Project Scope, Research Objectives, & Literature Review Report

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Introduction

In the ever-evolving landscape of agriculture, the integration of advanced technologies has become important for optimizing productivity and sustainability. Additionally, as time goes by and more advanced AI technologies and various other technologies emerge, these technologies are expected to be incorporated into agriculture and thereby improve productivity. This project focuses on the integration of smart farming initiatives with Internet of Things(IoT) sensors, a web-based platform, and Deep Neural networks(DNNs) models for measuring tomato size, size measurement, and harvest time, and thereby measuring tomato harvest time.

The main goal of this project is to seamlessly integrate data collected through various cameras with a DNN model and use the results and data from IoT sensors to provide real-time insight into the growth and development of tomato crops. Ultimately, the goal is to develop a system that allows farmers to easily access data from their farms and make informed decisions about when to harvest. By leveraging these cutting-edge technologies, the goal is to improve the efficiency, accuracy and management of tomato farming.

In this report, the project scope section presents a detailed overview of all aspects of the project. It describes the project boundaries and timeline and describes the activities and deliverables, including the various components and technologies involved in the integration of IoT sensors, web platforms, and DNN models.
Then, the research objectives section describes the specific goals and objectives of the study and what we expect to achieve through this study.
Lastly, in the Literature Review section, I summarize the current state of knowledge in the field I want to research and record any topics or important trends I want to research. You will also find papers in this field, outline and analyze them, and discuss your critical analysis. We also discuss research that leads directly to our project and plan future research based on this discussion.

Literature Review

Literature 1
- Enhancing Poultry Farm Productivity Using IoT-Based Smart Farming Automation System[3]

Agriculture, which plays an important role in maintaining human life and the economy around the world, has recently undergone significant changes through smart agriculture, which has emerged due to the development of Internet of Things (IoT) technology. Smart agriculture has emerged as a central solution to improve agricultural productivity while ensuring sustainable practices by leveraging IoT technologies. Several studies and market reports highlight the potential of IoT technology in revolutionizing agriculture, with the global IoT in the farming market projected to reach substantial growth figures by 2025. The adoption of IoT in agriculture promises increased efficiency, cost reduction, and improved economic practices. This literature review evaluates the current state of knowledge in the field, highlighting major themes, trends, areas of disagreement, and research that directly aligns with the integration of IoT sensors, web platforms, and DNN models for plant monitoring systems, particularly focusing on estimating tomato harvest timing.

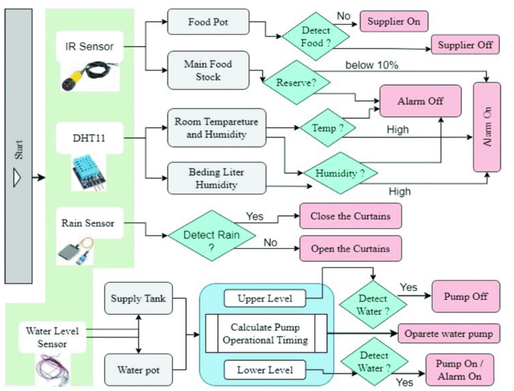
Smart agriculture utilizes cutting-edge technologies such as IoT sensors, data analysis, AI, and automation in agriculture, and collects and transmits data through the Internet and various sensors, allowing precise monitoring and control of various agricultural parameters. It also collects real-time data and monitors environmental conditions with the data, giving farmers improved decision-making. Modern times have advanced the accessibility and efficiency of smart agriculture, and these developments are transforming agricultural processes to become more automated and ensure higher yields. (M. Bacco et al, 2018)[1] Industry 4.0 principles, characterized by the integration of sensors, equipment and IoT systems, emphasize the role of IoT in automation and resource optimization and emphasize the accessibility and efficiency of smart agriculture.

The IoT-based smart agriculture automation presented in this literature integrates sensors that monitor important environmental factors such as temperature, humidity, and precipitation to address the specific needs of poultry farming and ensure optimal conditions for poultry. The DHT11 sensor for temperature and humidity monitoring and the rain sensor for precipitation and weather detection plays an important role in ensuring optimal farm conditions. Infrared (IR) sensors also help monitor food and ensure food safety. Studies like this are consistent with our goal of integrating IoT sensors for plant monitoring systems and also highlight the importance of IoT-based environmental monitoring in plant culture.

According to this literature, automation and control systems form the backbone of smart agriculture, enabling efficient resource management and adversarial response to environmental factors. By applying automation to water management systems, Getu and Attia's research shows how IoT devices can streamline operations and ensure consistent water supply. (Getu, Attia, 2016)[2] . Automation also goes beyond environmental monitoring to alleviate essential farm tasks such as food and water distribution and optimize resource utilization. This literature highlights the role of automation in improving the efficiency and

yield of smart farms, which is relevant to the goal of improving productivity and efficiency by integrating IoT sensors into our plant monitoring systems.
Effective data management and analytics are essential to derive actionable insights from IoT-generated data. Leveraging data analytics and predictive modelling in smart agricultural systems improves decision-making in smart agricultural systems. Additionally, by analyzing historical and real-time data, farmers can gain actionable insights and optimize farm management for increased productivity and yield. This is consistent with our goal of integrating a DNN model into our plant monitoring system to analyze various data and predict tomato harvest time.

Additionally, according to this literature, web and mobile applications have become essential components of smart agricultural systems, providing farmers with real-time monitoring, remote monitoring, and control capabilities. Farmers can also use these applications to remotely access farm data anytime, anywhere and facilitate informed decision-making. This also leads to optimal productivity, which emphasizes the importance of web platforms in the agricultural sector. This is in line with the goal of building a web platform that provides farmers with a variety of data in real-time from plant monitoring systems, allowing farmers to monitor.



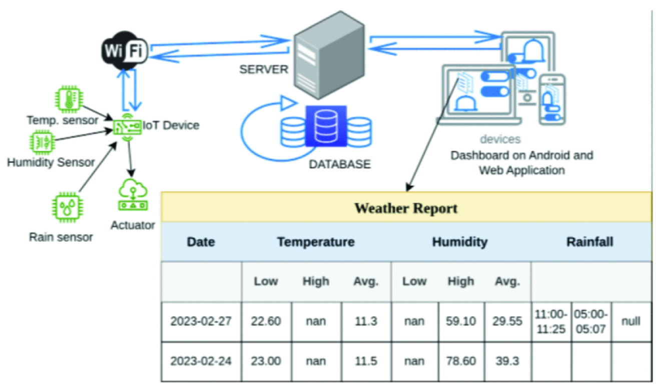


Figure 1. System Overview of IoT-based Automated Farm

Figure 2. Data-Driven Web Server

Figure 1 provides a detailed overview of how the structure and functionality of an automated smart agricultural system is implemented utilizing various sensors in this literature. And Figure 2 shows how the information collected from each sensor is stored on the server and displayed.
In Figure 1, various sensors are connected to a microcontroller, which transmits data from the sensors via WiFi or Bluetooth. This diagram shows what role each sensor plays and how it acts based on data. It also indicates how sensors interact with each other to act on a specific system. Our study builds a plant monitoring system through various sensors by integrating microcontrollers such as ESP32 and various IoT devices, as shown in Figure 1 of this literature.
In Figure 2, data obtained from various sensors is stored on a server through IoT devices and WiFi. And the data is stored in database form, and the data is displayed in table form whenever requested through a web service or Android application. Likewise, in our research, the data obtained through the sensor is stored in the form of a database on the MySQL

server whenever an HTTP request is made through WiFi, and the data information is displayed on the web platform whenever the user wants.
Overall, this literature provides valuable insights into specific aspects of smart agriculture, such as environmental monitoring and automation systems. However, despite the potential benefits of smart agriculture, there are costs and limitations in establishing this system, making it less accessible, especially in resource-limited or underdeveloped agricultural environments. This literature does not take into account costs, infrastructure or technical expertise. So these issues need to be addressed for the sustainability of this system.

In conclusion, while the literature on smart farming and IoT-based automation systems demonstrates significant progress and potential, there are still challenges and limitations that need to be addressed. By addressing these challenges and leveraging the transformative potential of smart farming, we can pave the way for a more resilient, efficient, and equitable agricultural future.

Literature 2
- Developing Smart Precision Farming Using Big Data and Cloud-Based Intelligent Decision Support System[4]

Introduction:
In recent years, the agricultural sector has witnessed significant advancements driven by emerging technologies such as Internet of Things (IoT), cloud computing, and artificial intelligence (AI). This literature review explores the integration of smart farm projects with IoT sensors, webpages, and Deep Neural Network (DNN) models to develop a plant monitoring system, with a focus on improving crop management and optimizing harvest timing.

Background:
Agriculture plays a vital role in the global economy, and advancements in technology are essential for addressing challenges such as resource efficiency, climate change, and food security. The integration of IoT sensors, web-based platforms, and AI models presents promising opportunities to revolutionize traditional farming practices by enabling real-time monitoring, data-driven decision-making, and predictive analytics.

Summary of Current KKnowledge:
1. Smart Precision Farming and Decision Support Systems:
This literature highlights the importance of smart precision agriculture systems with decision support systems based on big data analytics and cloud computing.
These systems leverage data from a variety of sources, including weather station data, soil sensors, and satellite imagery, to optimize agricultural operations and improve productivity. And the system provides farmers with timely advice on resource, soil, crop and water management to help them make better decisions.

2. Integration of IoT and Cloud Computing in Agriculture:
The findings in this literature demonstrate the feasibility of integrating IoT devices with cloud-based platforms for agricultural applications. IoT sensors provide real-time data on environmental conditions, soil moisture levels, and crop health, a variety of environmental

parameters that are important for crop growth. Additionally, by combining big data and cloud-based intelligent decision-making systems, big data can be analyzed in the cloud to provide farmers with actionable insights. These studies highlight the importance of IoT integration for improving agricultural productivity and resource efficiency.

3. Deep neural network modelling for crop monitoring:
Deep neural network (DNN) models have shown promise in analyzing agricultural data such as satellite images and sensor data to detect crop diseases, predict yields, and optimize agricultural practices. According to this literature, researchers can leverage convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to identify patterns in sensor data and provide early warnings of potential crop threats. This literature also discusses how to apply DNN models to predict harvest time, allowing farmers to optimize harvest conditions and minimize crop losses. These AI-based models provide advanced capabilities for plant monitoring and decision support in smart agricultural systems.

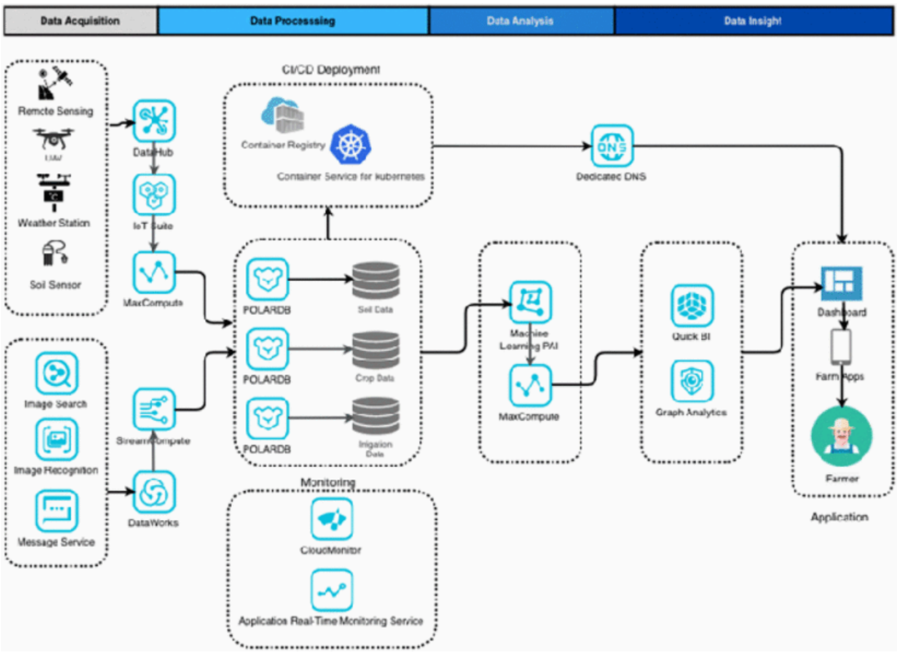


Figure 3.Big data cloud-based system architecture

Figure 3 above shows the architecture of a smart agricultural system based on big data and cloud. Looking at the diagram above, various data are collected through drones, weather stations, and various sensors, and the data is stored in SQL format on the server. And based on that data, services such as image recognition and image search operate on the same cloud server. Afterwards, this data goes through a data processing process and a data analysis process using AI, and is then stored on a large-capacity cloud server so that it can be used through the web or app platform whenever the user wants.

This diagram is similar and related to our project. In our plant monitoring system, data obtained from sensors is stored on the server in SQL format, goes through data processing based on data obtained from cameras, and goes through a data analysis process using a DNN model before being stored on the server. This data and predictions are then displayed on a web platform so that users can access it whenever they want.

According to this literature, the integration of IoT, web platforms, big data, cloud servers, and AI models such as DNNs has tremendous potential to improve plant monitoring in agriculture and dramatically change the agricultural sector. However, there are challenges that need to be addressed, such as data interoperability, scalability, and privacy issues. In addition, in places such as indoor farming environments, there are fewer problems because the parameters are minimized, but in actual outdoor farming environments, there is a need to carefully consider various factors such as accuracy of the AI model, interpretability, and resources due to various parameters.

In conclusion, the Smart Farm project represents a promising approach to modernizing agriculture and addressing the multiple needs of farmers. It has the potential to improve agricultural sustainability and increase agricultural production through the development of plant monitoring systems based on real-time data collection, AI-based data analysis and prediction.

Research Objectives

We develop an integrated smart farm system utilizing IoT sensors, webpage interface, camera data, and DNN models to accurately estimate tomato harvest timing.

1. Design and implement an IoT sensor network for real-time data collection on environmental factors affecting tomato growth, such as temperature, humidity, soil moisture, and light intensity.

- Specific: Implement a network using IoT sensors and esp32 boards to collect environmental data related to tomato growth.
- Measurable: Measured IoT sensor data will be stored in the MySQL server at regular intervals, and users can view this data in real-time.
- Attainable: Utilize commercially available IoT sensors and establish data transmission over WiFi.
- Relevant: Environmental data such as humidity, light intensity and temperature have a direct impact on tomato growth and harvest timing in indoor farms.
- Time-based: Implementation will be completed within 3 months of project start

2. Implement an existing pre-trained DNN model and measure tomato harvest time.
- Specific: Measures various information such as ripeness and size of tomatoes using data obtained from various cameras and a pre-trained DNN model.
- Measurable: Measures the performance and accuracy of the DNN model using validation data and test data.
- Attainable: Use a model whose performance has already been confirmed.
- Relevant: Tomato harvest time can be predicted through tomato information obtained using a DNN model.
- Time-based: Basic implementation is completed within 4 months of the project start or before Semester 2 begins.

3. Build an integrated plant monitoring system
- Specific: Integrates IoT sensors, cameras, web pages, DNN models, and servers into one so that all data is visible on the web page.
- Measurable: All data, such as IoT sensor data and DNN model results, must be visible on the web page and easily accessible to all users.
- Attainable: Build a framework to easily integrate all systems
- Relevant: This integrated plant monitoring system helps farmers make informed decisions regarding harvest timing.
- Time-based: It will be implemented by August of this year.

Project Scope

Our project aims to create a plant monitoring system by integrating IoT sensors, various DNN models and data sets, a server that can store this information, and a web page that can display all the data. To achieve this, an IoT sensor system is implemented using sensors that can measure humidity, temperature, steam, light intensity, etc., and the ESP32 Development board that operates these sensors and allows them to communicate with the server. The sensor's data is stored in a MySQL database server through HTTP requests, and this data is displayed on the web page.
We will also use and develop currently existing DNN models to measure the size and harvest level of tomatoes and use that data to find out when to harvest tomatoes. And we will create a plant monitoring system that displays all this data on a web page.

In Semester 1, we will set goals and plans for our project through a literature review. Then, we create a physical server that can obtain data through IoT sensors and store that data. After that, the data will be displayed in real-time on the web page through the backend and frontend. In Semester 2, we will use the DNN model to predict information on tomato harvest levels and complete a plant monitoring system that integrates everything. Afterwards, we will write a report, create a poster, and make a presentation.

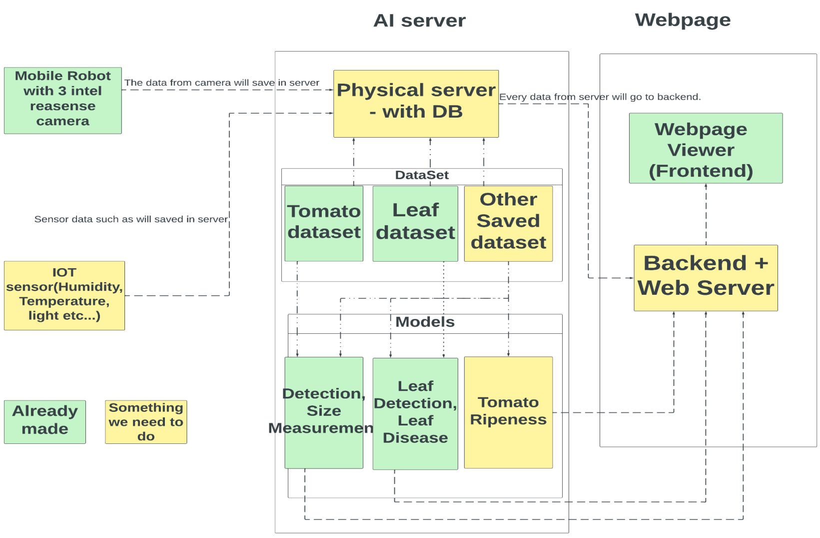


Figure 1. Project Diagram

The above diagram is a diagram created for our project. The diagram above shows all the components of the plant monitoring system connected. Through this diagram, we can see at a glance what we need to accomplish through the project. The green parts of the diagram are already complete or need only minor modifications, and the yellow parts are the parts we need to develop this year.

Conclusion

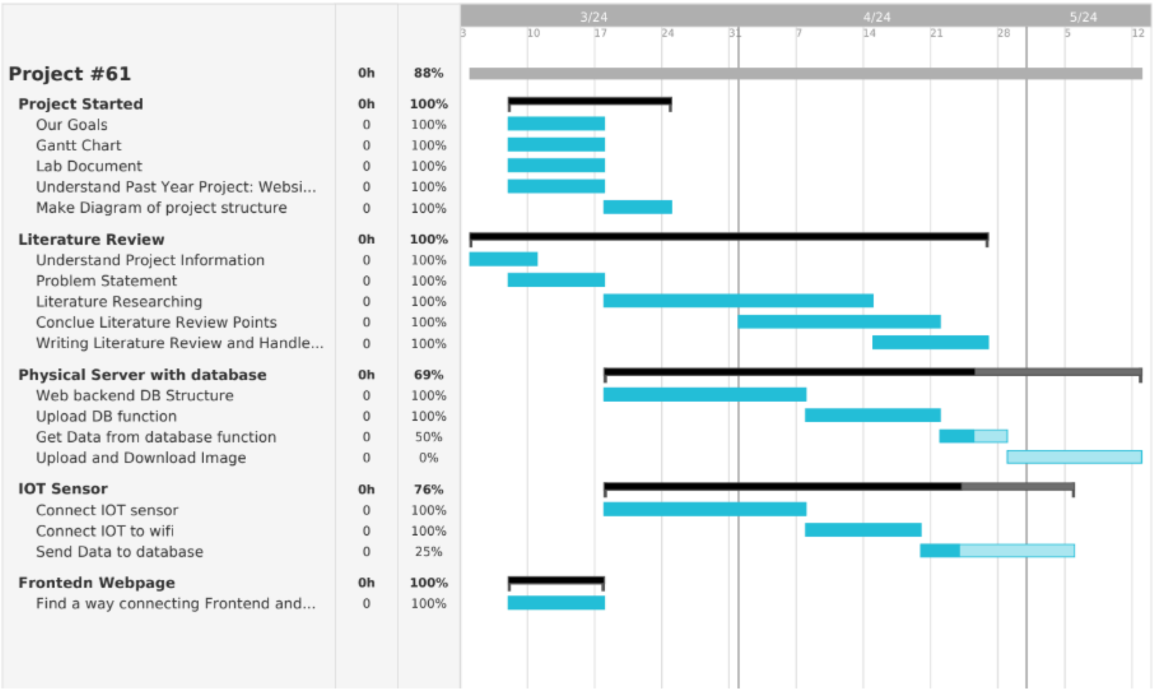
The reviewed literature highlights the importance of leveraging IoT technologies to monitor environmental factors and automate agricultural processes to increase agricultural productivity and sustainability. It also supports farmers' decision-making by displaying sensor data to farmers through a web platform.

Literature 1 focused on poultry farming and emphasized the role of IoT-based smart agricultural automation systems. This highlighted the importance of environmental monitoring, automation and data analytics in improving farm efficiency. These points follow closely with our research to develop a plant monitoring system for tomato farming. However, while Literature 1 only used data from IoT sensors, our study seeks to develop a better plant monitoring system by incorporating not only IoT data but also data analysis through camera data.

Literature 2 mentions a smart agricultural system utilizing big data and cloud-based intelligent decision-making systems. Here, data processing using IoT sensors, cloud computing, and AI algorithms was emphasized to optimize agricultural operations and improve crop management. This is very closely related to our research. In particular, research is being conducted to predict tomato harvest time by not only using IoT sensors but also processing camera data with AI algorithms.

In conclusion, the reviewed literature provides a strong foundation for our research project, highlighting the potential benefits and challenges of integrating various advanced technologies in agriculture. By building on and further developing this literature, our project strives to contribute to the development of smart agricultural practices in the tomato sector and ultimately improve the productivity and sustainability of the agricultural sector.

Gantt chart



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