# AUTO GREEN: A GREENHOUSE AUTOMATION BASED ON ARDUINO FOR DEPARTMENT OF AGRICULTURE IN TAGUM CITY

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## ABSTRACT

A hydroponic greenhouse is a production method that uses water instead of soil to give nutrients to the plants. The Department of Agriculture advocates an urban agriculture to help the low areas to their income generating activity. This study aims to provide an automation or monitoring solution in order the assigned personnel to avoid less hassle. By using Arduino, we can automate the machine and provide a mobile application.

**Keywords:** *BS Computer Science, hydroponic, greenhouse, automation, IoT, Philippines*

## INTRODUCTION

A greenhouse is a plastic-enclosed structure used in growing plants. It is a controlled environment for plants to grow faster and productively. Temperature, humidity, light, and ventilation is one of the most important measures in greenhouse. Failure of monitoring the temperature, humidity, light, and ventilation will result in failure farming(*Encyclopedia Britannica*, n.d.)[1].

Tagum City is one of the fastest growing cities in Davao Region (*Executive Summary*, n.d.) [2]. Due to urbanization, population continues growing rapidly while farmland was converted into commercial areas such as housing, and commercial buildings and it will result in food shortage. The Government in Tagum City specially department of Agriculture, thought that Greenhouse can prevent the food shortage in the city, because it only needs a small area to produce a good amount of food. However, maintaining the greenhouse is a huge work. It needs to be check from time-to-time to avoid failure.

Department of Agriculture in Tagum City manually operate and monitor the greenhouse which needs an enough amount of manpower. There are possibilities of delays and failure to act due to non-working days that will result in failure farming and throwing of money and time invested.

The Internet of Things' potential for controlling plant growth factors is the primary focus of this study. While contrasting plants with controlled growth factors and unregulated systems, regulated plant growth factors are in the desired range of the plant, whereas in unrestrained systems there are undesirable value spans of the plant, which can cause the plant to not fully grow or even wither [3]. Based on cloud computing platforms and wireless networks, the Internet of Things (IoT) is a network of "connected objects and objects." It gathers information from sensor groups and does decision making to influence the way it operates control and feedback of

objects, such the greenhouse monitoring system. The Internet of Things has altered the traditional agricultural production model, transforming it into the "smart agriculture" manufacturing-operation-sales model, which at this point in China's agricultural development provides a path toward resilience [4].

Thai government is attempting to increase agricultural output. Thailand 4.0" should be changed to make a significant transition from traditional agriculture to modern agriculture by emphasizing smart farming. Hydroponics has become popular to grow plants without soil. The system can regulate important environmental elements like water, humidity, and temperature that have an impact on plant growth. The application system automatically mixes the chosen solution to produce the desired value. It also gathers data on how much solution was mixed at the time of planting. This information can be used to estimate the cost of growing vegetables and determine the profitability of each vegetable to help farmers decide whether to grow them [5].

Automation, mechanized labor, and automated work are ideas that have been around for a long time. Automation is defined as "the application of machines to previously performed by humans' tasks or, increasingly, to tasks that would otherwise be impossible. While the term "mechanization" is frequently used to describe the straightforward substitution of machines for human labor, "automation" generally refers to the incorporation of machines into a self-governing system." [6].

Using both wired and wireless Internet, the Internet of Things (IoT) is a network of gadgets for M2M communication. An innovative technology that can be used to increase agricultural production all year round is the Internet of Things in agriculture. of different types of communications, such as 5G. With better crop quality and output as well as labor savings, IoT-based agriculture outfitted with a communication system suitable for each agricultural setting can advance agricultural automation [7].

Controlled environment agriculture is a crucial tactic for year-round crop production given the rising global demand for food. Greenhouses are a significant type of controlled environment agriculture. For optimum crop development in greenhouses, key interior environmental factors such carbon dioxide, moisture, illumination, and temperature must be controlled. Because of their lightweight design and ineffective operation, greenhouses take more fossil fuel energy to run their mechanical systems than other structures of the same size, which results in greater carbon footprints. Therefore, energy simulations help analyze the complex thermal processes in greenhouse operation and contribute to energy efficient greenhouse operation [8].

Maintaining environmental variables like humidity, temperature, etc. at an appropriate level is a constraint of hydroponic plant cultivation in a greenhouse environment. Additionally, it is already common practice to manually monitor crops, which is a very little task. The goal of the research is to create a fully automated, Internet of Things (IoT)-based hydroponic framework that would support crop development in an environment that is adaptable. It may be used to statistically optimize greenhouse farming and automate most labor-intensive chores [9].

The key concern with greenhouse-based farming is to address the greenhouse conditions as best as possible to satisfy both the economic and ecological requirements. Extreme heat and humidity must be regulated, and irrigation is crucial to provide moisture. Data logging and Automated Greenhouse System planning are the solutions to these issues Watering system, humidity, and temperature sensor are the regulated variables in a greenhouse. The procedure is manually configured to make it simpler to monitor the greenhouse's condition from a distance, and the data is automatically collected for research purposes. The creation of a fully automated greenhouse system and data logging utilizing an Arduino as the central processing unit [10].

The management system still contained a lot of conventional. Techniques. Further research is being carried out by [11]. [12] created a system for maintaining track of the plants' status in sealed surroundings. Four variables have been assessed as inputs and considered, along with all information obtained as analog signals. The main component of the greenhouse system is the environment. IoT-based systems are more adaptable and a good fit to provide monitoring and controlling capabilities inside the greenhouse. To keep the green house's environment appropriate [13].

New strategies are required to maintain sustainable agriculture and a reliable supply of food in the future due to the rapid climate change, population growth, and shrinkage of arable land. By regulating the local environment and cultivating crops all year long, even in challenging outdoor settings, greenhouse agriculture is seen as a viable alternative and sustainable solution that can address the coming food problem. The evolving Internet of Things (IoT) technologies are thought to be the answer to the major problems facing greenhouse farming, including greenhouse local climate control, crop growth monitoring, crop harvesting, and others [14].

The Kingdom of Saudi Arabia is renowned for its harsh climate, when summertime highs sometimes approach 50 °C. Only cutting-edge environmental solutions and contemporary agricultural technologies can increase agricultural production. The direct influence of external climatic variables can be lessened in greenhouse farming by using Internet of Things (IoT) technologies. Their study introduces an IoT-based highly scalable intelligent system for controlling and monitoring greenhouse temperature. The primary goal of their system is to keep the greenhouse environment under control and to reduce energy consumption while maintaining favorable conditions that increase productivity [15].

The roofing structure and foundation help to keep warm temperatures inside by reflecting heat from hot interior surfaces [16].

A freshwater conduit has been built into the system for enhancement of the greenhouse's source of water [17]. The integrated analog to electronic converter, or ADC. of an ARM7 board was implemented. Therefore, there is no longer a need for another element, thereby decreasing mass and expense where possible. Yet, the only two sensors used and observed were those for temperature and humidity [18].

Energy use has recently emerged as a significant barrier impeding greenhouse expansion. However, the market for greenhouse energy-saving technologies with cost savings and efficiency has grown in popularity with the use of sophisticated control systems. To increase greenhouse yield and lower production costs, it is therefore important to continue studying coordinated energy saving and effective greenhouse environment control [19].

Food production is done in greenhouses. However, the delicate crops grown in greenhouses still require personal labor. If some adjustments are made, the results suggest that employing a vision system to automate greenhouse tasks is feasible. assisting with continuous initiatives to lessen manual labor and boost productivity in greenhouse agriculture [20].

Based on NB-IoT (Narrowband Internet of Things), a system aimed at tracking the greenhouse environment has been created. The device can transmit wirelessly data to the OneNET cloud platform while simultaneously identifying the air temperature, relative humidity, light intensity, and carbon dioxide concentration in greenhouses. To view information on the greenhouse environment, growers can access the website using a portable device such as smartphones [21].

A smart greenhouse management system built on NBIoT (Narrow Band Internet of Things) and a smartphone will be developed in order to achieve smart agricultural greenhouse management as well as improve the density and refinement of the

sensing and control terminal. NB-IoT network and connections via Bluetooth are enabled by the terminal node. The NB-IoT network is used by nodes to periodically gather environmental data such as temperature, humidity, light intensity, wind speed, and wind direction and to immediately upload that data to the cloud platform. For centralized management, the system has server-side, web, and data applications for storage. For provided on-site management of greenhouses, an Android application is developed. The APP implements single node continuous surveillance and temporary data storage. According to the test results, the system fits the greenhouse's real-time management needs with its dependable transfer of data and high packet exchange success rate [22].

It is challenging and occasionally risky to manually monitor every aspect of plant growth. In this project, a real-world model is constructed, where IoT sensors are used to regulate the hydroponic farm's lighting conditions and weather. Sensors constantly monitor the day's temperature and lighting variables to automatically maintain optimal conditions for development [23].

This internet-of-things (IoT)-based greenhouse monitoring system was created for monitoring and controlling different variables remotely. The system involves multiple-point, sensing involving three important variables, namely soil moisture, ambient temperature, and humidity soil moisture sensors, integrated humidity, and temperature sensors), for controlling the exhaust fan and water pump operation to maintain the desired environmental conditions inside and place it into the database [24].

According to J. Wang et.al, the planning and building of an inexpensive greenhouse which makes use of an open-source management platform. The objective of the research project was to further enhance the circumstances whereby onions and tomato plants were able to be cultivated [25].

## 1.2 Purpose and Description

The purpose of this study is to help the Department of Agriculture in Tagum City (D.A Tagum) in monitoring the greenhouse and to provide automation control for action needed.

The type of Greenhouse owned by Department of Agriculture (D.A) is hydroponic. Hydroponics is a type of farming where plants get nutrients in water solutions. It is also known as Modern farming.

The D.A has a unique way of monitoring and maintaining its Greenhouse. Due to limited space, the Greenhouse focuses in one cropping season. So far lettuce was the main crop. In terms of process the D.A uses Nutrient Film Techniques (NFT) in growing plants. The water that goes to NFTs was being monitored. From water storage, the water temperature will be checked and will flow to the pipes connected to NFTs. It will be a flowing process circulation.

The D.A focuses on monitoring the water temperature in the storage before it will be transferred in NFTs. It will serve as the basis for humidity and temperature inside the Greenhouse. The sprinkling of water was done manually every 11:00 AM, 12:00 NN, 1:00 PM and 2:00 PM daily, but it will also depend in the weather condition. In terms of water leakage, the D.A manually check it daily by checking the water level of its water storage.

Due to this current process the researchers came up with an idea of Automation. The AutoGreen is an IoT based that can monitor the water temperature that will be transferred in NFT hydroponic system inside the greenhouse and act according to what the greenhouse needs. In addition, it will accept manual command from the user through mobile application and user can set time intervals for water distribution.

Notifications can be delivered in two different ways, first is through mobile application and the second is through buzzer alarm which will be put in the D.A. Tagum office with tune differences depending on what problem has occurred. Buzzer alarm for leaking will activate only if there is a serious problem occurred inside the greenhouse. It will also have a database for activity logs.

## 1.3 Objectives

### *1.3.1* *General Objectives*

The general objective of this study is to automate the Tagum City Department of Agriculture's hydroponic greenhouse.

### *1.3.2* *Specific Objectives*

*1.3.2.1 To determine the level of water temperature for water distribution.*

*1.3.2.2 To provide a Mobile Application for monitoring and control remotely.*

1.3.2.3 *To determine the level of water storage for the purpose of identifying water leakage.*

*1.3.2.4 To notify the authorized personnel if there are abnormalities in the greenhouse. The notification will be distributed in two ways:*

*1.3.2.4.1 Mobile notification*

*1.3.2.4.2 Buzzer Alarm with tune differences depending on the problem occurred*

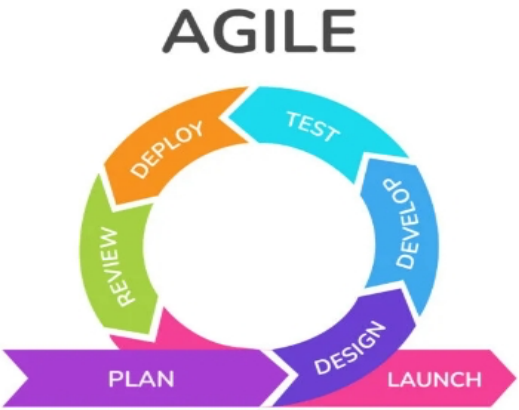
## 1.4 Scope and Limitation

This study focuses on the automating the greenhouse owned by the D.A Tagum. AutoGreen will only focus on the functionalities of greenhouse such as maintaining the appropriate water temperature and interval of water irrigation. The application will be available for a single android user only. In addition, it needs an internet connection.

## 2. Conceptual Framework

AutoGreen is an application where the assigned personnel can monitor and control the status of the greenhouse without going to the area to avoid hassle. A presentation of the said system as shown below.


**METHOD**




In this study, the researchers used Agile methodology. Agile Methodology is a process in which the project is divided into several phases. It let the researchers to focus on developing one phase at a time.

### 3.1 Plan

The researchers visited the Department of Agriculture in Tagum to know more about the greenhouse. The researchers found out that the greenhouse managed by the D.A Tagum was manually operated. The DA personnel need to go to the area even if it is a holiday or no duty just to check the status and manually open the machinery used depending on what the greenhouse needs. The D.A Tagum personnel said that it is good if there will be a system that will automate the daily routines inside the greenhouse and also, they can monitor it through activity logs.

### 3.2 Design and Development

The AutoGreen application will be android based. The researchers used arduino mega and some sensors in monitoring the greenhouse. It will send information and accept command from mobile application through internet. The researchers used the following software:

*3.2.1 Dart.*

It is object-oriented programming language. It is used for development of cross-platform application.

*3.2.2 Flutter*

It is an open-source UI software development kit that support the development of a cross-platform application.

*3.2.3 Android Studio.*

It is an IDE for developing of android application.

*3.2.4 My SQL Database*

*It is a relational database management system that developed by oracle that is based on structured query language.*

*3.2.5 Arduino Software*

*It is an open-source software, which is used to write and upload code to the Arduino boards.*

### 3.3 Test and Deploy

In this stage, the researchers will conduct the testing to test the connectivity of the AutoGreen mobile application and device. It will also test the compatibility of the application to the different vesion of android phones. It also includes the testing of sensors' sensitivity, functions, and actions.

### 3.4 Review

In this stage, the system was tested and it's time for the respondents to give an honest review for the researchers to know the errors occurred during the testing. With this, the researchers will go back to the planning stage for the debugging of the errors and change something on the functions depending on the recipient's request.

### 3.5 Launch

The final stage. In this stage, the system will be good and functional. It is ready for release. The researchers will continue receiving feedbacks from the recipient to make sure that the system will be good and ready to be used daily.

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