delay. The IoT-based hydroponic control and monitoring system has proven to be automated and allows for easy remote monitoring of plant conditions, contributing to the development of more efficient modern agricultural technology.

Keywords*: Hydroponics, IoT, NodeMCU ESP32, TDS, Monitoring, Automatic Control.*