


Chapter 4

Smart Hydroponics: Revolutionizing Agriculture With IoT and Cloud

Soumyajit Pal


 <https://orcid.org/0009-0006-9902-8653>

St. Xavier's College (Autonomous), Kolkata, India

Jaychandra De

St. Xavier's College (Autonomous), Kolkata, India

Debamoy Datta

 <https://orcid.org/0009-0005-8071-324X>

St. Xavier's College (Autonomous), Kolkata, India

ABSTRACT

Agriculture plays a significant role in the economic growth of a nation. Modern farming techniques involve growing plants in a soilless ecosystem with the help of nutrient solution. This alternative paradigm of sustainable agriculture falls under the field of hydroponics. In an effort to control the hydroponics plant growth, Internet of Things (IoT) and cloud computing are proving to be useful. IoT allows machine-to-machine (M2M) interaction, thereby controlling the hydroponics system autonomously and intelligently. The current work proposes an autonomous IoT-based hydroponics system developed using the Arduino Nano microcontroller, sensors, actuators and services in the cloud. The system is capable of providing the appropriate hydroponics environment based on multiple physical parameters. A prototype for chili plant growth as a case study is developed.

DOI: 10.4018/979-8-3693-6336-2.ch004

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1 INTRODUCTION

Agriculture is a key sector, which significantly contributes to the economic growth of nations, especially those having a large rural population (Alston & Pardey, 2014). A self-reliant agricultural system helps a country to abundantly feed its people, thereby creating a healthy workforce which contributes to economic growth. It also fosters global partnership by helping regions facing acute food shortage, as was seen during the Covid-19 pandemic, where India helped countries like Afghanistan, Sudan, Zimbabwe, among others, with thousands of metric tonnes of wheat, rice, pulses and lentils. (MoE, 2022; Chakradeo, 2020) Additionally, a robust agrarian economy also helps combat the malnutrition and the effects associated with it (Srivastava & Arya, 2021; Arya & Bisht, 2022). Agriculture in its native form is not suited in the current scenario where challenges of population growth (Alexandratos & Bruinsma, 2012) and climate change exist (Habibur-ur-Rahman et al., 2022; Zhao & Huang, 2023). Practices have to be in line with environment preservation. Thus, there is a need to adopt sustainable agricultural practices where every measure is guided by its environmental impact. A growing population which aspires for urbanisation needs to be adequately fed using food crops which are ecologically consistent. For example, farmers should grow a variety of crops instead of relying on a single crop (Nahar et al., 2024; Kurdyś-Kujawska, 2021). Irrigation practices should be well investigated so as not to deplete the groundwater levels (Paria et al., 2021). All these constraints necessitated a shift to sustainable agriculture, where every agricultural practice is pre-assessed by its impact on the surrounding environment. This helps the agricultural sector to not only become a viable economic framework but also prevents it from becoming a weapon aggravating anthropogenic climate change (Habibur-ur-Rahman et al., 2022; Zhao & Huang, 2023). However, a growing population means more people to feed by greatly increasing food production. Feeding a large aspirational urban economy is not a trivial task (Alexandratos & Bruinsma, 2012). Factors such as quick food production, maintaining nutritional value in food items and adopting sustainable practices are challenges that the farmer alone cannot meet. Often times the need for quickening crop yield necessitates exorbitant usage of pesticides leading to health issues of the consumer (Nicolopoulou-Stamati, 2021). Widespread automation is needed in the agricultural sector where the knowledgeable farmer takes help of technology to meet the demands of the future.

The human population has continuously grown. Consequently, the urban middle class has also grown at a rapid rate, and is set to grow even further (Shaban, 2021). Additionally, the modern youth is more aspirational than ever. The farmer alone cannot take up the burden of food production. He requires the assistance of technology. It is imperative to educate the farmer regarding the use of modern farming techniques. This will automate farming practices to a large extent, making it a lot

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