IOT ENABLED HYDROPONIC FARM MONITORING USING ARDUINO & CLOUD

THESIS

CASE STUDY

by

Jason Alexander Tan *2440042310*

BINUS INTERNATIONAL
BINUS UNIVERSITY
JAKARTA
2024

IOT ENABLED HYDROPONIC FARM MONITORING USING ARDUINO & CLOUD

THESIS

Proposed as a requirement for obtaining
Sarjana degree at
Business Information Systems
Master Track (Macquarie) – Information Systems Management
Education Level Strata-1 (Sarjana/Bachelor)

by

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BINUS INTERNATIONAL
BINUS UNIVERSITY
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THESIS

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2024

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PERNYATAAN
STATEMENT

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BINUS INTERNATIONAL

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Business Information Systems

Master Track (Macquarie) – Information Systems Management

Sarjana Komputer Thesis

Odd Semester 2023

IOT ENABLED HYDROPONIC FARM MONITORING USING ARDUINO & CLOUD

Jason Alexander Tan 2440042310

Abstract

This case study focuses on the development of an Arduino and PHP based integrated hydroponic farm monitoring system by leveraging IoT and cloud technologies. The system's objective is to deliver relevant environmental parameter data, such as parts per million (PPM), pH levels, CO_2 levels, humidity, and temperature, to greatly optimize the routine hydroponic monitoring activity performed by JUST HYDROPONICS.

Preliminary information collection is done qualitatively, which is used in the system's conception process. The Arduino is used as the sensor. The detailed specifications of the Arduino's software and hardware are discussed in detail, including the specific models of the components and subcomponents used in the creation of the Arduino prototype, which are specifically compatible with Arduino. The web application provides the users with an interface to visualize the collected data. The web API, which is built into the web application serves as a receiver for data from the Arduino. The design of the web application and API are also discussed in detail. The cloud platform provides application hosting, data storage, and remote access to the system.

Primary evaluation of the system's performance is done by studying the system's accuracy and reliability. A secondary evaluation is done qualitatively by directly interviewing JUST HYDROPONICS's owners & management about the system's impact and effectiveness.

The findings of this case study contribute to the progress of research on IoT and precision agriculture, which are highly important fields in addressing the sustainability and security of food in the world. The findings of this case study should be easily adaptable to a variety of hydroponic farm types.

Key Words

IOT, Hydroponic, Farm, Arduino, Cloud

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This case study is dedicated to a few people, without whom I would have to endure unspeakable difficulties to get to where I am today. Words alone cannot express how grateful I am to have their unyielding support and company.

1. To my core family, especially my mother, to whom I owe everything.
2. To my extended family, which have been so kind and supportive as to allow me to use their business as the object of this case study and put up with my annoyingly large number of questions.
3. To my girlfriend, for her unwavering support, for her words of encouragement, and for her extraordinary ability to calm me down when times are difficult.
4. To my closest friends, for their invaluable friendship, their company, and the laughs we shared, which has opened many doors to me, be it physical, mental, or emotional.
5. To my thesis supervisor, Samuel Mahatmaputra T, S.Kom., M.Info.Tech., for providing me with invaluable guidance and inspiration during my thesis period and throughout the years since I started studying in Binus International, for being the lecturer who taught me the very lessons that are quintessential to my ability to perform this case study, for being the anchor of stability in my efforts of navigating Binus's bureaucratic nightmare for Master Track, all of which were crucial in enabling me to finish this case study.

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Appendices

Appendix 1: UI Design Suggestions

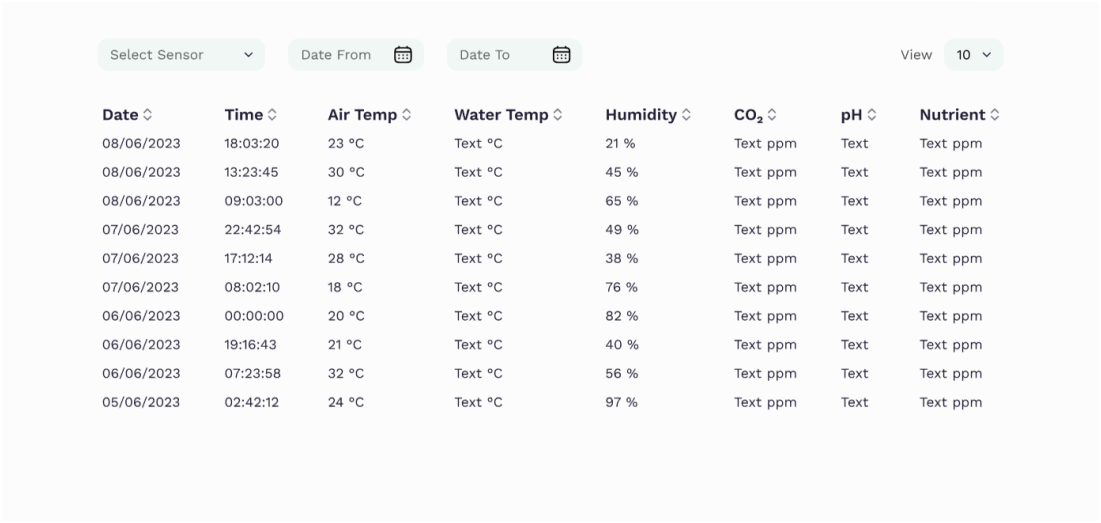

Figure A1.1 – UI Suggestion 1

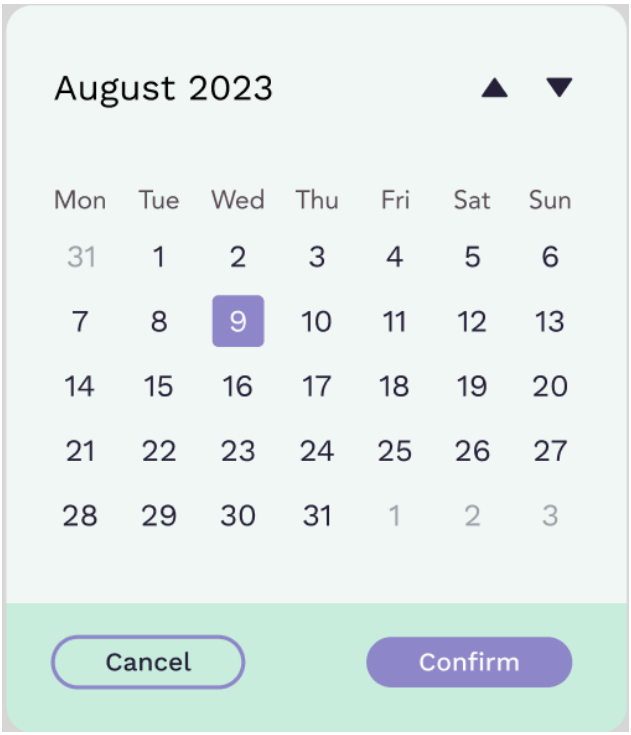

Figure A1.2 – UI Suggestion 2

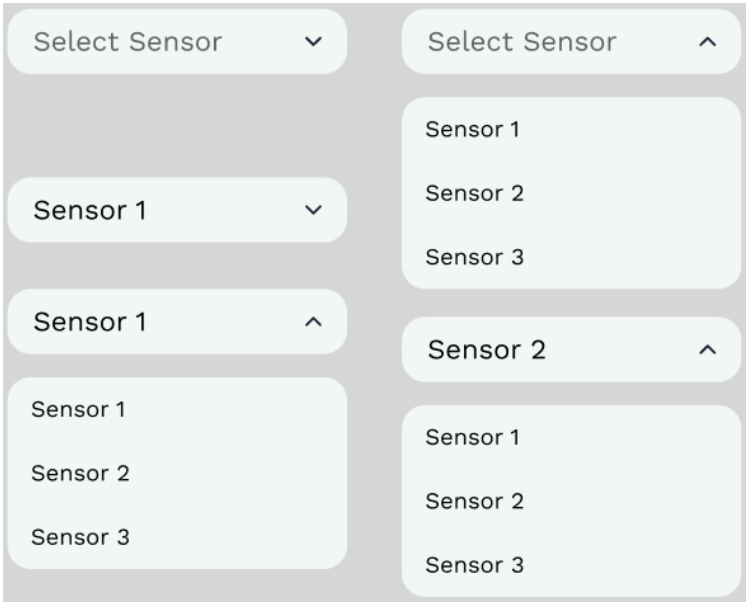

Figure A1.3 – UI Suggestion 3

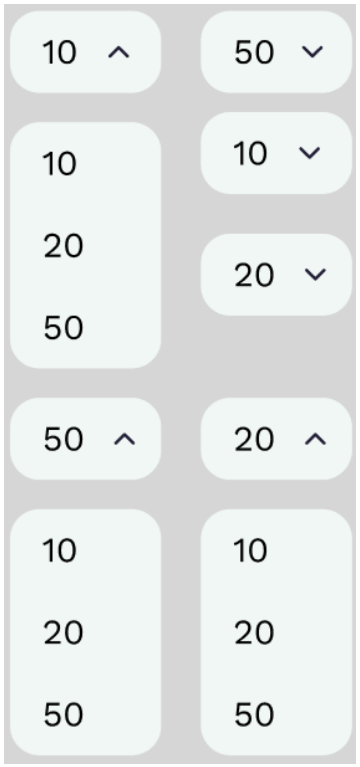

Figure A1.4 – UI Suggestion 4

Appendix 2: Results of Interview with Just Hydroponics

(Interview Results)

Date : Sunday, 1st of January 2023.

Time : ~11:00 AM

Location : Just Hydroponics, Outskirts of Bogor City
Jl. Pasir Bogor, Cipelang, Cijeruk, Bogor, Jawa Barat 16740

Interviewee : Anton & Ina (Owners of Just Hydroponics)

**Note: This interview is not a 100% accurate & direct reference to what was said during the interview. For the sake of readability, the written transcript has been modified, rewritten, translated to English, and had some unnecessary dialogue which covers some banter, finances, other people's comments and the business's customer base removed.*

[Begin Interview]

Jason : Hi Auntie Ina, so I have this case upcoming case study thesis that I will need to start writing soon. I've been looking for ideas and your hydroponic farm seems like it would be a great object of study for my thesis. Do you mind if I use it and ask you some questions?

Ina : Hi Jason! Sure, of course. We've actually had someone else, I forgot who it was, who asked us the very same thing. He also wanted to use my farm for their thesis.

Jason : Do you mind giving me a tour of the place?

Ina : Yes sure! Everyone else can also come! We're planning to give you all a tour anyways, and at the end you can get your pick at some of our cancelled orders, on the house!

[*Tour* – Aunt Ina showed me (and quite a number of people from my extended family) her hydroponic farm, accompanied by her husband, Uncle Anton.]

Jason : Oh, so these whiteboards are where you write down the information about the [hydroponic] trays?

Ina : Yes, we measure the "PPM" of the hydroponic waters and write them down here for reference.

Jason : How do you measure the PPM levels?

Ina : Ah, I don't know too much about that, Uncle Anton usually handles this. <Calls uncle Anton over.>

Anton : Ah yes, we use handheld test kits, think I have them somewhere over here… Here it is. So you just dip this end into the water and… <explains how the tool works>.

Jason : So you only measure the "PPM"?

Anton : Yes, it's the "nutrient density". I don't really understand how the science behind it works, but I follow guides.

Jason : How about other things like CO_2 and temperature?

Anton : That's why we built this greenhouse around it. I don't know exactly how much CO_2 there is and is needed, but this greenhouse works wonders.

Jason : And you store the nutrient density notes on these whiteboards? What if they get wet, or accidentally wiped?

Anton : Well of course we will try not to let that happen, but what's the worst that could happen if it does get wiped? It's not like the crops are just going to die, it's still going to grow normally, it's just that we won't know exactly what's going on, until we measure it again that is, which is pretty simple. Plus, these greenhouses don't allow rainwater in, so the whiteboards won't get wet.

Jason : But what if I can come up with a way to store these notes like on a database or something?

Anton : It would be interesting, but I'm getting old, might be too much for me to learn.

Jason : Shouldn't be a problem, I should be able to make it very simple to use. You do have Wi-Fi here right?

Anton : Yes, but it's rather slow, and can be unreliable at times.

Jason : Hmm, its good that there is Wi-Fi, but the unreliability could be a problem…

[*Tour* – We moved to the far end of the farm complex, to the undeveloped lands around it.]

Ina : Well, our lands are quite big as you can see.

Jason : Wow, that's quite large, I wonder how much all of this costs.

Ina : Well, it's remote, with difficult access to almost everything really, so it's not too expensive. This whole entire land costs around IDR 2 bio.

Jason : Wow, that's really cheap for a land this massive, especially compared to Jakarta.

Anton : Yeah, that's the point, we plan to expand because demand is on the rise.

Jason : Wouldn't it get more and more tedious to individually monitor and care for all these greenhouses the more you expand?

Anton : Well yes, but that's why we have staff tending to the crops. Of course, it will eventually get difficult, but that's still far in the future, might even be a decade ahead, so we'll think about that when it comes to it.

Jason : I might be able to do something about that with my case study.

Ina : Really? We'll it'll be interesting to see what you can come up with, maybe we'll even pay you hahaha.

Jason : Yeah…, maybe…, haha…

Anton : Well, do you have any other questions?

Jason : No, I think that's it for now… thanks a lot for all of this. I know I must be bothering you.

Ina : Oh no not at all…, <proceeded to shift the conversation to about my university life.>

[End Interview]

Appendix 3: Additional Attachments

I have included the following attachments onto the final submission of this thesis:

- Arduino High-Level Architecture Diagram
- Web Application High-Level Architecture Diagram
- Class Diagram
- Empathy Map
- Process Cycle Diagram
- Use Case Diagram
- Value Proposition Canvas
- Arduino “Final” Schematic
- Schematic of ESP-01 in Bypass Mode
- Schematic of ESP-01 in SoftwareSerial Mode
- Schematic of the MH-Z19B in Analog Mode
- Schematic of the PH-4502C

Any tables, figures, or diagrams not attached in this appendix should be available directly in this report in high-resolution. Please zoom-in to view.

Appendix 4: Database Seed File

I will also be attaching the **.SQL** *seed* file, which was generated via *mysqldump* from my own local test database.

Appendix 5: Web Application Code, PHP Project Folder

I am attaching the web application’s source code in the form of the PHP project folder as an appendix for inspection.

Appendix 6: Hydroponic Sensor Code, Arduino Project Folder

I am also attaching the Hydroponic Sensor device’s source code in the form of the Arduino project folder.

Curriculum Vitae

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