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Smart Plant Pot Monitoring System

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1 General overview

The natural environment plays a quintessential part in our lives. Therefore, keeping it safe is a mandatory duty in order to live on a comfortable and healthy planet. That's why, we have to plant trees as the quote says 'Let's save our planet and plant a tree'. Unfortunately, Most people would love to have nice Ornamental plants inside their houses, but few have the time to maintain them. Above all, plants require the most important factors for the quality of plant growth temperature, humidity , and light. With Continuous monitoring of these environmental variables you can keep your houseplants perfect. Thus, they need to know about the basics of gardening, including the different plant types, how to look after your plants, detect anomalies, and give advice on what to do when things go wrong. For that reason, it is necessary to develop a smart plant pot monitoring system utilizing Cloud of Things technologies that allow the users to keep track of their plants in real-time: provide automatic watering, cooling, sunlight, and detect plant diseases and defects. This project aims to provide the following functionalities:

- measure the following climate variables: temperature, humidity, and light.
- perform the needed actions which can be supplying the plant with water, lighting, or changing the ambient temperature when one of the climatic parameters crosses the safety threshold which has to be maintained to protect the plants.
- Alert the user if an anomaly is detected based on the images retrieved from the camera
- Alert the user, when they are in proximity to the plant and the water level in the pump reaches a pre-defined threshold using the location-based service (LBS).

2 Target clients

The clients that will benefit from this solution will be individuals who have a passion for indoor plants in their homes or workplaces. This project will let them enjoy the beauty and smell of these green plants without wasting time in their care.

3 Components

Raspberry pi v3: Raspberry Pi is a single-board computer that has many general-purpose input/output pins. Since it is a computer, it requires an operating system to function properly; hence, it can be programmed in many languages such as Java, Python, C, C++, etc. It can also connect to WiFi without the use of additional modules; hence it is a great choice for this solution.

LDR-Light Dependent Resistor: LDR sensor is used to measure the intensity of light; the sensor is useful in light/dark circuit conditions. LDR device has a resistance that varies according to the intensity of light falling on its surface.

LM35 temperature sensor: The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling

Soil Moisture Sensor: This sensor can be used to detect the moisture of soil or judge if there is water around the sensor.

Camera: This camera will be used to capture images of the plants. With appropriate image processing techniques and algorithms, it can help detect anomalies such as diseases on leaves or other plant health issues.

Pump: A pump can be used to take reserved water, increase the pressure, and deliver the water to your plants via a hosepipe.

Fan: Fans and air coolers should be used to maintain plant health during warm summer months.

Artificial Light: Since sunlight does not reach all areas in the house such as, we need to use alternative sources for providing light to our houseplants. We can achieve this by using artificial lights.

4 Technologies

To achieve the different parts of this project, multiple technologies and frameworks will be implemented:

- **Backend:**
  - **MQTT:** MQTT is a lightweight messaging protocol for communication between the different Internet of Things components. This protocol requires a MQTT broker which will be the intermediary between the communication of two devices to ensure the decoupling of the two devices. In this case, we will be using Mosquitto as the MQTT broker.
  - **MongoDB:** MongoDB is a NoSQL document-oriented database used to store all the data in this project such as data captured by the sensors and data of users of the application.
  - **Node-Red:** Node-Red is an open source tool used in Internet of Things projects to manage the data flow of the sensors.
- **Middleware:**
  - **Jakarta Entreprise Edition:** Jakarta Enterprise edition is a Java-based framework for developing API's for enabling communication between different and numerous applications. Jakarta's main selling point is the high level of security it provides that is not possible with other Java frameworks.
  - **WildFly:** Wildfly is a Java Entreprise Edition lightweight application server designed by Red Hat providing all the necessary functionalities to run a Java web application.
- **Machine learning model:**
  - **SVM:** A support vector machine is a type of supervised learning algorithm used in machine learning to solve classification and regression tasks; SVM is particularly good at solving binary classification problem which is our use case: this model detects plant anomalies based on images retrieved from the camera using Bag of Features (BoF) as a technique to extract features from the images.

- **Frontend:**
  - **PWA:** Progressive Web Applications are web applications that leverage service workers, manifests, and other web-platform characteristics along with progressive enhancement to provide users with a native app-like experience.

5 Architecture

Figure 1 demonstrates the architecture of the Smart Plant Plot Monitoring System:

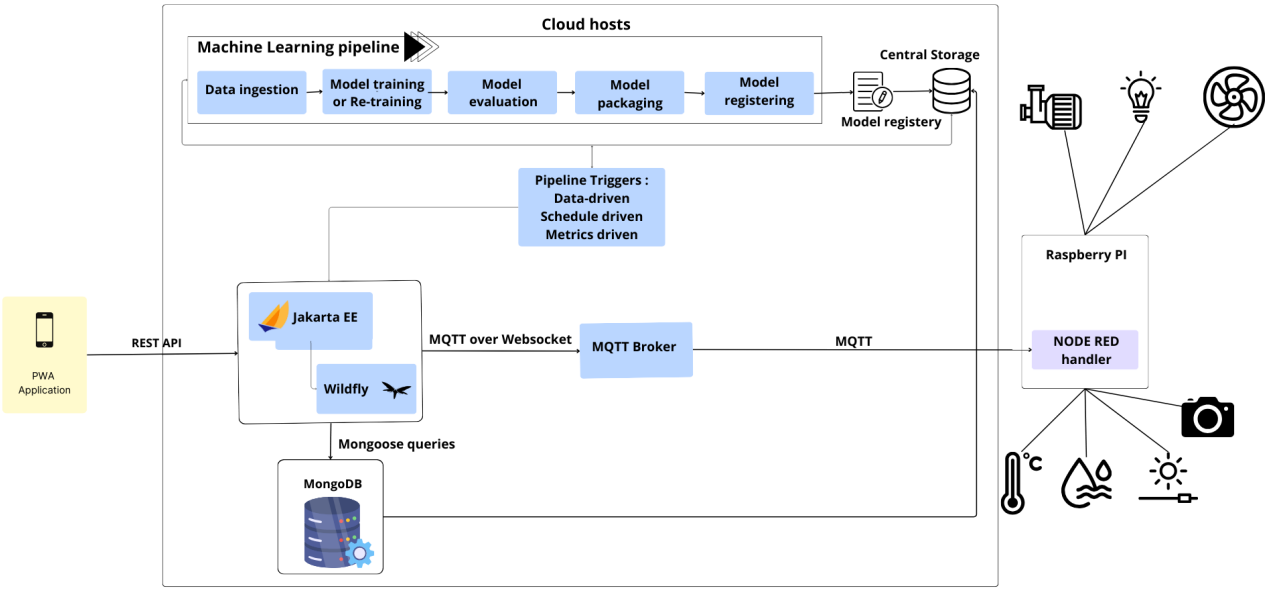

Figure 1: Smart Plant Pot monitoring system architecture

In this project, Cloud of Things technologies will be used. Therefore, the middleware server, the database,the trained model and the MQTT Broker, and will all be hosted on the cloud.

6 Timeline and Tasks:

The project development will undergo different steps:

Figure 2: Gantt diagram

7 Project deliverables

By the end of this project, these requirements must be delivered:

- **Source code:** The source code for the different parts of the project will be stored and delivered using Github.
- **Technical documentation:** A README.md file in GitHub detailing all the needed steps to launch the application.
- **Design document:** A document that describes the architecture of the application and its functionalities through different diagrams.
- **Demo:** A video in mp4 format that contains a demonstration of the proposed solution.

8 Constraints

The realization of all parts of the Smart plant pot monitoring system must be achieved no later than 7 January 2024.

9 Marketing study:

9.1 BMC

The figure below highlights the Business Model Canvas for the Smart pot monitoring system:

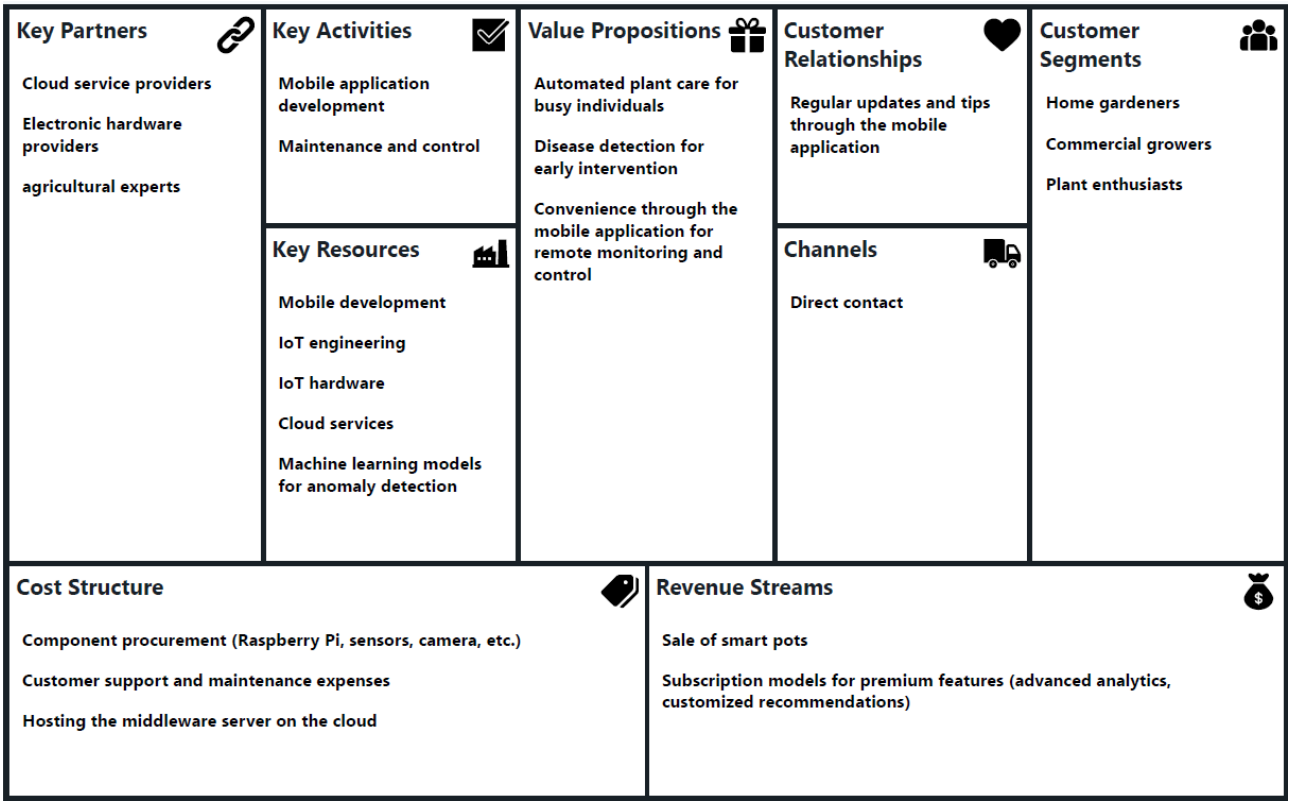

Figure 3: Smart plant pot monitoring system business model canvas

9.2 SWOT Analysis

SWOT analysis is a crucial strategic planning tool that our project team can utilize to conduct a situational analysis of the Smart Plant Pot venture. It serves as a valuable technique for assessing the current Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T) that our project may encounter in its existing business landscape. This analysis will provide valuable insights to help us make informed decisions and develop strategies to maximize the project's success.

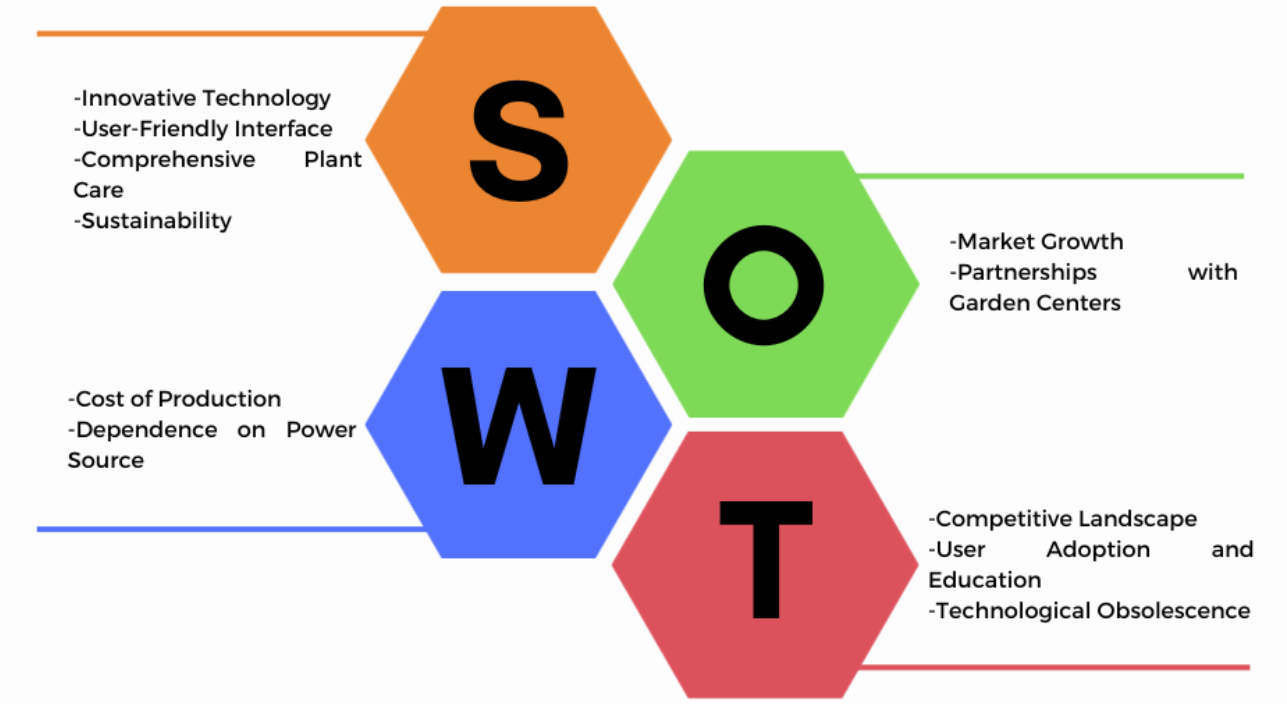

Figure 4: SWOT Analysis