Sri Lanka Institute of Information Technology

Remotely Navigated Automated Water Quality Sampling System

Software Requirement Specification

Professional Engineering Practice and Industrial Management - IE2090

Project ID: **PEP_11**

Submitted by:

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Date of submission
20/04/2024

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Revision History

Name	Date	Reason For Changes	Version
Muthukumarana T D	20/04/2024	Product Scope definition issues. Project Documentation definition issues. Operating Environment definition issues.	1
Muthukumarana T D	20/04/2024	Figure naming issue. Appendix add.	2

1. Introduction

1.1 Purpose

The SRS document specifies the software requirements for the Remotely Navigated Automated Water Quality Sampling System which is capable of measuring the water quality of large water bodies and physically inaccessible water bodies. Additionally, this document describes the entire system of products.

1.2 Document Conventions

- In this document, the titles of the sections and sub-sections are denoted using bold text.
- The font sizes 16,14,12 are used for Headings, Sub-headings and for the content of the document respectively.

1.3 Intended Audience and Reading Suggestions

This document targets system users, project team members, lecturers, and clients. It begins by defining the project scope through the cited sources. The next section provides a general overview of the system. Following that, the third chapter outlines the external interface requirements. The fourth chapter delves into the system's features, while non-functional requirements are detailed in the fifth chapter. It's essential for all stakeholders, including system users, lecturers, and clients, to understand the sequence of information in the SRS document thoroughly to achieve the desired objectives.

1.4 Product Scope

The system [Remotely Navigated Automated Water Quality Sampling System] allows remote readings of PH levels in different portions of the water. The objective of the system is to detect different levels of PH without physically being present in different parts of water. The system can be used to detect water that is suitable for consumption or daily uses. In addition, the said system can be utilized to detect water pollution and how the specific type of pollution can be ministered to.

1.5 References

https://www.electroniclinic.com/ph-meter-arduino-ph-meter-calibration-diymore-ph-sensor-arduino-code/

https://www.youtube.com/watch?v=XCOskRNX46I&t=127s

2. Overall Description

2.1 Product Perspective

The primary motivation driving our project is the importance of inland water bodies as a vital source of water for daily consumption. It is widely recognized that many of these water bodies are experiencing pollution due to various factors, including unsystematic waste disposal from industrial facilities and direct dumping of household waste. Given the extensive geographical spread of these water bodies, pinpointing the precise location of pollution, and effectively monitoring water quality presents a significant challenge for authorities, often requiring substantial manpower and resources.
In response to this challenge, we have developed a smart solution to reduce the manpower and associated costs and streamline the water quality monitoring process.

Our project entails the development of a water quality monitoring system, designed to be mounted on a boat which can be used to determine water quality in large water bodies. This system comprises 2 sensors to read the pH value and Turbidity level of water which are 2 prominent water quality measuring parameters. These 2 sensors are mounted on a robotic arm which can be lowered to obtain the readings in a certain location. Additionally, a GPS tracker is also included in this system to record real-time location data for each measurement point. This functionality allows the users to get better insights about the water quality in different areas of the water bodies. All the data recorded from the system are stored in a database along with the locations, dates, and times. Users can conveniently access this information from a dedicated web application.

2.2 Product Functions

- Rotational adjustment of robotic arm for sampling.
- Obtaining the pH readings.
- Obtaining the turbidity readings.
- Obtaining the geographical location of the sampling sites.
- Real-time display of recorded data.

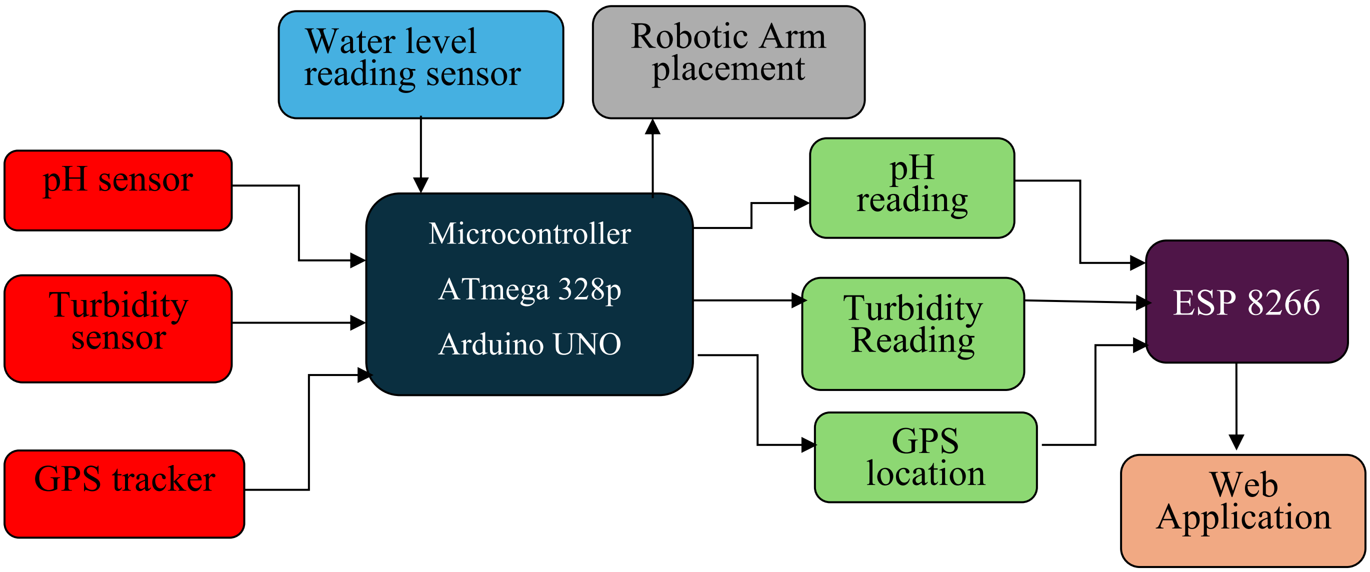

Figure 1 – High-Level Diagram of the System.

2.3 User Classes and Characteristics

National Water Supply and Drainage Board

- Reduction of manpower used in the process.
- Reduction of associated costs spent on ensuring the water quality.
- Ability to carry on more frequent tests.

Any individuals or organizations engaged in the monitoring and assessment of water quality within aquatic environments.

2.4 Operating Environment

This is a fully automated system which can be mounted on any device to obtain readings of water quality parameters in any inland water bodies such as lakes, and mildly aggressive water streams (Not recommended for highly aggressive streamlines).

This solution can be also implemented in marine environments where water flow is moderate, and the system should be deployed in temperatures between 0°C and 80°C.

2.5 Design and Implementation Constraints

- Malfunction in sensors, GPS tracker, and robotic arm would compromise data accuracy and system functionality.
- Extreme weather conditions and rough waters could impact system functionality.
- Potential vulnerability of database to unauthorized access, data breach or cyber-attacks.

2.6 Project Documentation

- Project Charter Document
- Software Requirement Specification Document
- Final Report

2.7 User Documentation

User Guide - A user guide will be provided to the users to inform them on how to use the system.

Installation guide – The installation guide will provide the step-by-step process to correctly assemble and install the product.

2.8 Assumptions and Dependencies

Assumptions

- Robotic arms and sensors will consistently perform accurately and reliably in various water conditions.
- GPS tracker will provide accurate location data without any significant errors.
- The web platform operates seamlessly and reliably ensuring uninterrupted real-time data viewing.

Dependencies

- The accuracy of data depends on the accuracy of the sensors.
- Real-time data display depends on the web application used.

3. External Interface Requirements

3.1 User Interface

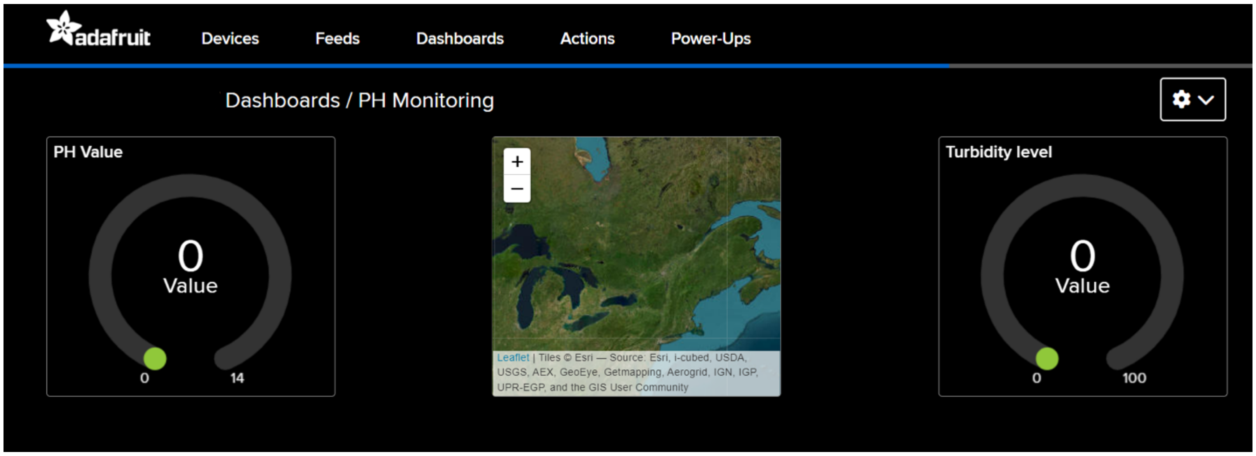

Figure 2 - User Interface of the Monitoring System.

3.2 Hardware Interface

As shown in the above diagram the user interface of the Data monitoring system for the Remotely navigated automated water quality sampling system is.

- pH value monitor
- Turbidity level monitor
- Location tracker

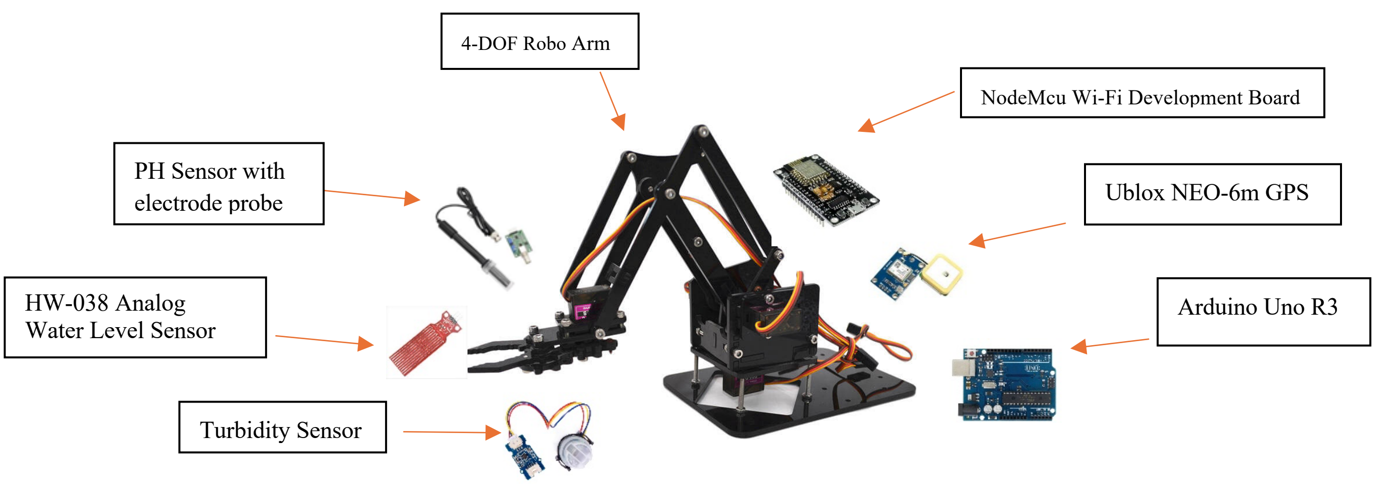

Figure 3 - Hardware Layout of the system.

- **Arduino UNO R3 Board:** The Arduino UNO R3 is the best board to get started with electronics and coding.

- **NodeMcu Wi-Fi Development Board:** NodeMcu is an IoT development board based on the ESP8266 chip, offering built-in Wi-Fi connectivity and GPIO pins for easy interfacing with various sensors and actuators.

- **Breadboard:** A breadboard is a solderless prototyping tool used to build and test electronic circuits by allowing components to be easily interconnected without soldering.

- **Ublox NEO-6m GPS:** The Ublox NEO-6m GPS is a compact and cost-effective GPS module commonly used for navigation and positioning applications.

- **PH Sensor with electrode probe**: A pH sensor with an electrode probe is a device used to measure the pH level of a solution. It consists of a pH electrode probe that detects the hydrogen ion concentration in a liquid, providing a pH reading for analysis.

- **Turbidity Sensor:** A turbidity sensor measures the cloudiness or haziness of a fluid caused by suspended particles. It's commonly used in water quality monitoring to assess the clarity of water by detecting the presence of particulates.

- **Servo Motor:** A servo motor is a rotary actuator that allows for precise control of angular position, velocity, and acceleration.

- **PWM Servo Motor Driver:** A PWM (Pulse Width Modulation) servo motor driver is a device that controls servo motors by varying the width of electrical pulses sent to them, allowing precise control over their position and speed.

- **4-DOF Robo Arm:** A 4-DOF Robo Arm is a robotic arm with four degrees of freedom, allowing it to move in four different directions or axes. We use it to fix the pH sensor to measure the pH value.

3.3 Software Interfaces

- **Arduino IDE:** Arduino IDE is an integrated development environment used for writing, compiling, and uploading code to Arduino microcontroller boards.

3.4 Communication Interfaces

- **io.Adafruit:** io.adafruit is an IoT (Internet of Things) platform provided by Adafruit Industries, offering services for connecting, managing, and controlling IoT devices over the Internet using protocols like MQTT. To connect a NodeMCU Wi-Fi Development Board to io.adafruit, we typically use the MQTT (Message Queuing Telemetry Transport) protocol.

4. System Features

4.1 Functional Requirements

Function 01	Rotational adjustment of robotic arm for sampling.
Input	Remote signal triggered by the user. Water Detection.
Process	Horizontal rotation of the robot arm to the desired degree. Vertical rotation of the robot arm until the water detection sensor detect water.
Output	Robotic arm in the desired position, giving sensors (pH, Turbidity) the ability to read & obtain values of the water.
Definition	An automated process which the user triggers a remote signal to activate the robot arm. First the robot arm will rotate horizontally to a specified position, then rotates vertically until the water detection sensor detects water level, precisely positioning the arm to at the water surface for sample collection.

Function 02	Obtaining the pH Readings.
Input	pH value of water obtained by the pH sensor.
Process	Reading pH values. Reading sensor data to the Arduino board.
Output	Sending obtained values received from the Arduino board to the Web Application via NodeMCU (esp8266).
Definition	The function is responsible for acquiring water pH level using the pH sensor. This involves reading the sensor data, applying calibrations. The Arduino Board will read appropriate sensor data and sends the data to the NodeMCU board allowing transmission of obtained data to the Web Application.

Function 03	Obtaining the Turbidity Readings
Input	Turbidity value of water obtained by the Turbidity sensor
Process	Reading Turbidity values. Reading sensor data to the Arduino board.
Output	Sending obtained values received from the Arduino board to the Web Application via NodeMCU (esp8266).
Definition	The function is responsible for acquiring water Turbidity level using the Turbidity sensor. This involves reading the sensor data, applying calibrations. The Arduino Board will read appropriate sensor data and sends the data to the NodeMCU board allowing transmission of obtained data to the Web Application.

Function 04	Obtaining geographical location of the sampling site
Input	GPS locations obtained using the GPS Module
Process	Retrieve Location Data Read Data to the Arduino Board
Output	Sending obtained values received from the Arduino board to the Web Application via NodeMCU (esp8266).
Definition	The function is responsible for acquiring location data of the sampling location using the GPS Module. This involves reading the sensor data, applying calibrations. The Arduino Board will read appropriate sensor data and sends the data to the NodeMCU board allowing transmission of obtained data to the Web Application.

Function 05	Real time display of recorded data.
Input	Sensor readings obtained.
Process	Retrieving data from NodeMCU. Positioning retrieved data on appropriate labels on the Web Application.
Output	A user-friendly Web Application capable of Providing useful information.
Definition	This function is responsible for displaying the retrieved data from NodeMCU, on the Web Application Interface. This includes positioning these data under the correct label, providing precise data and information about pH level and Turbidity level of the sampling location to the user.

4.2 Design Diagram

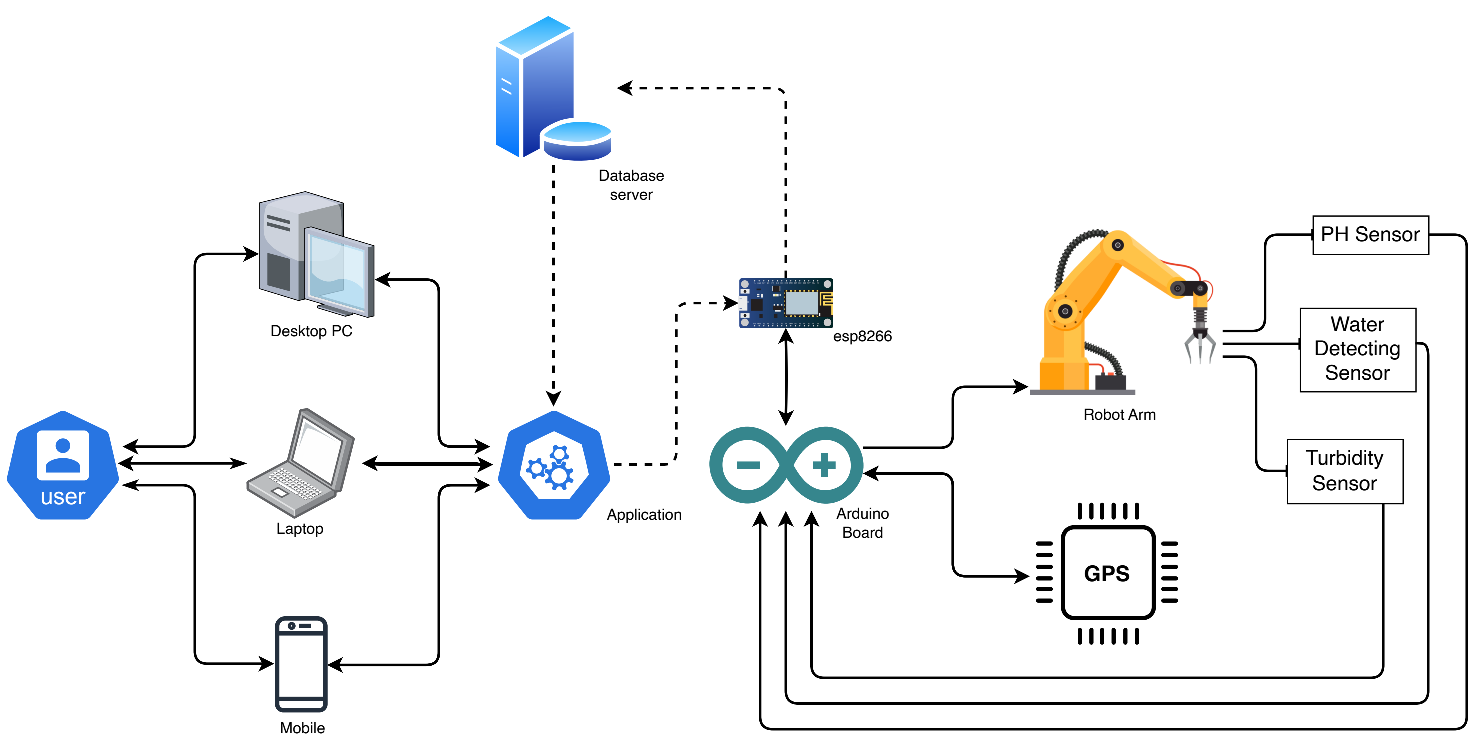

Figure 4 - Design Diagram of the System.

4.3 Block Diagram

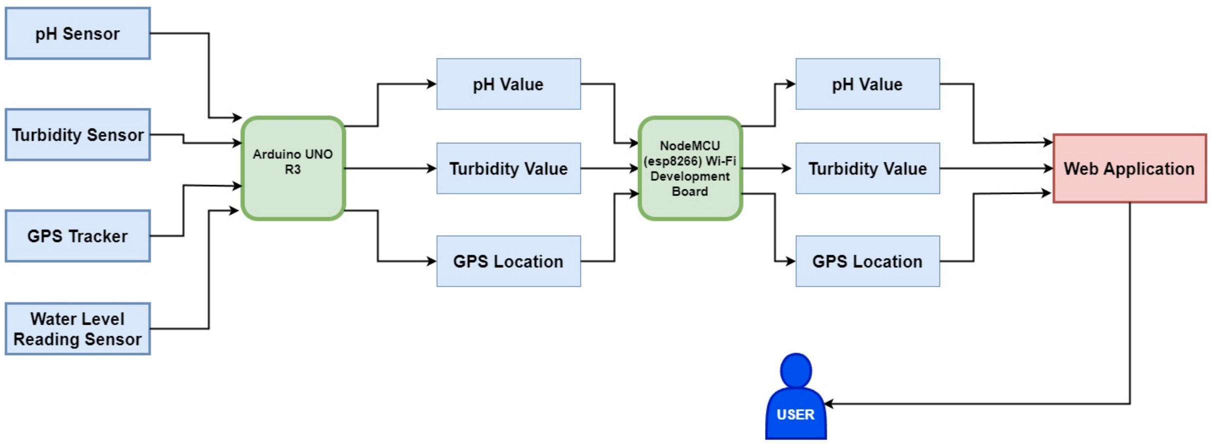

Figure 5 - Block Diagram of the System.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

- This system requires a power source to operate.
- Response Time: To improve user experience and enable smooth operation, respond to inputs in rather a short time.
- Data Storage and Retrieval: For data-driven decision-making and historical access to water quality data, store and retrieve data from the database within a short time.
- Robotic Arm Movement Speed: To guarantee timely data gathering, move the robotic arm to designated spots inside the water body in less than a minute.
- GPS Accuracy: Identify pollution sources and create a detailed spatial map by providing the location data with accuracy within the specified dimensions.

5.2 Safety Requirements

Robotic Arm Safety: The arm's movements should be programmed to steer clear of anything like debris or underwater structures. If the robotic arm moves or malfunctions, safety measures should be put in place to protect operators and onlookers from harm.

Electrical Safety: To avoid the risk of electric shock, all electrical parts and connections must adhere to the applicable safety regulations. Proper insulation and shielding of wiring are necessary to reduce the likelihood of electrical malfunctions or short circuits. batteries that are used by the system for power should be safely stored and guarded. To keep an eye on battery health and avoid overcharging or overheating, proper battery management systems need to be in place.

Sealing with water: It is imperative that all electrical components, including sensors and control units, have sufficient waterproofing to withstand submersion in water and guard against water-related damage.

5.3 Security Requirements

The Remotely Navigated Automated Water Quality Sampling System must meet thefollowing security standards to protect user privacy and data protection:

Data Encryption: To avoid unwanted access or sensitive information being intercepted, all communication between the system's components and the data kept in the database should be encrypted using industry-standard encryption methods. It is important to implement strict password standards that mandate users to establish and update complicated passwords on a regular basis. While administrators ought to have unrestricted access, other users should only be granted access to the functionalities relevant to their roles.

Regulatory Compliance: The system must abide by all applicable privacy laws and guidelines on the gathering, storing, and processing of personal or sensitive data. Any security or privacy certifications required by regulatory bodies should be obtained to demonstrate compliance.

5.4 Software Quality Attributes

To satisfy users and developers, the Remotely Navigated Automated Water Quality Sampling System needs to have the following features in its software:

Reliability: To provide dependable functioning in a range of environmental circumstances, the system must reliably and properly gather data on water quality without errors or malfunctions. More than 100 hours of continuous operation is required for the Mean TimeBetween Failures (MTBF).

Availability: There should be little downtime for maintenance or repairs, and the system should always be usable.

Maintainability: The system should be made to be simple to maintain and troubleshoot, enabling prompt problem discovery and resolution.

Usability: The system should be simple to operate and intuitive, needing little training for operators to carry out operations in an efficient manner.

Robustness: The system must be able to withstand unforeseen inputs and environmental changes, handle faults with grace, and recover without losing data or experiencing a system failure.

Security: Encryption, authentication, and access control techniques should be used by the system as a priority to safeguard sensitive data and user access.

5.5 Business Rules

Roles and Permissions:

- **Administrators**: Have full control over system configuration, user management, and functionality.
- **Operators**: Can view and generate reports and conduct data-gathering tasks. They cannot alter system settings.
- **Technicians**: Responsible for software updates, hardware repairs, and troubleshooting. They have limited access to relevant features and data.

Data Access Restriction:

- Users can only access features and data that are relevant to their roles and permissions.
- Access rights can be granted or revoked by administrators as necessary.

Quality Control Measures:

- To guarantee reliable readings, operators must calibrate the sensors before deploying the system for data collection. Administrators must be notified of any anomalies or variations in data readings so that they can do additional research.

Data Integrity and Confidentiality:

- Users oversee preserving the confidentiality and integrity of the data they have gathered. Administrator consent and adherence to privacy laws are prerequisites for sharing data with third parties.

Guidelines for System Usage:

- For safe and effective system operation, users should adhere to the normal operating procedures listed in the user handbook. Administrators or technicians should be notified as soon as possible of any problems or difficulties with the functionality or performance of the system.

Appendix A: Glossary


ALPHATRONIC

Alphatronic Technologies

28 BAS Building Highlevel Road, Homagama
www.alphatronic.lk
0767658217/0740168369
info@alphatronic.lk

ceipt No.: 24-200-001425
/6/2024 1:19:40 PM
ser: Thisaru
rder No.: 12685

6 Channel 12-bit PWM/Servo Driver I2C
nterface - PCA9685
x Rs.1,750.00 Rs.1,750.00
iquid PH Sensor Module With Electrode Probe
x Rs.5,950.00 Rs.5,950.00
Robot Arm 4 Axis DOF
x Rs.1,590.00 Rs.1,590.00
Tower Pro Micro Servo 9g
pcs x Rs.490.00 Rs.1,960.00
tems count: 4
ax 0%: Rs.0.00
TOTAL: Rs.11,250.00
ash: Rs.11,250.00
aid amount: Rs.11,250.00

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No warranty and/or exchanges possible

Figure 8

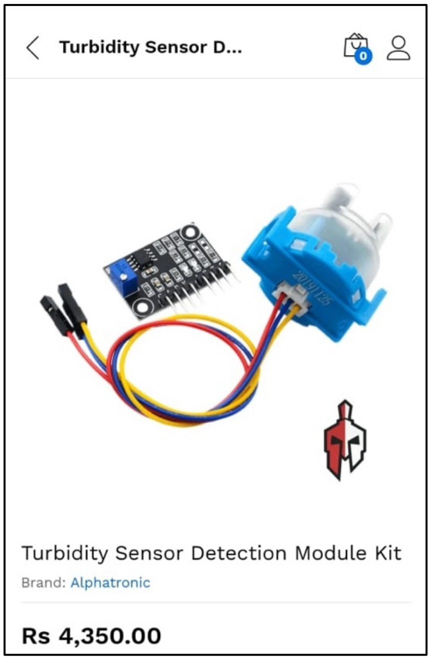

Figure 6

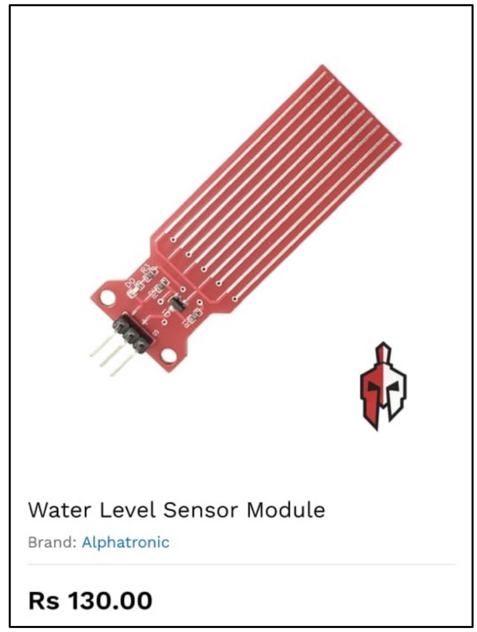

Figure 7

Figure 9

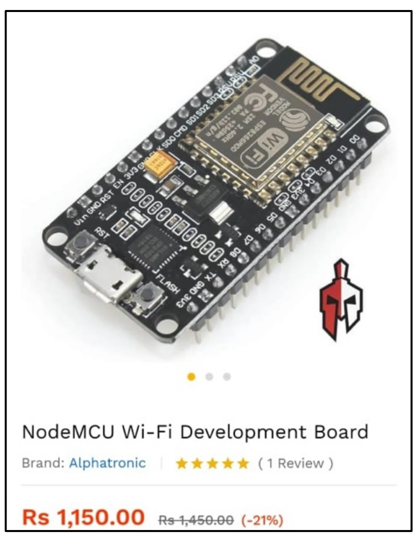

Figure 11

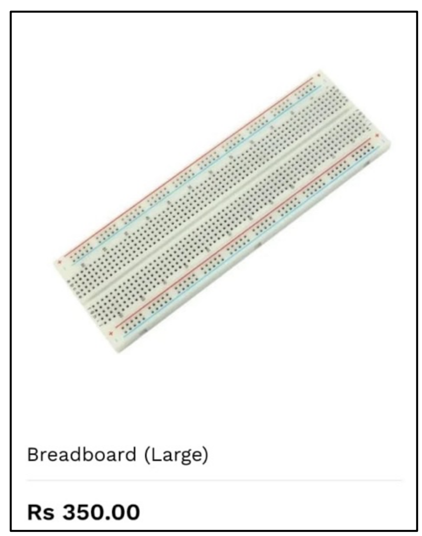

Figure 10

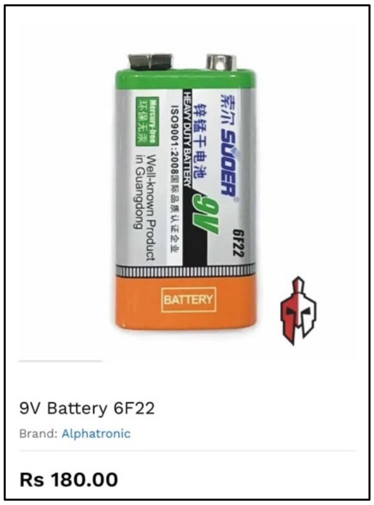

Figure 12

Figure 13

Figure 14