# Review: Mobile-Based Hydroponic Plant Monitoring with IOT Mode and Image Processing-Based Plant Pest Detection

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## ABSTRACT

Hydroponics is a new agricultural concept in limited places and areas, in this modern era the process of hydroponic plants is very effective and economical in  use of fertilizers and water sources, over time the concept of hydroponic plants has several advantages, namely that plants become resistant to pests and easy plant growth, monitored even though on a large area of land another advantage is that the yields are more profitable and increase production yields, this hydroponic farming system able to advantage of closed areas that can be made in a narrow space, while in a large area and farmers have a large space to move while In hydroponic plants is in  planting process in different places and narrow areas so that the space for farmers to be narrow and limited too, the solution to these problems able to  implementation IOT technology based on mobile devices used for monitoring of water because hydroponic plants themselves use water media as an nutrient delivery media in plants for food and nutrients  or fertilizers, the most important thing is how to moisture is  soil because the concept of hydroponic plants itself functions to save and increase the effectiveness of water sources and fertilizers, using IOT technology allows hydroponic plants  able to monitored From a distance, a separate and remote plant location can be monitored, the monitoring process is to display a temperature change data taken from a sensor connected to a server device, from that server  data can be displayed become information on water conditions and temperature, remotely and farmers themselves can controlled the watering process with the help of sensors connected to a motoric device connection, the most important thing is how to make a tool that can detect and recognize the types of pests that attack plants, namely by utilizing image technology processing that can be applied with a computer or mobile device.

## Introduction

In several modern studies in the field of agriculture, it always tries to improve the quality and quantity of agricultural products in the middle of a limited land area, this limitation is due to the increasing number of settlements, the negative impact of this is that agricultural products are increasingly narrowing and have an impact on production and yields which are contrast  with number of human growth and settlements, this study will discuss how to use a small area of land but can increase the amount of production, the solution is to apply the concept of hydroponic agriculture which utilizes water sources used to provide nutrients and fertilizers to plants, the advantages of the agricultural concept hydroponics compared to conventional agriculture is that hydroponics doesn't require soil media and a large area so that it is effective in using water and fertilizers, another advantage is that the monitoring system can use a sensor device is connected to a network or IOT device, so that room temperature, water pH and soil moisture readable easily, the sensor can display information which can be used as material for analysis and consideration for calculating future harvests and their causes, the last combination is utilizing an image processing technology that is useful for reading and recording and analyzing if there are plants that are affected by pests and types of plant diseases as well as the control process, with the method the farmer will have an overview of the next action that is useful for taking preventive actions, so that the agricultural production line can sustainable and stable even increasing.

## Literature Review

In principle, a hydroponic plant concept is a method of farming that doesn't require a lot of land but only requires water, a source of food and nutrients, this concept has become an innovation by taking advantage of limited land but not

limited to one type of plant, this hydroponic concept maximizes use water and nutrients and the techniques used are made floating or with containers stored in water, several countries have developed this hydroponic plant and commercialized the largest hydroponic plant developing countries include United States of America, the Netherlands and Japan, in these countries the hydroponic agriculture sector has become a necessity where in the implementation of modern agriculture and included in state income, the application of computerization in modern agriculture cannot be separated from the use of cell phones, in the next development we allow us to control all devices household remotely and control temperature, light and the process of watering plants [1].

Humans are creatures that need to eat and drink both to meet their needs, this concept enters into a primary need or basic needs, so that to fulfill this, humans indirectly need a large area of land and living space that can be used to support their lives, for example. Humans use extensive agricultural land but along with the increasing number of population makes agricultural land narrow because it is pressed by the number of settlements so that agricultural land becomes increasingly narrow, to overcome this problem the concept of hydroponic agriculture that utilizes small land and uses water media has emerged, with this method. if implemented properly it can produce the same amount of yields with conventional agricultural concepts [2].

Opening a new agricultural land will have a serious impact which will cause deforestation and can cause landslides, several other problems will be caused to reduce soil fertility and land clearing methods for new agriculture will result in reduced soil fertility, whereas if the current is moved to an area densely populated will unsuitable in urban areas where conditions are different, another solution is the use of a greenhouse which is used for the implementation of hydroponic plants [3].

The hydroponic system is a combination of the concept of planting without using soil, this system mixes all the nutrients that plants need into the water medium, the regulatory process can use the pH size, this measure will be used as a benchmark for changes in whether or not nutrients are in the water, the monitoring system on This research uses an Arduino device, this device is very easy to assemble and use and is very familiar among programmers, this tool can monitor based on three stages, namely temperature, humidity and pH levels [4].

The advantage of the concept of hydroponic plants is that they can improve the quality and yield of agriculture and use optimal resources, this method does not apply to conventional agriculture which requires many sources of water and nutrients, hydroponic farming is often combined with the use of a greenhouse, the use of a greenhouse can reduce the use of harmful chemicals. which can harm plants and can reduce the spread of pests on plants [5].

Modern agricultural systems have changed their perspective towards computerization and digitization aimed at increasing quality and productivity, several modern agricultural methods have begun to implement, for example, from a genetic revolution that aims to produce long-lasting crops and increase higher production yields from these. then an analysis can be done whether the method is effective or not, the implementation of a technology today is a challenge in itself which is expected to be able to increase a production value by increasing the quality of good agricultural products and using environmentally friendly technology [6].

The use of technology in agriculture is how to use an electronic sensor that is able to change the picture of agricultural land conditions into data, in fact the use of IOT technology will provide complete and a lot of data about information and the state of agricultural land and be able to increase the value of agricultural productivity to 70% [7].
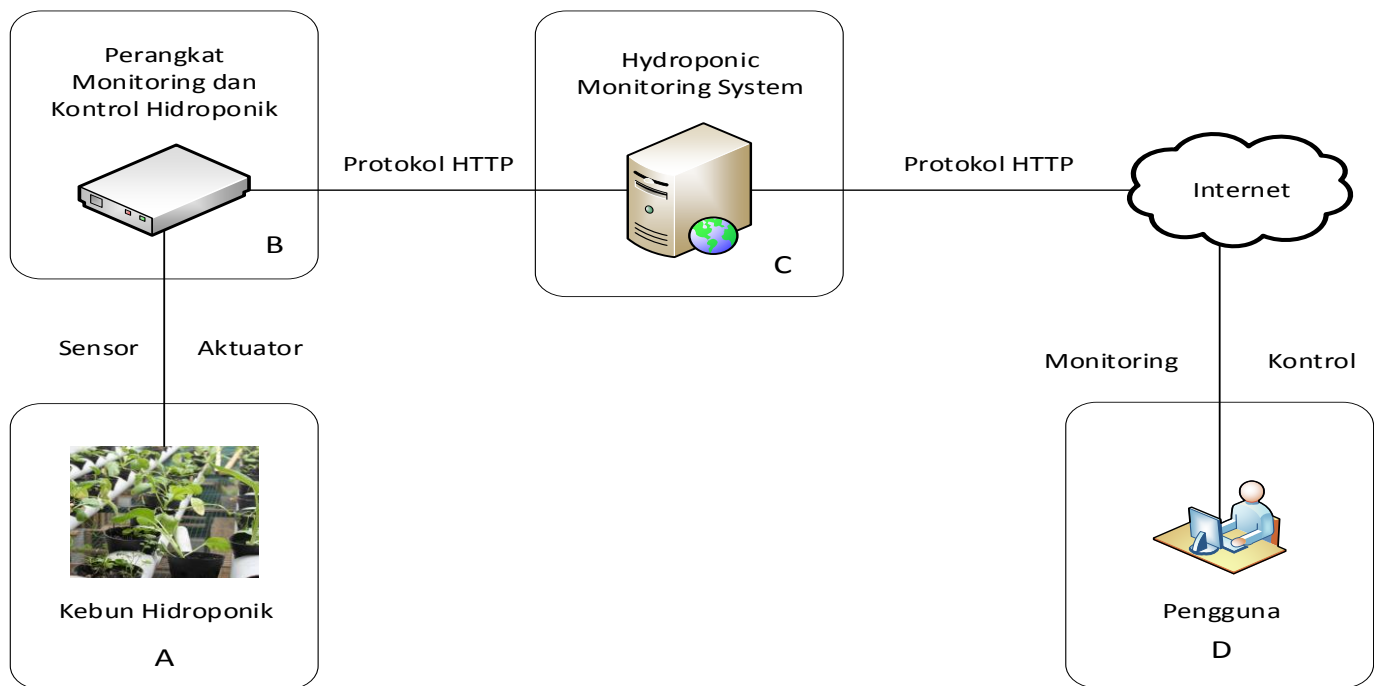
## Methodology

**Figure 1.** Stages of monitoring hydroponic plants

In Figure 1 is the monitoring stage of hydroponic plants with a web server device, the web server function itself will provide data information taken from a sensor that is connected to the device, the device provides a signal where the signal will provide information on changes in room temperature, from the data the device IOT is an intermediary tool for conveying information from sensors into data into a website so that it can be displayed in graphic form. The detailed stages of the monitoring process are as follows:

a) Hydroponic gardens and plants

The concept of hydroponic plants is to utilize a small space media that can use used plastic pipe media and other items that recycled able, in this hydroponic plant concept the process of placing and providing water sources and using fertilizers can be accommodated in advance and used if the conditions are the condition of the plant is lack of water or fertilizer but this condition is different and depends on the type of plant.

b) Control of hydroponic sensors

In a hydroponic plant control and monitoring requires a sensor to see water content, soil temperature and soil pH, these three components are very important where an error in recording the state of the plant can cause the plant to die and can be transmitted to other plants, the sensor can be installed on the paralon. planted with plants, the sensor is then connected to a microcontroller device where in this section the signal will be received by the sensor is converted into a number so that data changes on the sensor can be measured.

c) Web server

on the web server, it functions as a data storage place if there is a change in temperature, the data is then stored, the data will change automatically received from a sensor and can become an analysis data, the data is raw data and can be used for further analysis and research.

d) Data cloud Computing

A server requires a large data capacity, cloud computing technology allows a wireless transmission of data so that data from a sensor installed in a plantation position located far away on hydroponic plants is unlimited and can still be read by the system.

e) Users or farmers

In the user section it can be interpreted as admin or user of an application, in detail and in detail the admin can see plant conditions and temperatures in hydroponic plants, if connected to an IOT device an administrator or user can control the device to drain fertilizer or water even though it is in a location different.

**Results and Discussion**

In this part, the system testing process uses three stages of testing on a sensor device system that can use a pH sensor and is connected to a microcontroller device, the second test is to use a mobile device or application so that in hydroponic agriculture it can detect and monitor if there are pests and diseases in plants. and the last is testing on the webserver, namely in the process of sending data so that the data on the sensor can be displayed on a visual graphic.

a) Testing using sensors



**Figure 2.** pH and humidity sensor

In Figure 2 is a sensor that is used to read the pH levels in water and soil that will be used to monitor hydroponic plants, this measurement is very important because the type of plant itself has different properties and pH so that data reading errors can cause plants to die quickly and be attacked by pests. disease, each sensor has a data cable where each cable is connected to a microcontroller device that will send changes to the electric current signal which will be sent to a server.
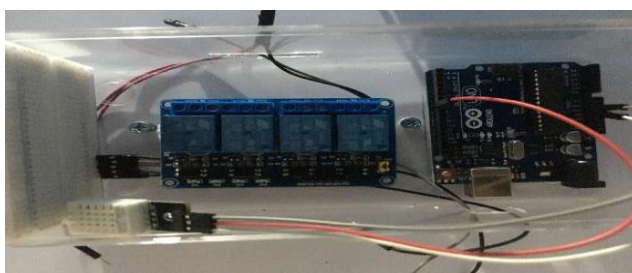


**Figure 3.** pH and humidity sensors connected to a microcontroller

Figure 3 is a process of detecting room temperature and humidity, in the hydroponic planting process a sensor called the DHT22 sensor will be used, the sensor is placed in the room, then the sensor will detect the room temperature and humidity, the room temperature recording results from the DHT22 sensor it will be processed via

Arduino Uno R3. Then the sensor recordings will be sent to the cloud computing database from AWS.

a) Image processing techniques for hydroponic plant disease detection



**Figure 4.** An example of a chili growing process with a hydroponic concept

In Figure 4 is an example of hydroponic planting with potting media or plastic pipes, this part appears to be attacked by pests that attack the leaves, in conventional agriculture we will guess what disease attacks the plant and can carry out the analysis process by reading the PH level from the sensor or check it manually, a more modern step of this research is to combine the use of sensors with image processing technology used to detect disease in plants and have high accuracy reading values, this concept has been widely researched and proven to be accurate compared to expert system-based web-based methods. , image processing techniques can be installed on a mobile device and easy to use.
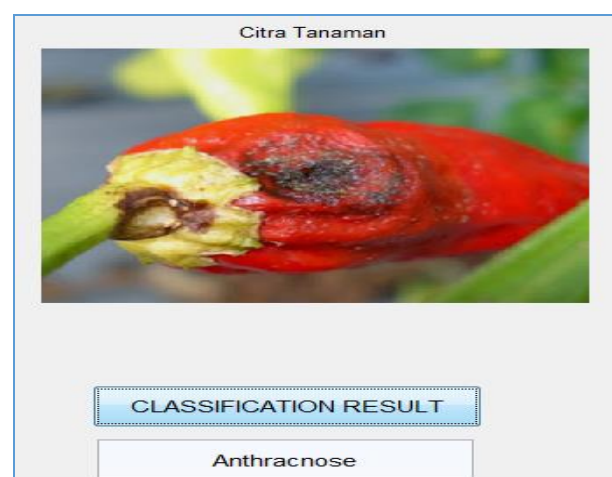


**Figure 5.** Example of disease detection in plants using image processing techniques

In Figure 5 is a disease identification test in chili plants that can be implemented using a mobile device, the development of this application is not

too difficult because there is already a lot of open source data that we can use as a database with different plant types and pests, with Using image processing techniques, a farmer can detect and directly analyze pests that attack plants so that they can take quick and effective preventive steps.
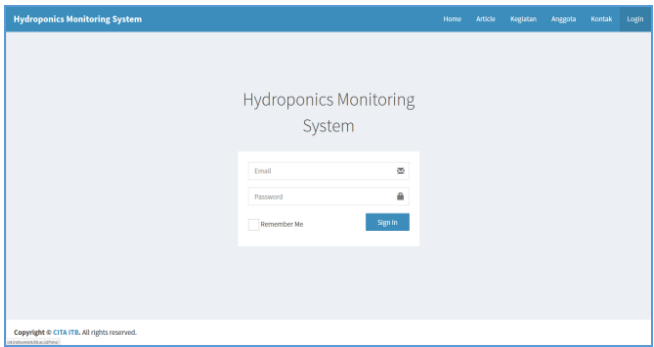
b) Testing with a webserver



**Figure 6.** An example of the monitoring process with a web server

In Figure 6 is a hydroponic plant monitoring process using a web server, this step is a very important part because the concept of different hydroponic planters and remote locations can be monitored easily, so that temperature and humidity data and plant conditions can be seen easily and technically we can regulate the use of water resources and fertilizers as needed.
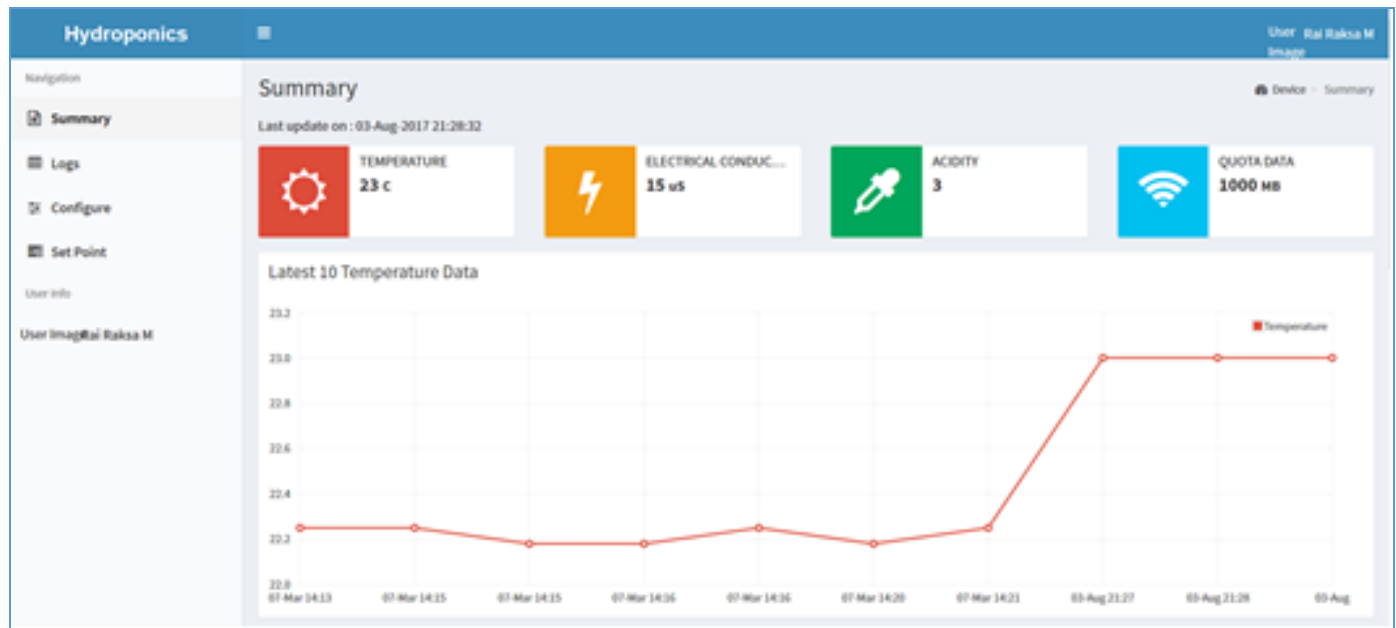


**Figure 7.** An example of the main part of monitoring plants with a web server

In Figure 7 is an example of the main page on a server-based monitoring system, on this menu we can easily read the condition of a plant in graphical form, this graphic data is taken from a data or signal sent from a sensor which can be near or very far, this can happen because of the help of the use of cloud computing where a data can be stored on a server from the source of the sensor device can be more than one or more, then the data is stored in a database and displayed in graphical form, this data will continue to change. and increases according to sensor readings, while previous data will not be lost and stored in the database so that it can be used for further analysis and research.

## Conclusion

From the stages of several experiments from the concept of hydropic plants, it can be concluded that, this hydroponic concept has an advantage, namely that we can use a small space so that we can grow crops and this concept if implemented on large areas can increase agricultural yields because the concept and process of maintaining plants is easy and use water media to regulate fertilizer needs and water content, in other conditions when the plant is monitored we use the help of a sensor where the sensor functions as the main tool to record the pH level in water because hydroponic plants themselves use water media as a substitute for soil, sensor data automatically will provide an information on the condition of the plant and can send the change data through cloud computing so that the position of distant and separated farms can be easily monitored, how to monitor by a farmer by reading change data through a webserver and can see in graphical form, another important step is the implementation of computerized technology used to detect a pest or disease attacking hydroponic plants, this technology has been developed and has high accuracy so that a farmer can easily identify the disease and can immediately do it. prevention process so that plants affected by pests do not spread immediately.

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