**Functional Document Smart Monitoring Using IoT For Polyhouse**

1. Introduction

The Smart Monitoring Using IoT for Polyhouse Environments project aims to revolutionize controlled environment agriculture by implementing an advanced IoT-based monitoring system. This system utilizes Raspberry Pi microcontrollers and various sensors to track critical environmental parameters in real-time, enabling precise management of crop growth conditions.

1. Product Goal

The primary goal of this research study is to investigate the effect of environmental parameters on the growth of plants under a regulated setup. This paper attempts to gather and examine live data in the form of vital parameters like temperature, humidity, soil moisture levels, light intensity, pH levels, and levels of NPK using IoT sensors coupled with a Raspberry Pi to monitor plant parameters. The focus is to determine conducive conditions for the growth of the plant, gather an in-depth understanding of the delicate interaction among multiple environmental parameters, and develop data-driven strategies for maximizing crop production and quality by continuous monitoring and evaluation of data. This research project has gigantic potential in reinventing precision farming by determining the precise environmental demands of plants and thus enabling optimum utilization of resources and ensuring sustainable agriculture.

1. Demography (Users, Location)

Users:

* Agricultural researchers and scientists
* Polyhouse managers and operators
* Small to medium-scale farmers adopting controlled environment agriculture
* Agricultural technology developers and IoT specialists

Location:

* Research institutions and universities with agricultural programs
* Controlled environment agriculture facilities worldwide
* Regions with a focus on precision agriculture and sustainable farming practices

1. Business Processes
   1. Data Collection and Sensor Management:
      1. Continuous monitoring of environmental parameters using IoT sensors
      2. Regular calibration and maintenance of sensor arrays
      3. Real-time data transmission to the central Raspberry Pi unit
   2. Data Processing and Analysis:
      1. Processing of raw sensor data by the Raspberry Pi
      2. Application of data analysis algorithms to identify trends and correlations
      3. Generation of insights on plant growth patterns and environmental impacts
   3. Data Storage and Management:
      1. Secure storage of collected data in MongoDB cloud database
      2. Implementation of data backup and recovery procedures
      3. Management of historical data for long-term analysis
   4. Reporting and Visualization:
      1. Creation of real-time dashboards for monitoring environmental conditions
      2. Generation of periodic reports on plant growth and environmental parameters
      3. Visual representation of data trends and correlations
   5. System Maintenance and Upgrades:
      1. Regular software updates for the Raspberry Pi and sensor firmware
      2. Hardware maintenance and replacement of faulty components
      3. Continuous improvement of data analysis algorithms and models
2. Features
   1. Feature #1: Multi-parameter Environmental Monitoring

* Description: Implementation of a comprehensive sensor array to monitor key environmental parameters including temperature, humidity, soil moisture, light intensity, pH levels, and NPK concentrations.
* User Story: As an agricultural researcher, I want to simultaneously monitor multiple environmental parameters in real-time so that I can analyze their combined effects on plant growth and health.

5.2 Feature #2: Real-time Data Processing and Storage

* Description: Utilization of Raspberry Pi for immediate processing of sensor data and storage in MongoDB for efficient retrieval and analysis.
* User Story: As a polyhouse manager, I need access to real-time and historical environmental data so that I can make informed decisions about adjusting growing conditions and track long-term trends.

5.3 Feature #3: Visual Plant Growth Monitoring

* Description: Integration of a camera system for capturing periodic images of plant growth, enabling visual tracking and analysis of crop development.
* User Story: As a researcher, I want to visually monitor plant growth progress over time so that I can correlate visual changes with environmental data and identify key growth stages or stress indicators.

5.4 Feature #4: Data Analysis and Correlation

* Description: Development of algorithms to analyze relationships between environmental parameters and plant growth metrics.
* User Story: As an agricultural scientist, I want to identify correlations between specific environmental conditions and plant growth outcomes so that I can optimize growing parameters for different crop varieties.

1. Authorization Matrix

| **Role** | **Data Collection** | **Data Analysis** | **System Configuration** | **Reporting** |
| --- | --- | --- | --- | --- |
| Research Lead | Full Access | Full Access | Full Access | Full Access |
| Researcher | Full Access | Full Access | Read Only | Full Access |
| Polyhouse Manager | Read Only | Read Only | No Access | Read Only |
| System Administrator | Full Access | No Access | Full Access | No Access |

1. Assumptions

* The Raspberry Pi and sensor hardware will function reliably in polyhouse environments with potential humidity and temperature fluctuations.
* Internet connectivity will be consistently available for real-time data transmission to the cloud database.
* Users have basic technical proficiency to interact with the system's interface and interpret data visualizations.
* The selected sensors are capable of providing accurate readings within the expected ranges of environmental conditions in a polyhouse.
* The MongoDB cloud database will have sufficient capacity and performance to handle the volume of data generated by the system.
* Regular maintenance and calibration of sensors will be performed to ensure data accuracy over time.
* The research team has the necessary expertise to interpret complex data correlations and derive meaningful insights for plant growth optimization.