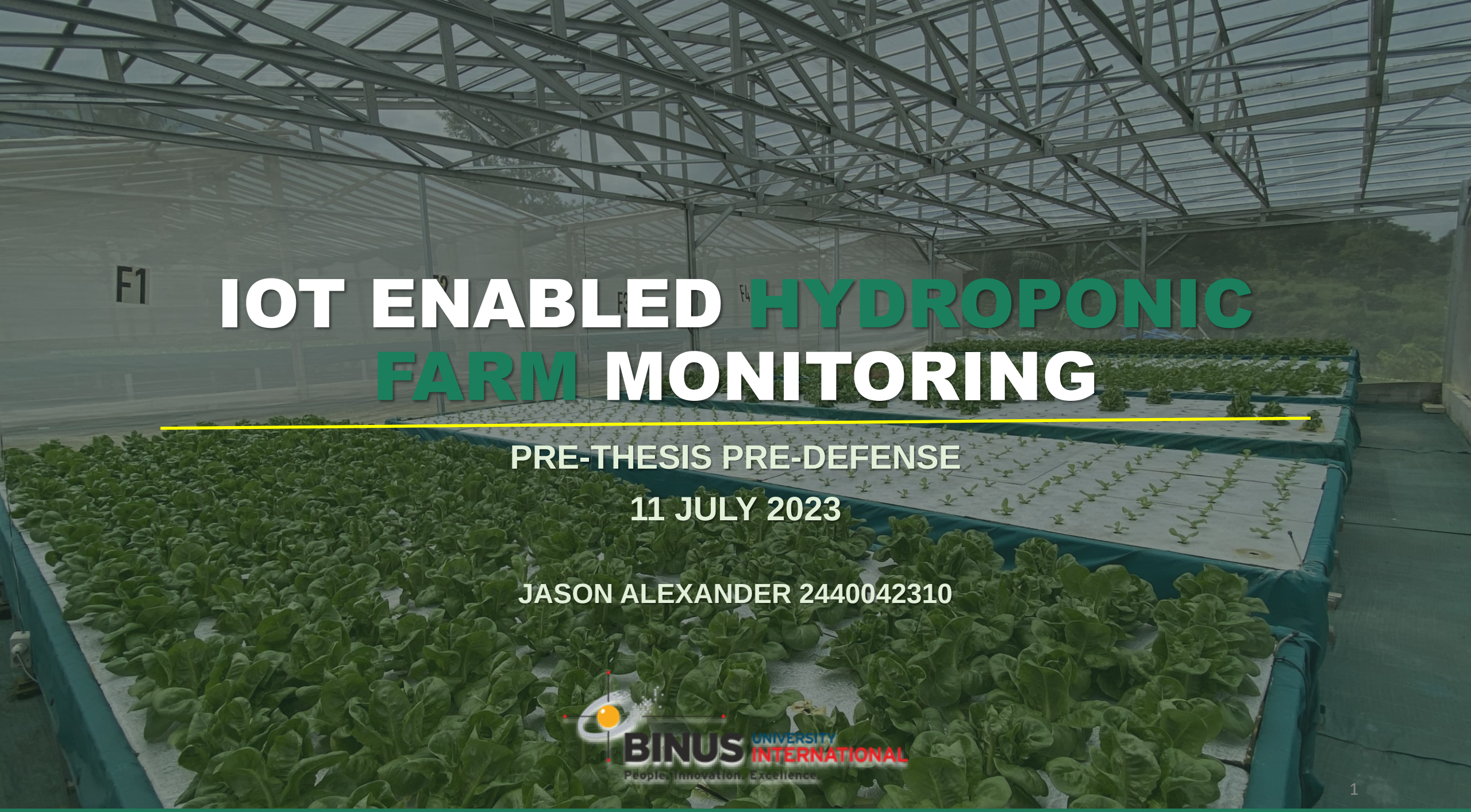

IOT ENABLED HYDROPONIC FARM MONITORING

PRE-THESIS PRE-DEFENSE

11 JULY 2023

JASON ALEXANDER 2440042310

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Table of Contents

General Summary of this Presentation's Chapters (5 Chapters)

Introduction

This chapter provides a general overview on what this case study is about.

It also covers a short analysis of the problems currently faced by *Just Hydroponics*.

Objectives

This chapter covers the **research questions** of the case study.

It also covers the **aims and benefits** of the case study.

Solution

This chapter delivers a general overview of what the proposed solution is.

It covers the main components that make up the solution.

Scope

This chapter explains the limitations of this case study.

It covers what are strictly included and what are not within this case study.

What Comes Next

This chapter will explain about my plans for the second semester of my thesis writing.

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01 Introduction

Background – Current Process

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Background

- Ever-increasing population increases strain on agriculture. This creates a need for a faster and more efficient food production.
- Several practices has been developed to tackle this problem. **Hydroponics** is one of them. It offers **faster growth rates** and **higher yields**.
- *Unfortunately*, compared to conventional methods, hydroponics is more difficult to get right due to their high sensitivity to environmental factors.
- *Fortunately*, advancements in IoT, cloud, and sensor technologies has made it easier and cheaper than ever to devise a solution.
- Combining these technologies can lead to the creation of a truly powerful solution.

Company Profile

Just Hydroponics

Company Profile

Just Hydroponics

- Family-owned company.
- Located in the outskirts of Bogor.
- Medium-sized farm with around a dozen lots. Plans for further expansion.
- Employs a few staff members. Mostly locals, blue-collar, little formal education background.

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Current Process

Method of Data Collection and Storage

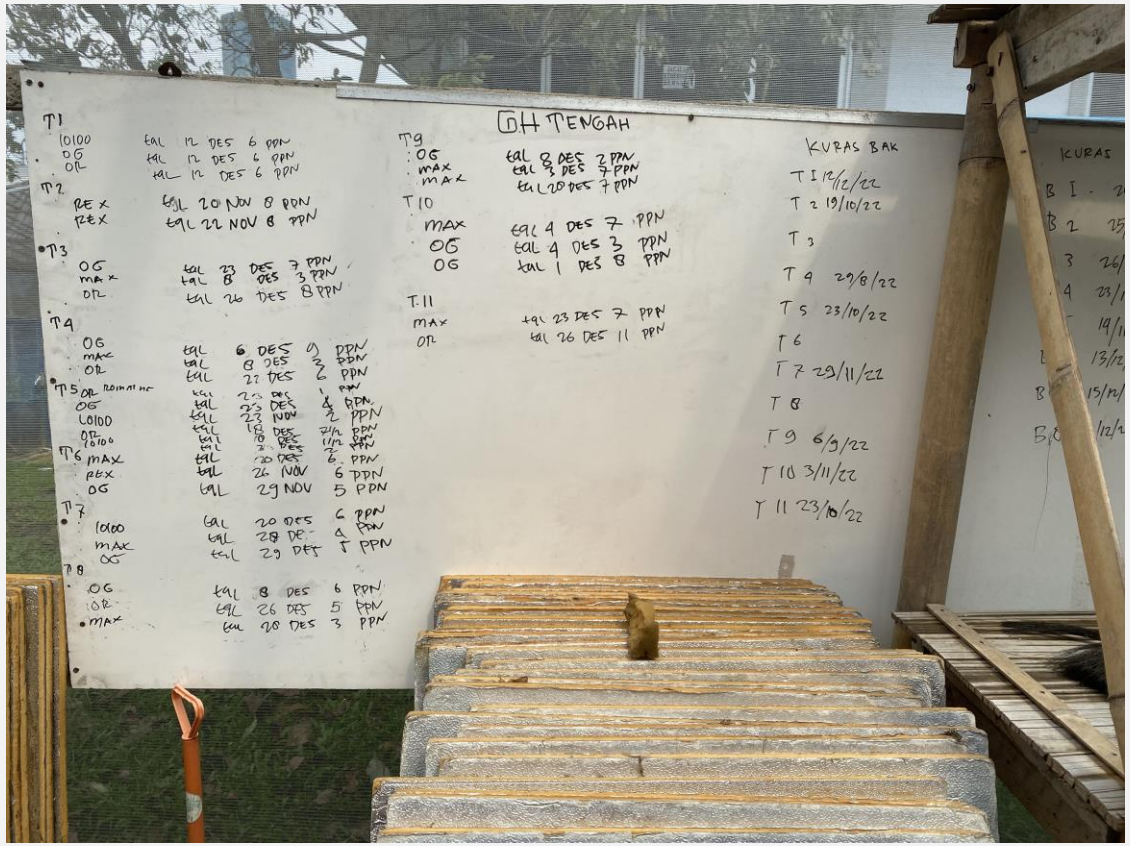
- The method of data collection currently utilized by Just Hydroponics is manual and scattered.
- Data is collected **once a day**.
- Data collected manually, using hand-held tools.
- No set standard for the measuring tool. There are a variety of brands in their inventory.
- Different brands and manufacturers will have varying tolerances. This compromises data consistency.

- **A standardized, consistent, and more frequent method of data collection is needed.**

Current Process

Method of Data Storage

- Currently, they store their data on whiteboards.
- A practical and pragmatic approach, but with apparent drawbacks.
- A small amount of rainwater or an accidental wipe will delete the data beyond recovery.
- **A better method of data storage is needed.**



Current Process

So, what's the problem?

It's **a lack of scalability**.

- Current operations are relatively small. Allows for their inefficient processes to be tolerated.
- They have a large land and currently only use a tiny portion of it. They wish to expand.
- Expansion will expose the drawbacks of their current processes.

- **A scalable solution is needed.**

02 Objectives

Research Questions – Aims & Benefits

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Research Questions

1. Is it possible to devise an Arduino-based and cloud powered solution to track changes in a hydroponic plantation's environmental factors?
2. Is it possible for the Arduino device to communicate the data it collected into a database without a need for direct involvement from the staff during day-to-day operations?
3. Is it possible to create a web application that can automatically compile the information collected from the Arduino and present it in an easy-to-understand manner?

Aims & Benefits

Aims

**Important to note that there has been minor changes to this section compared to the original report.*

The **aim** of this case study is to create a *proof of concept* of a hydroponic farm environment monitoring system using an Arduino-based sensor device and a web-based application with the following objectives:

- Improving the ease, speed, efficiency, and effectiveness of the hydroponics environment data collection in hydroponic farms, and to a greater extent, Just Hydroponics.
- Migrating the method of environment data collection from a manual process to an automated approach utilizing electronic sensors.
- Migrating the data storage means from literal whiteboards to a database.

Aims & Benefits

Intended Benefits

**Important to note that there has been minor changes to this section compared to the original report.*

From the results of this case study, I hope that the resultant system can deliver the following improvements to any hydroponic farm:

- Increased operational efficiency, to reduce costs.
- Achieve a higher degree of consistency through systemization and automation.
- Increasing data security and longevity.
- Increase the accessibility of data by utilizing a centralized data access system.
- Increased response time by drastically increasing the frequency of data collection.

Aims & Benefits

Case Study Findings

**This did not exist in the report originally submitted for pre-defence.*

During the creation and execution of this case study, I have made several discoveries which I hope may be of use as a reference material in future research into this field.

- Documentation of the ESP8266 Wi-Fi module for Arduino is sparse and are often unreliable. Gathering information on it was rather difficult.
- Documentation and discussion on the use of the *SoftwareSerial* class in the Arduino IDE is also unreliable with almost no citations, leading me to have to experiment to determine how to properly use it.
- The nature of the Arduino IDE itself is also not made immediately apparent, being buried deep inside documentation.

I've written down whatever knowledge I've compiled during the process of writing this case study within the second chapter, which cover theoretical foundation.

03 Solution

Arduino Design – Web Application Design

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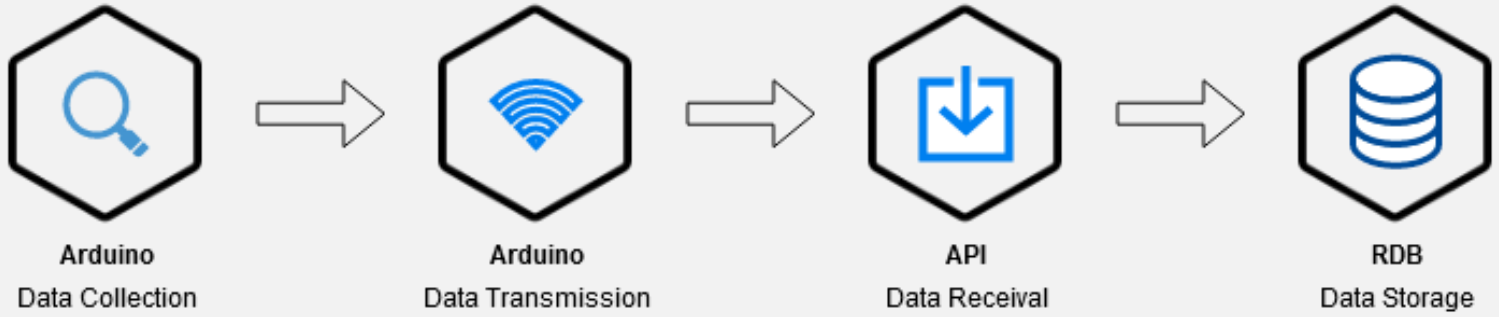
Architecture Overview

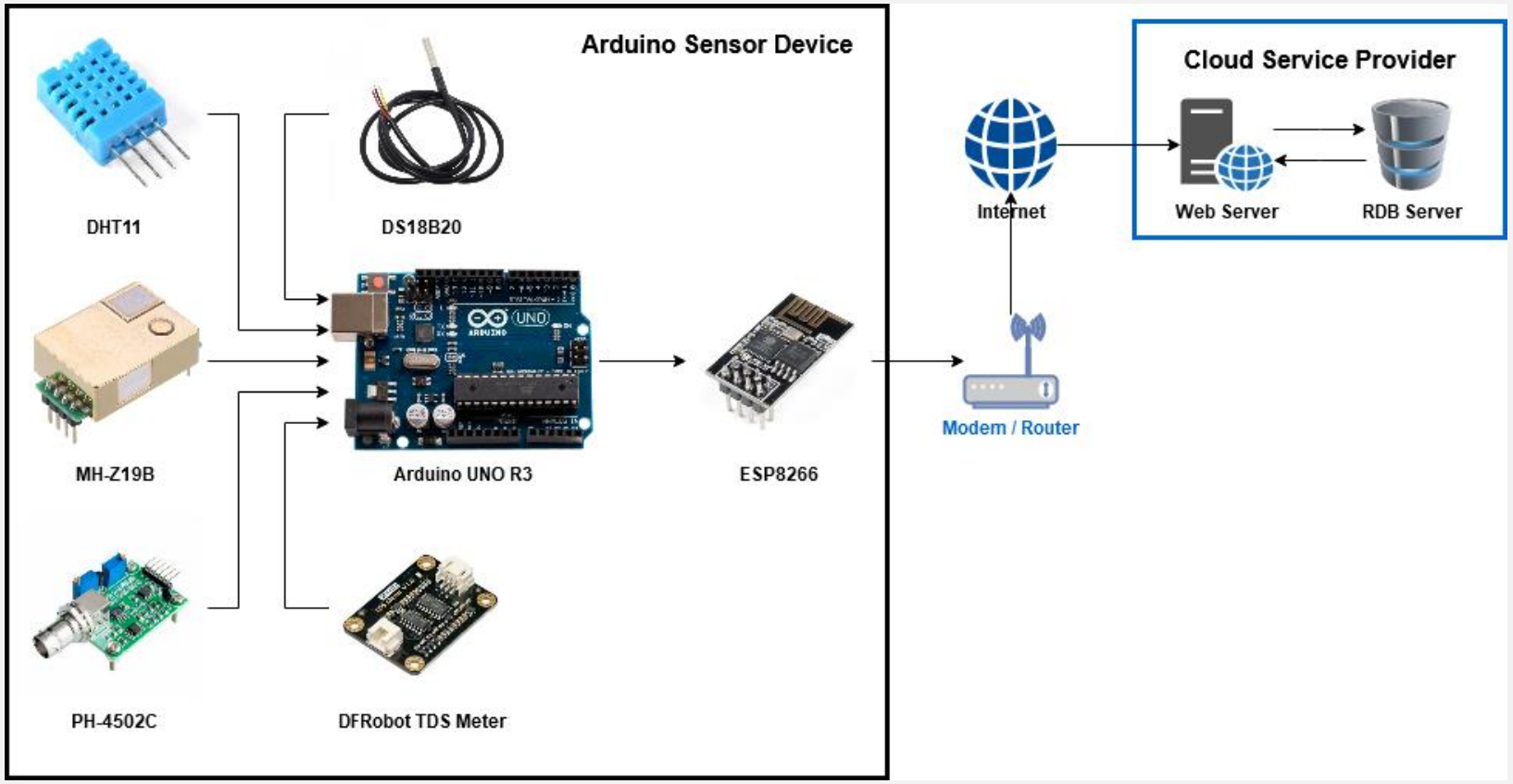
Process Cycle



1. Data is collected by sensors connected to the Arduino device.
2. The data is then formatted into a $_GET superglobal string and then transmitted via internet to the API.
3. The data string is received by the web application's API.
4. The web application then formats the data into an SQL query to insert the data into the RDB server.

Architecture Overview

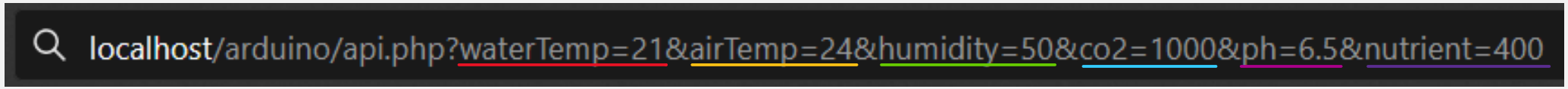
Arduino



- Five sensors retrieves six variables from the environment.
  - DS18B20 collects **Water Temperature** data.
  - DHT11 collects **Air Temperature** and **Humidity** data.
  - MH-Z19B collects **CO_2** data.
  - PH-4502C collects **pH** data.
  - The TDS Meter collects **Nutrient TDS** data.
- The ESP8266 Wi-Fi module transmits data.

Architecture Overview

Web Application - API



- The *String* above illustrates how the sensor data will be transmitted into the API.
- Because the web application and the API uses PHP, the data *String* is formatted to be compliant with PHP's $_GET superglobal variables.
- The data *String* above is formatted to transmit the following data:
  - Water Temperature is 21 ^{o}C.
  - Air Temperature is 24 ^{o}C.
  - Humidity is 50%.
  - CO_2 is 1000 ppm.
  - pH is 6.5.
  - Nutrient Concentration is 400 ppm.

Architecture Overview

Web Application – User Interface

Select Sensor | Date From | Date To | View 10

Date	Time	Air Temp	Water Temp	Humidity	CO_2	pH	Nutrient
08/06/2023	18:03:20	23 °C	Text °C	21 %	Text ppm	Text	Text ppm
08/06/2023	13:23:45	30 °C	Text °C	45 %	Text ppm	Text	Text ppm
08/06/2023	09:03:00	12 °C	Text °C	65 %	Text ppm	Text	Text ppm
07/06/2023	22:42:54	32 °C	Text °C	49 %	Text ppm	Text	Text ppm
07/06/2023	17:12:14	28 °C	Text °C	38 %	Text ppm	Text	Text ppm
07/06/2023	08:02:10	18 °C	Text °C	76 %	Text ppm	Text	Text ppm
06/06/2023	00:00:00	20 °C	Text °C	82 %	Text ppm	Text	Text ppm
06/06/2023	19:16:43	21 °C	Text °C	40 %	Text ppm	Text	Text ppm
06/06/2023	07:23:58	32 °C	Text °C	56 %	Text ppm	Text	Text ppm
05/06/2023	02:42:12	24 °C	Text °C	97 %	Text ppm	Text	Text ppm

04 Scope

Case Study Limitations

Scope

Arduino

a. The capability of the device will be strictly limited to monitoring environmental variables. It will not be able to perform any actions that can directly influence the hydroponic farm.

b. The environmental variables stated in point (a) will be limited to six:

    a. Water Temperature

    b. Air Temperature

    c. Humidity

    d. CO_2 Levels

    e. pH Levels

    f. Nutrient PPM

Scope

Web Application

a. In its role as a terminal for users, the web application will have a user interface.
    i. The user interface will be able to display data collected from the Arduino.
    ii. The user interface will have a feature that allows the user to display data from a specific selected sensor.
    iii. The user interface will also have a feature that allows the user to filter data based on a range of time.

b. In its role as a receiver for data from the Arduino, the web application will include a URL-based API for the Arduino to access.
    i. The data will be passed on via PHP's $_GET super global variable passed by URL.
    ii. The data will then be processed by the API code and be automatically inserted into the database.

Scope

Web Application

c. As a rudimentary website that features neither valuable data nor features that can be a security risk to the hydroponic farm, the security feature of the website will be limited to a simple password. Individual user accounts are deemed to be unnecessary, as the website will not feature differing access levels/tiers.

d. Due to the simple nature of the web application, for ease of development due to the limited time and resources, it will be developed using the base PHP 8. It will not utilize any frameworks.

05 What Comes Next

Improvements – Changes – Implementation – Evaluation

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What Comes Next?

My plans after the pre-defence.

- Still some incomplete parts in chapters 2 – 4.
  - (2) Theoretical foundation for the ESP8266.
  - (3) Current processes.
  - (4) Arduino final schematics.
- Do chapters 5 – 7.
- Implement your suggested changes.
- Many of these parts are basically already done, but with foreseeable minor changes, I felt it pointless to put it in the report only to remove / replace them repeatedly.

THANK YOU