CAPSTONICS

SYSTEM AND DEVICE USER MANUAL

IOT – BASED DECISION SUPPORT SYSTEM FOR NUTRIENT FILM TECHNIQUE HYDROPONICS CULTURE MONITORED THROUGH ION-SELECTIVE ELECTRODES

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APPLICATION OVERVIEW

The IoT-Based Decision Support System for Nutrient Film Hydroponics Culture integrates advanced IoT technology and sensors to provide real-time data on vital water quality parameters, including water flow, level, acidity, temperature, and total dissolved solids (TDS). With automation features, it precisely administers liquid solutions to adjust water acidity, electric conductivity, and temperature, while regulating water flow. Designed to streamline monitoring and management, this system equips hydroponic farmers with a sophisticated tool to elevate their farming practices. Focusing on Nutrient Film Technique (NFT) hydroponics farms in General Santos City, the primary goal of this IoT-based decision support system is to optimize crop growing conditions. By offering comprehensive monitoring and automated management of crucial water quality parameters, it empowers farmers to enhance crop yields, boost plant health, and improve operational efficiency.

APPLICATION OVERVIEW

The development of this system holds immense significance for multiple reasons. Continuously monitoring and optimizing factors like water acidity, temperature, electric conductivity, flow, and container water level, ensures plants receive ideal nutrition, leading to healthier crops and increased yields. Furthermore, its automation reduces manual labor requirements, allowing farmers to allocate more time and resources to strategic farming activities such as crop selection and harvesting. Additionally, real-time notifications alert farmers to anomalies in water quality, enabling swift intervention to mitigate potential damage or losses. The findings from implementing and testing this system can serve as a valuable reference for hydroponic farmers in General Santos City and beyond, fostering the adoption of IoT-based systems and driving productivity, profitability, and sustainability in agriculture.

This innovative solution is the result of collaborative efforts by a dedicated team including Sofia B. Macaludos, Jessie Conn Ralph M. Sam, Zaki C. Sarmiento, and Niña Rose M. Sebial guided by the expertise of their project adviser, Dr. Lumer Jude P. Doce, whose supervision played a pivotal role in the successful realization of this project.

DEVICE SPECIFICATION

Device Specification: IoT-Based Decision Support System for Nutrient Film Technique Hydroponics Culture Monitored Through Ion-Selective Electrodes

1. Device Name:

IoT-Based Decision Support System for NFT Hydroponics

2. Key Components:

- Enclosure:
  - Material: Weatherproof, durable plastic (IP65-rated for outdoor use)
  - Dimensions: 150mm x 100mm x 60mm
  - Ports: Waterproof access points for power, sensors, and network cables
- Microcontroller Unit (MCU):
  - Model: ESP32 (or similar)
  - Features: Dual-core processor, built-in Wi-Fi, Bluetooth
  - Operating Voltage: 3.3V
  - Connectivity: Wi-Fi and GSM for real-time data transmission
- Power Supply:
  - Input Voltage: 5V DC
  - Power Source: AC adapter with rechargeable Li-ion battery backup
  - Battery: 3.7V, 2500mAh (provides up to 8 hours of backup power)

DEVICE SPECIFICATION

3. Sensors:
- Ion-Selective Electrodes (ISE):
  - Function: Monitors pH and electrical conductivity (EC)
  - Range: 0-14 pH, 0-20 mS/cm for EC
  - Accuracy: ±0.1 pH, ±0.02 mS/cm
- Flow Sensor:
  - Model: YF-S201
  - Range: 1-30 liters per minute (L/min)
  - Accuracy: ±5%
  - Output: Pulse signal
- Water Level Sensor:
  - Type: Capacitive or Ultrasonic sensor
  - Range: 0-100 cm (adjustable)
  - Accuracy: ±2 mm
- Temperature Sensor:
  - Model: DS18B20
  - Range: -55°C to +125°C
  - Accuracy: ±0.5°C
- Total Dissolved Solids (TDS) Sensor:
  - Type: Conductivity-based sensor
  - Range: 0-1000 ppm
  - Accuracy: ±10 ppm

DEVICE SPECIFICATION

4. Communication Module:
   - GSM Module:
     - Model: SIM800L (supports 2G/4G networks)
     - Frequency Bands: GSM 850/900/1800/1900 MHz
     - SIM: Nano SIM slot, supports SMS and GPRS for remote communication
   - Wi-Fi Module:
     - Protocol: IEEE 802.11 b/g/n
     - Range: Up to 100m (indoors) / 300m (outdoors, line-of-sight)
5. Display & User Interface:
   - Web-Based Dashboard:
     - Accessible via browser on mobile or desktop devices
     - Displays real-time data for water flow, water level, pH, EC, TDS, and temperature
     - Provides graphs for historical data tracking
     - User alerts via SMS/Email for abnormal readings
6. Software:
   - Embedded System:
     - Software developed in C/C++ (for the microcontroller)
     - Integrates sensor data, processes, and sends commands to control actuators (if applicable)
   - Cloud Integration:
     - Cloud-based platform for data storage and dashboard interface
     - Communication Protocol: MQTT/HTTP

DEVICE SPECIFICATION

7. Actuation System (Optional):
- Solenoid Valve Controller (for automatic solution adjustments):
  - Voltage: 12V DC
  - Function: Adjusts nutrient and water flow based on sensor readings
8. Environmental Requirements:
- Operating Temperature: 0°C to 50°C
- Humidity Range: 20% to 90% RH (non-condensing)
9. Certifications:
- CE, FCC compliance for electronic safety and interference
  -

GETTING STARTED

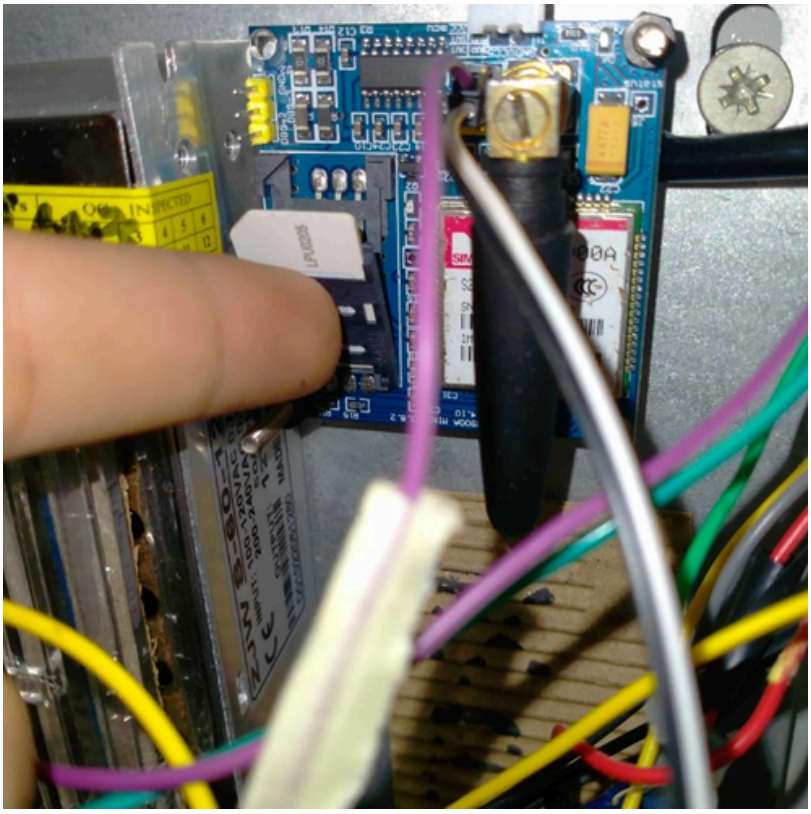
Congratulations on acquiring the IoT – Based Decision Support System for Nutrient Film Hydroponics Culture Monitored Through Ion-selective Electrodes! This user manual will guide you through the setup process and provide detailed instructions on how to utilize the system effectively.

GETTING STARTED

To begin using the Automated Hydroponic Monitoring System, follow these steps:

1. *Insert the SIM card of your choice into the SIM holder located in the GSM module. Only use a 2G/4G SIM card.*

2. *Ensure that the SIM card inserted is topped up. If it's not, please recharge it. We suggest using a promotional plan with unlimited data for optimal usage.*



GETTING STARTED

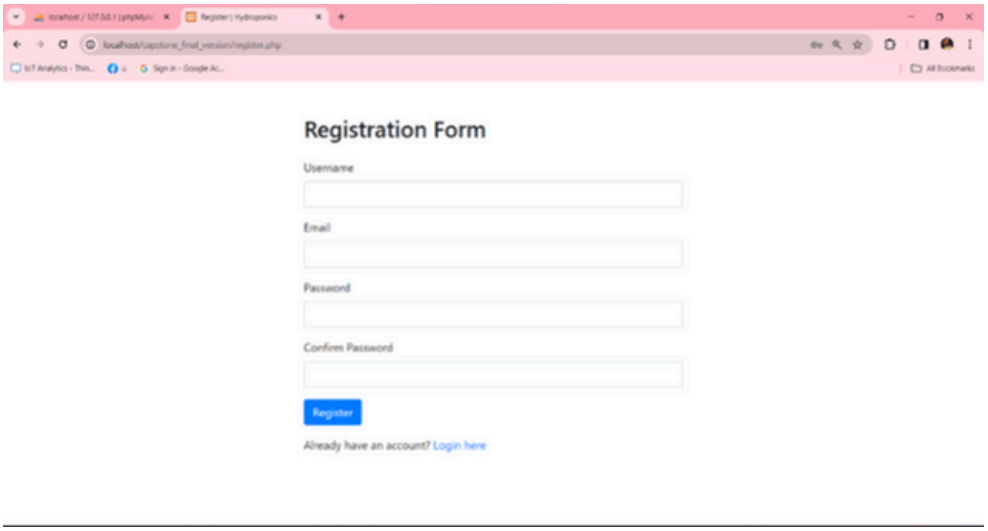
3. Place the device securely near the water reservoir, ensuring that all sensors are positioned within the water.

4. Plug in the device to a power source.

5. *Access the system through the website link that will be provided upon purchase.*

REGISTRATION PROCESS

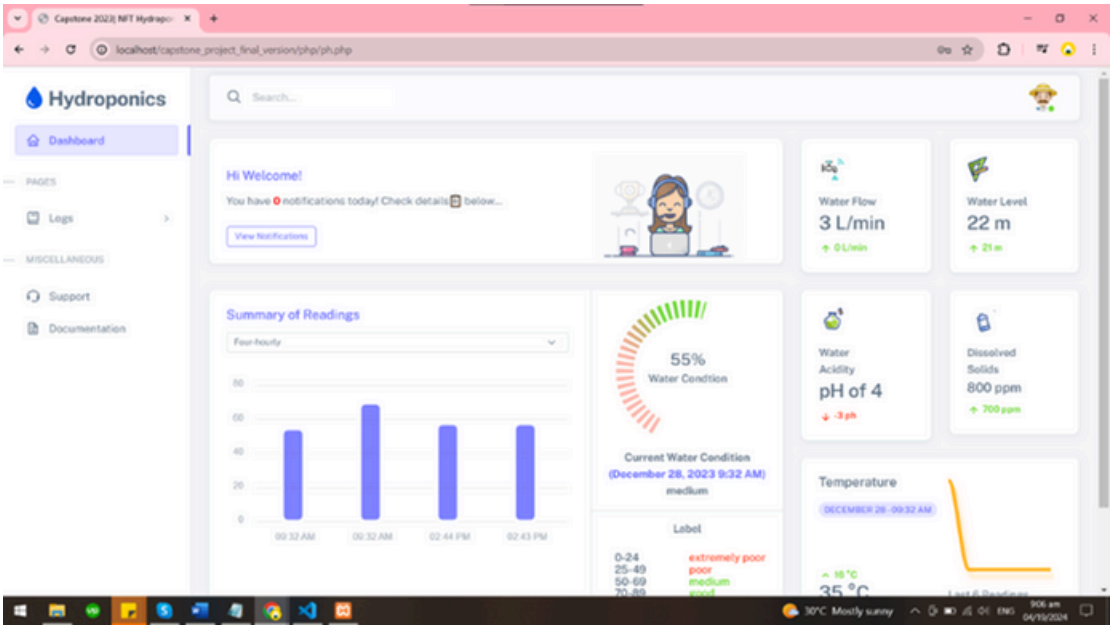
After accessing the link, you will be directed to this form:



To access the features and functionalities of the system, users must register and log in. Follow these steps to complete the registration process:

- Navigate to the registration page on the system's website.
- Complete the registration form by providing your chosen username, email, and password.
- Submit the registration form.
- If required, verify your email to gain access to the system.

MAIN DASHBOARD OVERVIEW



Upon successful registration and login, you will be directed to the main dashboard. The dashboard provides a comprehensive interface with the following sections:

Overall Water Conditions

Logs

- Four Hourly Readings
- Water Flow
- Water Level
- Acidity
- Temperature
- Total Dissolve Solids

Support

Documentation

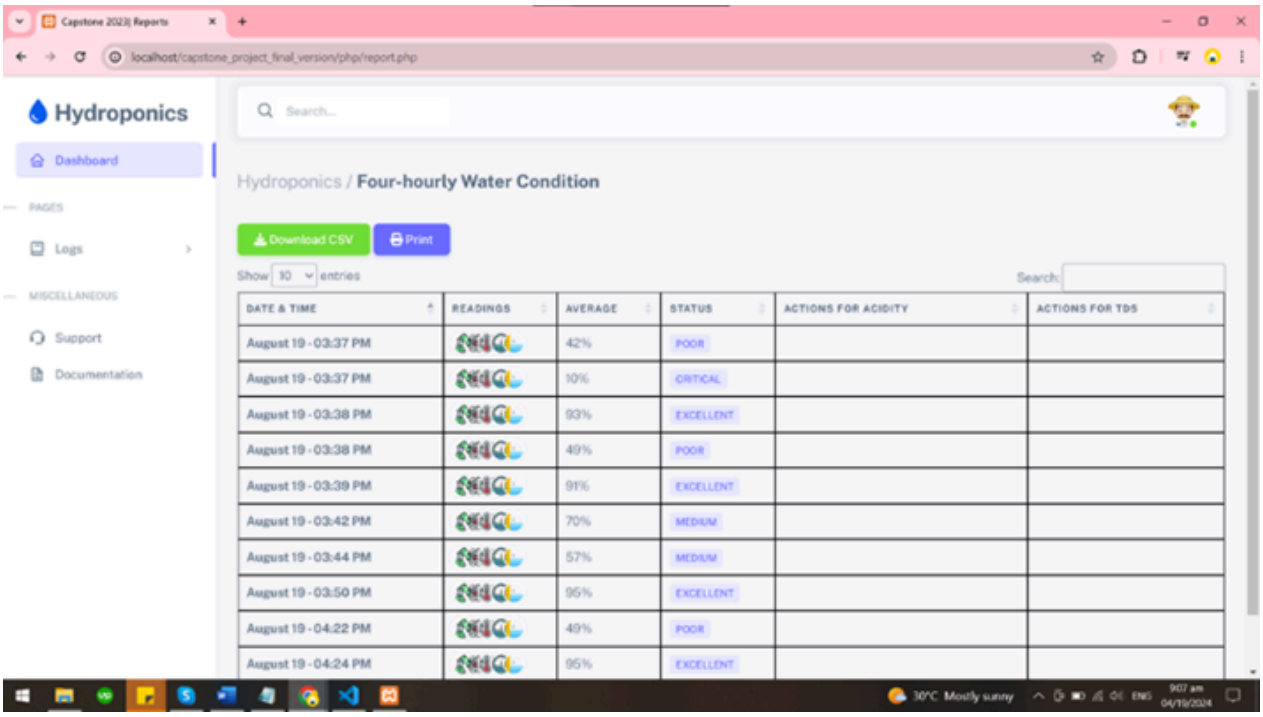
MAIN DASHBOARD OVERVIEW

Each section offers detailed metrics and information related to your hydroponic setup.

LOGS OVERVIEW

The Logs section of the dashboard provides detailed insights into various parameters monitored by the system. The following logs are available:

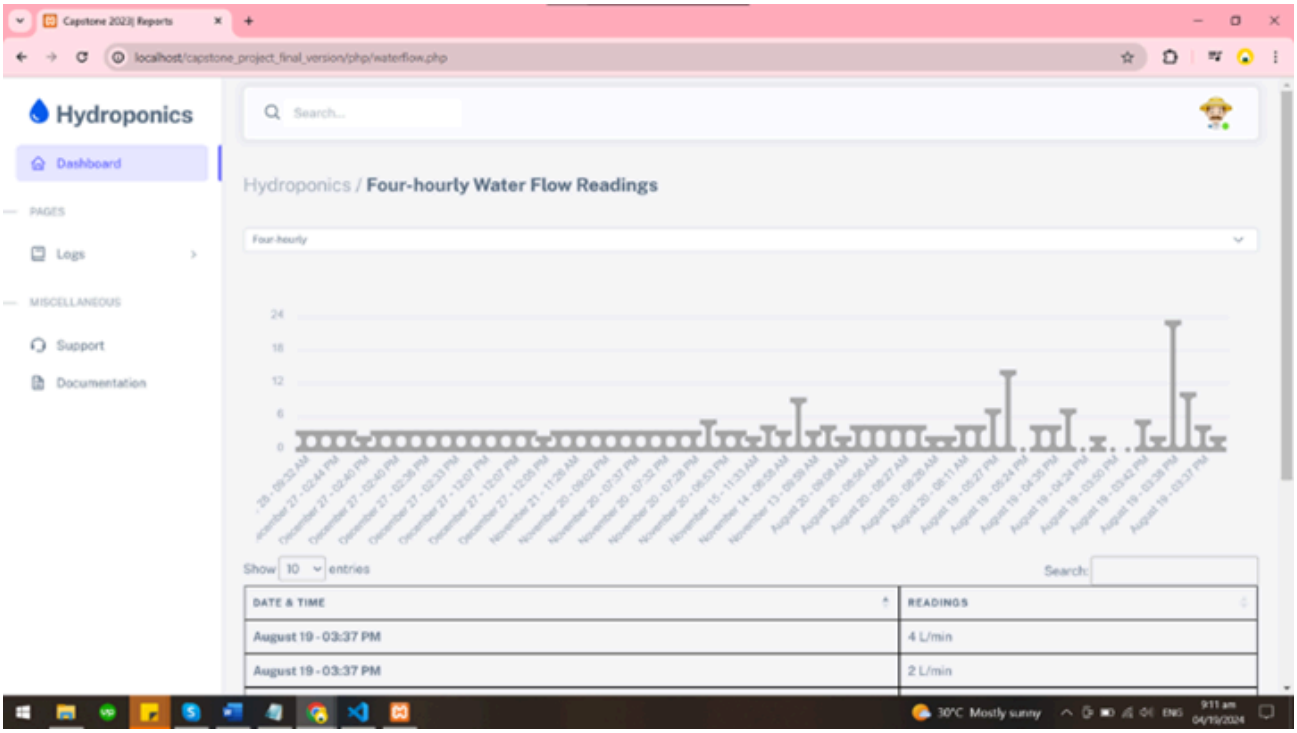
E.1 Water Condition Logs



The interface displays a data table presenting water condition metrics like acidity, total dissolved solids, water flow, water level, and temperature and total dissolved solids (TDS), with interactive features for actions and navigation controls for easy browsing.

LOGS OVERVIEW

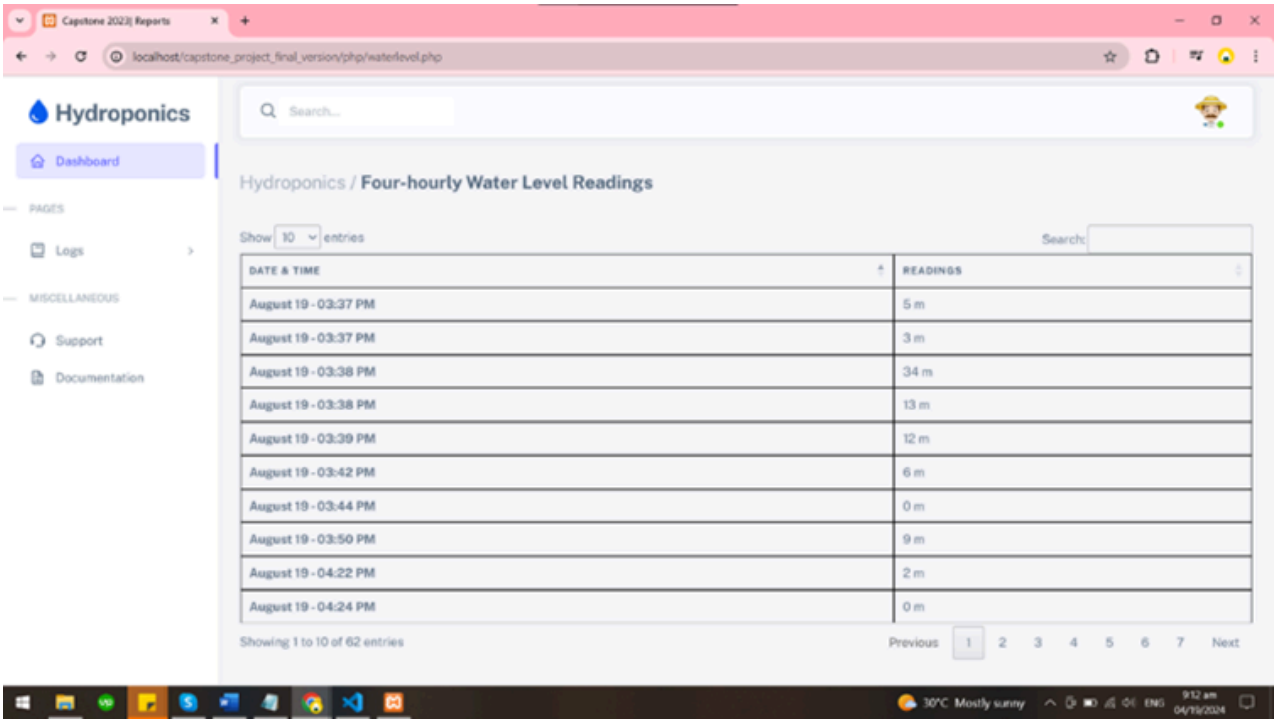
E.2 Water Flow Logs



The interface shows the date and time in order, along with water flow measurements in liters per minute. Simple navigation buttons and extra information make it easy to use and understand.

LOGS OVERVIEW

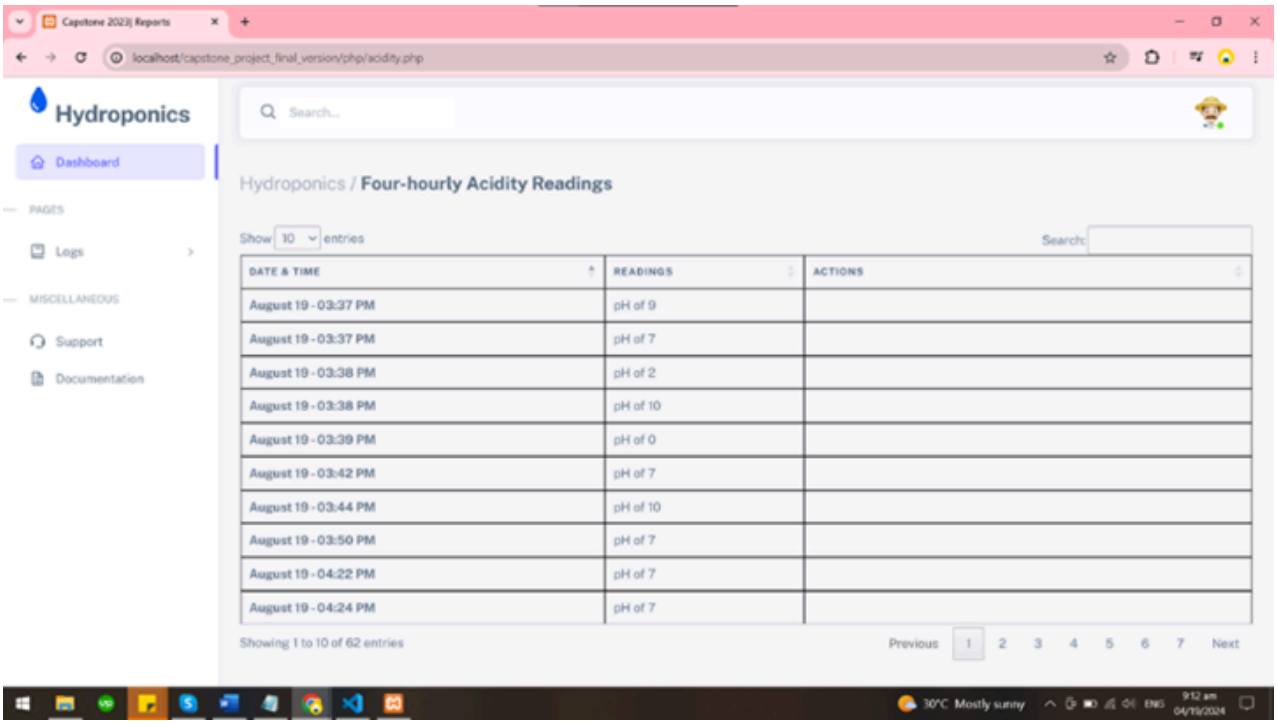
E.3 Water Level Logs



The interface displays different water level readings in an organized table. It has columns for date and time, the readings themselves, and other details, making everything easy to read and understand.

LOGS OVERVIEW

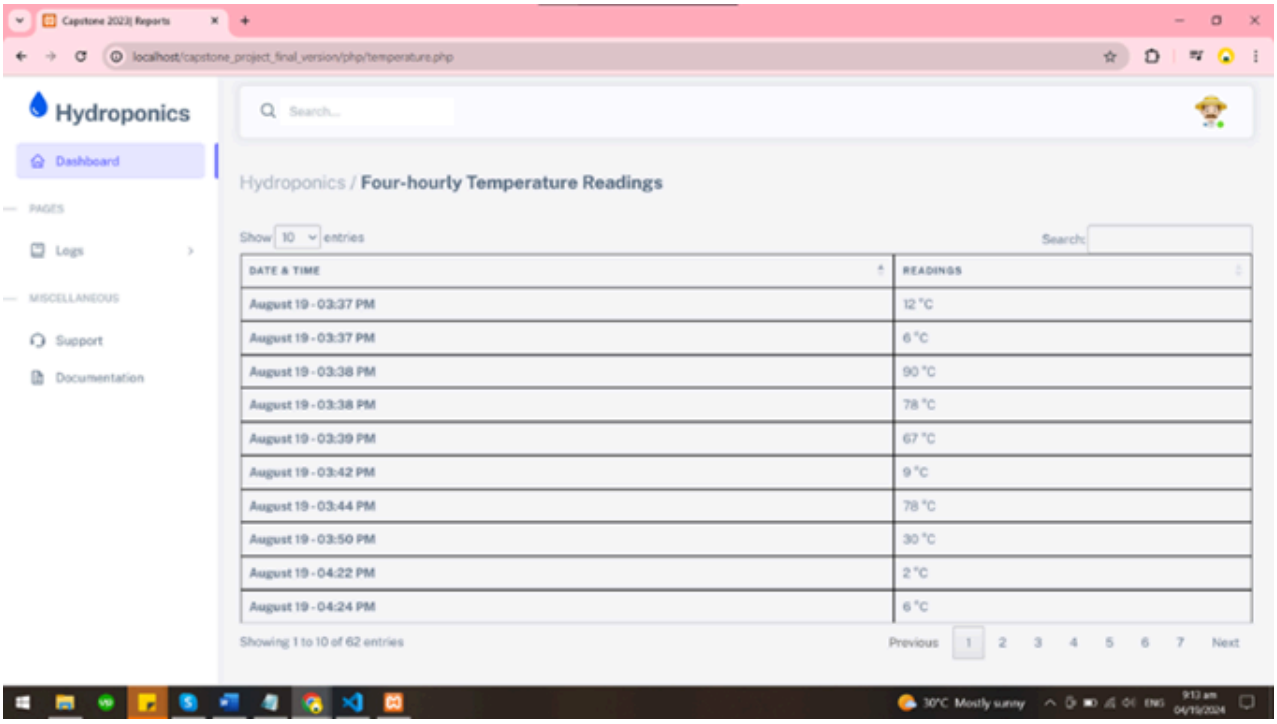
E.4 Acidity Logs



The interface displays pH (acidity) readings in a clear table format. It has columns for date and time, the readings, and any actions taken. The main goal is to show acidity levels recorded at different times, giving a complete picture of the data.

LOGS OVERVIEW

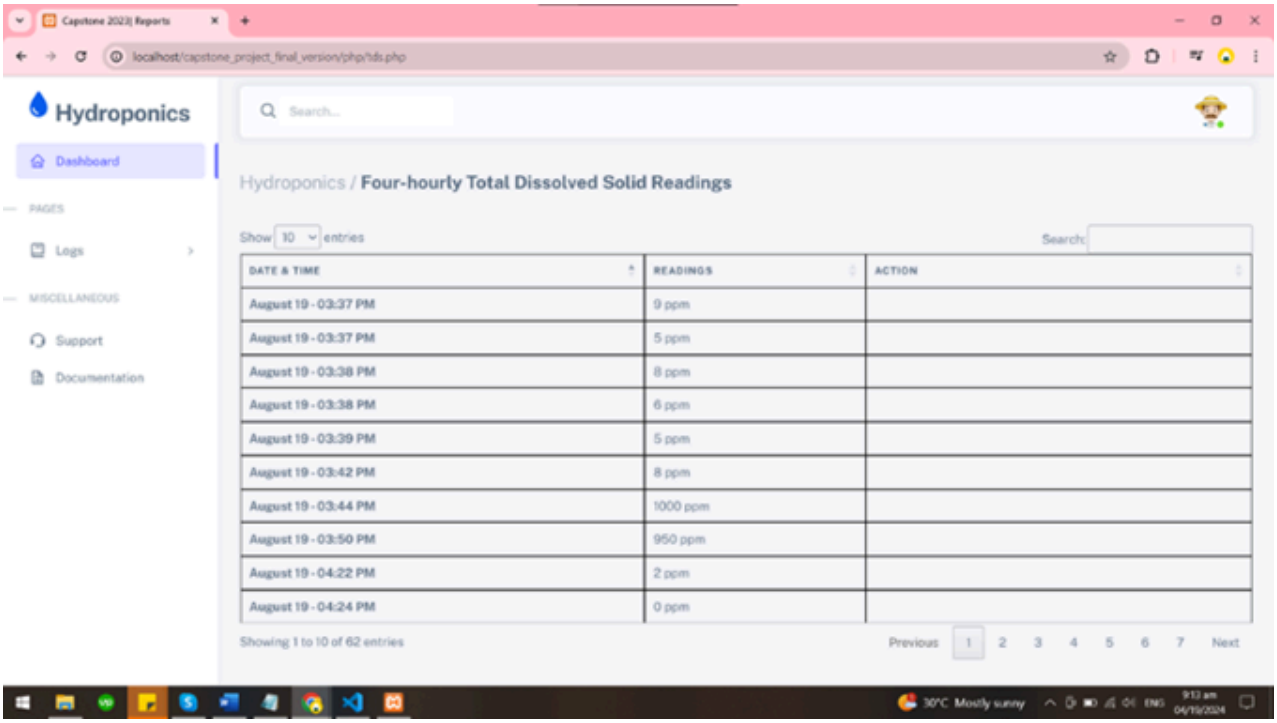
E.5 Temperature Logs



The interface displays a table representing temperature readings along with the exact dates and times they were recorded. This setup provides a clear and detailed view of the temperature data over time.

LOGS OVERVIEW

E.6 Total Dissolved Solid Logs



The interface displays a table that shows detailed information on Total Dissolved Solids (TDS), including exact dates and times, actions taken, and extra details. This setup gives a complete view of the data. The logs are organized chronologically and include interactive features for more in-depth analysis.

DEVICE OVERVIEW

The Automated Hydroponic Monitoring System consists of a compact device housing advanced sensor.

The device includes:

Device Case: Designed to protect and house monitoring sensors for various environmental applications.

DEVICE OVERVIEW

Inside of the Device: A compact array of high-tech sensors arranged to monitor water quality, including indicators for acidity, temperature, dissolved solids, flow rate, and water level.

DEVICE COMPNENTS

Name	Specifications	Sample Image
5V4A DC CCTV LED Centralized Power Supply Adapter	Model: S20-5 S504 Output voltage: DC 5V 4A Input voltage: AC110/220V ± 15% Grid frequency: 50/60HZ	
Relay Module 6 Channel 5v With Optocoupler Projects Arduino Compatible	Control Voltage: 5V DC Max Control Capacity:10A@250VAC or 10A@30VDC	
DC 6-12v food grade 385 diaphragm pump self-priming micro pump DC computer circulating water	Pump size:1.6*3.5*1.4inch(40mm*90mm*35 mm) Working voltage: DC12V Working current: 0.5-0.7 A (power must be more than 6W) Flow: 1.5-2 L/Min (or so) The largest suction:78.7inch(2m) Pump Head: vertical maximum 118inch(3m) Life: 2500 h(maximum) Water temperature: up to 80 °C	

DEVICE COMPNENTS

High Quality Passive Buzzer Module for Arduino DIY Kit	1 passive internal without shock source, so if use dc signal can't make it. Must use 2 k ~ 5 k square wave to drive it For more than 2 sound frequency control, can make "m hair sola west" effect. 3 in some particular case, can reuse and LED a control	
Waterproof Ultrasonic Module JSN-SR04T / AJ-SR04M Water Proof Integrated Distance Measuring	Electrical parameters: JSN-SR04T Operating voltage: DC 5V Quiescent current: 5mA Total current work: 30mA Acoustic emission frequency: 40khz Farthest distance: 4.5m Blind: 25cm Wiring: + 5V (positive power supply) Trig (control side) RX Echo (the receiver) TX GND (negative) Module size: 41mm * 28.5mm Resolution: about 0.5cm Angle: less than 50 degrees Working temperature: -10 ~ 70 ° Storage temperature: -20 ~ 80	
Sim900a Sim900 Mini V4.0 Wireless Data Transmission Module GSM GPRS Board Kit w/Antenna for Arduino	Size: 49mm*47mmNet Weight: 28g Weight: 38g	

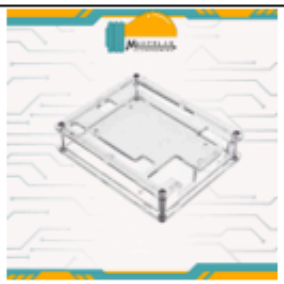
DEVICE COMPNENTS

Dupont Line	10 cm Male to Male	
Dupont Line	20cm Female to Female	
Dupont Line	20cm Female to Male	
12V Water Flow Sensor DC 5-18V Flowmeter Hall Flow Sensor Water Control Liquid Flow Sensor Switch 1-30L/min 2.0MPa YF-S201	External threads: 1/2" Temperature: -25~+80 Allowing Pressure: pressure 1.75Mpa Operating Humidity range: 35%~90%RH (no frost) Use Temperature: 80 Load Capacity: 10 mA (DC 5V) Working Voltage Range: DC 5~18 v Maximum Operating Current: 15 mA (DC 5V) Lowest Rated Working Voltage: DC 4.5 5V-24V Size : 6x4cm Color : Black	

DEVICE COMPNENTS

DS18B20 Temperature Sensor Module Kit Waterproof 100CM Digital Sensor Cable Stainless Steel Probe Terminal Adapter for Arduino (1 SET)	Temperature sensor supply voltage: 3.0V ~ 5.5V Temperature sensor resolution: 9 to 12 adjustable resolution Temperature range: -55 ~ +125 ° (lead can only withstand the highest temperature of 85 degrees) Temperature Sensor Output Lead: Yellow (DATA) Red (VCC) and Black (GND) Adapter Cables: DATA, VCC, BLK, Suitable platform: for Arduino and Raspberry Pi	
TDS Sensor Water Conductivity Sensor for Arduino Liquid Detection Water Quality Monitoring Module DIY TDS Online Monitor	Input Voltage: DC 5V Output Voltage: DC 1.0V-24.0V Output Power: 3W(Max) Conversion efficiency: 94% Working current: 30mA Working Temperature range: -20℃~85℃ Working Humidity range: 0%-95%RH Size: 70*26*22mm	
DFRobot Gravity: Analog pH Sensor/ Meter Kit for Arduino	Module Power: 5.00V Module Size: 43 x 32mm (1.69×1.26″) Measuring Range :0 – 14PH Measuring Temperature: 0 – 60 °C Accuracy: ± 0.1pH (25 °C) Response Time: ≤ 1min pH Sensor with BNC Connector pH2.0 Interface (3-foot patch) Gain Adjustment Potentiometer Power Indicator LED	
20x4 LCD Display I2C White on Blue	20*4 LCD display with I2C adapter board	

DEVICE COMPNENTS

MB102 Breadboard 830 points for electronics or Arduino prototyping	compatible with breadboard power supply Arduino compatible standard pitch 2.54mm 830 points with slots for connection with another breadboard's sticker base	
12V Oil Pump Electric Water Pump Fuel Dispenser	Power: 12V	
Arduino UNO R3 Acrylic Case	3mm acrylic Light and easy to transport good heat dispersion Dimensions: 80mm x 65mm	
PH-4502C Liquid PH Sensor with E201-BNC probe (Kit)	V+: 5V DC input G: Ground pin Po: pH analog output Do: 3.3V DC output To: Temperature output	

DEVICE COMPNENTS

Diode 1N4007	1N4007/1N4001 Characteristics: Maximum Recurrent Peak Reverse Voltage 1000V/50V. Maximum RMS Voltage 700V/35V. Maximum DC Blocking Voltage 1000V/50V. Average Forward Current: 1.0A. Peak Forward Surge Current: 30A Maximum Instantaneous Forward Voltage: 1.0V Maximum DC Reverse Current At Rated DC Blocking Voltage: 5.0μA @ 25°C Typical Junction Capacitance: 15pF Typical Reverse Recovery Time: 2.0us Mounting Type: Through Hole Operating Temperature: -55°C ~ 150°C	
pH Buffer Solutions (Set)	pH 4.01, pH 6.86, and pH 9.18	
SIM Card	TNT	
SIM Card Load	TNT	

DEVICE COMPNENTS

Garden Hose	½"	
Base Box Electric Control Box Indoor Distribution Box Powerful Control Box	25*30*14cm	
Base Box Electric Control Box Indoor Distribution Box Powerful Control Box (Electronic Protection)	(Electronic Protection)	
Altering of Base Box	Altered to put the LCD Display on the front of the base box	

DEVICE OVERVIEW

With the Automated Hydroponic Monitoring System, managing your hydroponic setup has never been easier. Utilize the real-time data and comprehensive features provided by the system to optimize your crop production and ensure optimal growing conditions. If you encounter any issues or have any questions, refer to the support section of the dashboard or consult the documentation.

Happy farming!

ENDNOTE

The IoT-based Decision Support System for Nutrient Film Technique (NFT) Hydroponics Culture was developed as part of the Capstone Requirement for the Bachelor of Science in Information Technology (BSIT) degree at Mindanao State University - General Santos City during the 2023-2024 academic year. Supervised by Lumer Jude Doce, the project aimed to address the monitoring challenges in hydroponic farming.

BSIT students Sofia Macaludos, Jessie Conn Ralph Sam, Zaki Sarmiento, and Niña Rose Sebial collaborated to design and implement this system, utilizing technology to make a positive impact on agriculture. Their commitment to innovation and improving the farming community led to the development of a robust decision support system that monitors key factors like acidity, temperature, electrical conductivity, water flow, and container water levels.

Through this project, the team hopes to inspire greater support for farmers, ensuring that innovations like theirs are accessible and backed by government initiatives. This system not only optimizes growing conditions but also contributes to a more sustainable agricultural future, leaving a meaningful legacy in both farming and technological advancement.

Sofia B. Macaludos, a Bachelor of Science in Information Technology student majoring in Networking, played a key role in planning and executing the network infrastructure. Her attention to detail in wiring and data gathering, along with her ability to incorporate feedback from respondents, contributed to a more user-centered system. Sofia's problem-solving skills helped overcome technical challenges and optimize the network's performance.

Jessie Conn Ralph Sam, also a BSIT student majoring in Database and an accomplished full-stack developer, led the development of the project. His ability to translate complex requirements into functional code, combined with his innovative ideas and technical expertise, ensured the project's success. His leadership and attention to detail made him a critical asset to the team.

Zaki C. Sarmiento, a Bachelor of Science in Information Technology student majoring in Database, played a critical role in designing and structuring the database system. Her expertise in diagramming and thorough documentation provided a strong foundation for the project. Zaki's keen attention to detail and commitment to high standards ensured clear, precise, and professional documentation, which was essential to the project's success.

Niña Rose Sebial, also a BSIT student majoring in Database, excelled in data gathering and documentation, contributing to an efficient and reliable database design. Niña's strong presentation skills were highlighted when she represented the group at the research colloquium, effectively communicating the project's goals and outcomes. Her ability to simplify complex technical concepts helped the team gain recognition, making her a key spokesperson for the project.

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AN UNDERGRADUATE CAPSTONE PROJECT
PRESENTED TO THE FACULTY OF THE IT & PHYSICS DEPARTMENT
COLLEGE OF NATURAL SCIENCES AND MATHEMATICS
MINDANAO STATE UNIVERSITY – GENERAL SANTOS CITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

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TO GOD BE THE GLORY!