A Portable Plant Care Device for Monitoring Plants' Real-Time Conditions with AI Integration

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Abstract

The present invention relates to a portable smart plant care device, hereinafter referred to as the "Tars Portable." Tars Portable is designed to revolutionize indoor gardening by offering a compact, portable, and comprehensive solution for monitoring and optimizing plant health. Tars Portable is a compact and portable device that seamlessly integrates into any planter, eliminating the need for repotting. It features a suite of sensors to monitor temperature, humidity, soil moisture, and light intensity, providing real-time data to users from anywhere on any device via a companion web application. This patent application discloses the design, utility, and functionality of Tars Portable, including its hardware components, software features, and method of operation, along with detailed drawings, flowcharts and claims.

1. Background

Traditional plant care methods often rely on manual observation and maintenance, which can be time-consuming and prone to human error. With the rise of smart technology, there is an increasing demand for automated solutions that provide precise monitoring and care for indoor plants. Existing smart planters typically involve repotting plants into dedicated containers, limiting flexibility and convenience for users. There is a need for a portable and adaptable solution that can seamlessly integrate with existing plant setups while preserving the aesthetic appeal of their preferred plant containers, offering advanced monitoring through a web application and health assessment capabilities using Artificial Intelligence (AI).

2. Description of the Drawings

2.1. Figure 1

Figure 1 represents the ***Main Unit/Chassis***, This is the internal structure where all the primary electronic components such as the microcontroller, battery, sensors, etc., are mounted onto microcontroller hub[101f], sensor array hub[101a], power management hub[102f] and mounting hardware[103f].

2.1.1. Microcontroller Hub

Specifically referring to the central microcontroller component and its associated peripherals.

2.1.2. Sensor Array Hub

This is a compartment within the main unit specifically dedicated to housing sensors and mounts for supporting the rotation gear mechanism.

2.1.3. Power Management Hub

Encompassing the battery and any circuitry responsible for power distribution and management.

2.1.4. Mounting Hardware

This could include screws, brackets, or any hardware used to mount the housing unit.

2.2. Figure 2

Figure 2 represents the ***Outer Casing,*** This refers to the main enclosure that provides physical protection and houses the internal components.

2.3. Figure 3

Figure 3 represents the ***Display Unit***, This refers to the overall structure of the display unit that contains the hollow grooves[301f] for accommodating the OLED Display

2.4. Figure 4

Figure 4 represents the ***Charging Module,*** This refers to a module where the charging board compartment and support base[401f] are housed. It consists of a set of rotational gears[402f] which are mounted into the sensor array chamber mounts.

2.4.1. Charging Board Compartment

This is a section within the charging module where the electronic components like charging board, voltage regulators and step-up boosters are mounted.

2.4.2. Support Base

Referring to the supporting plane inside the Charging Board Compartment where the charging board is mounted or glued.

2.4.3. Sensor Array Chamber Mounts

These are the mounts on the main chassis where the rotational gears are attached, providing support for the mechanism.

2.5. Figure 5

Figure 5 represents the ***Solar Panel Enclosure,*** This refers to the outer cover part of the charging module where the solar panels array[501f] are mounted or snapped into place.

2.5.1. Solar Panel Array

Specifically referring to the collection of solar panels mounted within the solar panel enclosure. This could be a single solar panel or a set of solar panels stacked upon each other when closed and opened wide manually while using.

2.6. Figure 6

Figure 6 depicts the fully assembled product when the charging module is closed/snapped to main unit. It includes main unit/chassis, outer casing, display unit, charging module, solar panel enclosure, soil moisture sensor and m3 bolts from various views such as top view[6A], bottom view[6B], left view[6C], right view[6D], front view[6E], back view[6F], perspective top view[6G] and perspective bottom view[6H].

2.7. Figure 7

Figure 7 depicts the fully assembled product when the charging module is opened. It includes main unit/chassis, outer casing, display unit, charging module, solar panel enclosure, soil moisture sensor and m3 bolts from various views such as top view[7A], bottom view[7B], left view[7C], right view[7D], front view[7E], back view[7F], perspective top view[7G] and perspective bottom view[7H].

2.8. Figure 8

Figure 8 depicts the exploded view from perspective top view of 3d rendered parts that includes display unit, outer casing, main unit/chassis, soil moisture sensor, m3x6mm bolts, solar panel enclosure and charging module.

2.9. Figure 9

Figure 9 depicts the exploded view from perspective bottom view of 3d rendered parts that includes display unit, outer casing, main unit/chassis, soil moisture sensor, m3x6mm bolts, solar panel enclosure and charging module.

2.10. Figure 10

Figure 10 illustrates the sequential steps involved in the Tars Portable Arduino code. The flowchart begins with the initialization of system components and proceeds through various decision points, conditional branching and loops to execute specific functions based on input conditions and sensor data.

2.11. Figure 11

The figure 11 presented depicts a structured representation of the database schema. This schema serves as the backbone of the application, facilitating the organization and retrieval of essential plant information and care guides. Each field within the schema corresponds to a specific aspect of plant data, ranging from common and scientific names to growth specifications, care instructions, and associated images.

2.12. Figure 12

Figure 12 presents a database schema tree diagram outlining the structure and relationships within the database utilized by the system. The tree diagram illustrates the hierarchical organization of database tables, with parent-child relationships depicted through connecting lines. Each node in the tree represents a database table, while the branches indicate the relationships between these tables. The schema tree diagram provides a visual representation of the database architecture, facilitating understanding of data organization and query relationships within the system.

3. DESIGN

The Tars Portable was meticulously planned, prototyped, and refined to achieve the desired functionality, aesthetics, and user experience. Every component was carefully designed and integrated to ensure seamless functionality and compatibility with the overall device architecture. Considerations for ergonomics, ease of assembly, and durability were of utmost importance throughout the design process. Thermal analysis was conducted to evaluate the device's performance under various environmental conditions, ensuring optimal operation and safety of electronic components. With its portable and adaptable design, the Tars Portable sets a new standard for smart plant monitoring devices, revolutionizing the way users interact with and care for their indoor plants. The product consists of five main parts ***Display Unit, Outer Casing, Main Unit/Chassis, Charging Module and Solar Panel Enclosure***, each serving a distinct purpose in the functionality and aesthetics of the device.

3.1. Display Unit

The display unit features an OLED display, providing users with real-time data about their plant's environmental conditions, Wi-Fi status and battery percentage. This part serves as the primary interface for displaying real-time data and alerts.

3.2. Outer Casing

The outer casing not only shields the main unit/chassis but also contributes to its sleek and modern appearance. It integrates a capacitive touch sensor and a slide switch, enabling users to effortlessly interact with the device and toggle its functionality.

3.3. Main Unit/Chassis

The main unit/chassis contains essential electronic components for plant monitoring and data collection, including the microcontroller, soil moisture sensor, voltage booster, sensor unit chamber and battery. Within the sensor unit chamber, the temperature and humidity sensor, light sensor, and mounting unit are strategically positioned to ensure optimal performance.

3.4. Charing Module

The charging module housing accommodates the charging board and step-up boosters, facilitating efficient battery recharging. A gear shaft mechanism enables the module to rotate up to 110 degrees, allowing easy access to the solar panels for maximum sunlight exposure. The housing is designed to be securely mounted onto the main chassis.

3.5. Solar Panel Enclosure

The solar panel enclosure acts as a protective covering for the charging module housing, which contains the solar panels. These panels harness solar energy to recharge the device's battery, promoting sustainability and reducing dependence on traditional power sources.

4. Hardware Components

4.1. D1 Mini NodeMCU

The D1 Mini NodeMCU is a compact development board based on the ESP8266 Wi-Fi module. It integrates a microcontroller unit with built-in Wi-Fi connectivity, allowing seamless communication with other devices and the Internet. The board supports programming via the Arduino IDE and offers GPIO pins for interfacing with sensors, actuators, and external peripherals, making it an ideal platform for IoT prototyping and deployment.

4.2. ESP32 Mini

The ESP32 Mini is a compact microcontroller module based on the ESP32 system-on-chip (SoC) manufactured by Espressif Systems. It features a dual-core Xtensa LX6 CPU, Wi-Fi and Bluetooth connectivity, numerous digital and analog GPIO pins, and various integrated peripherals such as UART, SPI, I2C, ADC, DAC, and PWM. The ESP32 Mini is programmable using the Arduino IDE or the Espressif IDF (IoT Development Framework), making it highly versatile for a wide range of IoT (Internet of Things) applications, including home automation, sensor networks, wearable devices, and industrial automation. Its low power consumption, robust connectivity options, and extensive feature set make it an attractive choice for projects requiring advanced wireless communication and processing capabilities.

4.3. DHT11

The DHT11 is a digital temperature and humidity sensor module widely used in various applications. It employs a calibrated digital signal output to provide real-time temperature and humidity readings. It consists of a capacitive humidity sensor and a thermistor for temperature sensing, encapsulated in a compact package with integral resistive heating elements to prevent condensation.

4.4. Capacitive Soil Moisture Sensor

This sensor utilizes the principle of capacitance to measure soil moisture levels. It consists of two electrodes placed in the soil, and the dielectric constant of the soil changes with its moisture content, altering the capacitance between the electrodes. This change in capacitance is then converted into a measurable electrical signal, allowing precise monitoring of soil moisture levels crucial for efficient irrigation and agriculture management.

4.5. BH1750 Light Intensity Sensor

The BH1750 is a digital ambient light sensor capable of accurately measuring light intensity in lux. It utilizes a photodiode array combined with a digital converter to provide precise light intensity readings over a wide dynamic range. This sensor finds applications in automatic lighting control systems, display brightness adjustment in electronic devices, and environmental monitoring.

4.6. OLED Display 1.3 Inch I2C

This display module features a 1.3-inch OLED screen with a resolution suitable for displaying text, graphics, and sensor data. It communicates with the microcontroller using the I2C protocol, enabling easy integration into various electronic systems. OLED technology offers advantages such as high contrast ratio, wide viewing angles, and low power consumption, making it ideal for battery-powered devices and portable electronics.

4.7. TP4056 1A Charging Board

The TP4056 is a lithium-ion/lithium-polymer battery charging module capable of charging single-cell batteries with a maximum charging current of 1A. It incorporates a precision voltage reference and charge termination circuitry for safe and efficient battery charging. This module is commonly used in portable electronic devices, IoT applications, and solar-powered systems.

4.8. DC-DC 1.8V ~ 5V to 3.3V Booster and Buck Power Module

This voltage regulator module is designed to convert input voltages ranging from 1.8V to 5V to a stable 3.3V output. It employs both boost and buck conversion techniques to maintain a regulated output voltage, ensuring compatibility with a wide range of power sources. This module is crucial for powering microcontrollers, sensors, and other electronic components requiring a stable voltage supply.

4.9. Mini DC-DC Boost Convertor 0.9V ~ 5V 600 mAh Module

This compact power module is designed to boost input voltages ranging from 0.9V to 5V to a stable 5V output with a maximum current capability of 600mAh. It employs a boost conversion topology to step up the voltage efficiently while providing a regulated output suitable for powering low-power devices, sensors, and microcontrollers in battery-powered or energy-harvesting applications.

4.10. Rechargeable Li-Po Battery 400 mAh 3.7V

This rechargeable lithium-polymer battery has a capacity of 400mAh and a nominal voltage of 3.7V. It is characterized by its high energy density, lightweight, and compact form factor, making it ideal for use in portable electronic devices, wearable technology, and IoT applications where space and weight constraints are critical.

4.11. Polycrystalline Mini Epoxy Solar Panel

This solar panel consists of polycrystalline solar cells encapsulated in epoxy resin, making it lightweight, durable, and weatherproof. It converts solar energy into electrical power, making it an ideal choice for charging batteries in solar-powered systems, outdoor electronics, and remote monitoring devices. The mini form factor and epoxy encapsulation enhance portability and resistance to environmental factors such as moisture, dust, and UV exposure.

4.12. Capacitive Touch Switch

A capacitive touch switch detects touch or proximity by measuring changes in capacitance. It typically consists of a touch-sensitive electrode and signal-processing circuitry capable of detecting minute changes in capacitance caused by the presence of a conductive object, such as a finger. This type of switch offers advantages such as durability, water resistance, and sensitivity to touch, making it suitable for various consumer electronics, automotive, and industrial applications.

4.13. Tactile Push Button Switch

A tactile push button switch is a mechanical switch that makes or breaks an electrical connection when pressed. It comprises a plunger or button that actuates a set of internal contacts, completing the circuit momentarily. These switches are widely used for user input and control in electronic devices, appliances, and industrial machinery due to their reliability, tactile feedback, and ease of integration.

4.14. SPDT Slide Switch

A SPDT (Single Pole, Double Throw) slide switch has three positions: ON, OFF, and ON. It enables manual switching between two different electrical connections by sliding a lever or toggle between the designated positions. These switches are commonly used for selecting between multiple operational modes, switching between power sources, or toggling between different signal paths in electronic circuits and appliances.

4.15. M3x6mm Bolt

An M3x6mm bolt is a metric fastener with a diameter of 3mm and a length of 6mm. It features a threaded shaft with a head for securing components together in mechanical assemblies. These bolts are commonly used in electronics, machinery, and construction applications for their versatility, strength, and compatibility with metric hardware standards.

5. Software Features

5.1. Tars Portable

5.1.1. Tars Access Point

The Tars Access Point feature makes it easy for users to set up their Wi-Fi network. Unlike previous systems that required manually entering Wi-Fi credentials into microcontrollers, this feature allows users to connect to their Wi-Fi network by scanning a QR code. Scanning the QR code opens a webpage on the mobile device, providing the necessary credentials. These credentials are then stored in the microcontroller's EEPROM. Additionally, the device is equipped with a reset button that allows users to delete the Wi-Fi credentials when switching networks.

5.1.2. Data Monitoring (on Device)

The device is equipped with an OLED Display to show real-time data on temperature, humidity, soil moisture, light intensity, Wi-Fi status, and battery level. This allows users to monitor the data directly on the device, even when there is no access to the web app or the internet.

5.1.3. Power Saving Mode

The device's sensors, including temperature, humidity, soil moisture, and light intensity, capture data every 500ms. The OLED display and microcontroller consume a lot of power, especially when updating data to the cloud server using Wi-Fi. This high power usage drains the battery quickly. To optimize power consumption and extend operating time, the device has a power saving mode and touch-to-wake-up features. In power saving mode, the device captures data, updates the cloud server, goes into a deep sleep for a set time, and then wakes up to repeat the process. Touch-to-wake-up is specifically for the OLED display, which turns off display automatically after a set time and wakes up the display only when the user touches the capacitive touch sensor on the device.

5.1.4. Real-Time Data Transfer over Internet

The data collected from the sensors is sent to the cloud server using HTTP requests or web sockets. To optimize data transfer, the system compares the most recent data with the previous data. If there is a difference, only the latest data is uploaded to the cloud server. This optimization reduces the frequency of HTTP requests.

5.2. Database for Plant Care

The Tars Plant Care Database API is an essential feature of the web application, offering users access to a wide range of plant information and care instructions. Users have the option to select from various plant types available in the Tars Plant Care Database API and can retrieve comprehensive plant data, including common and scientific names, family information, growth specifications, foliage and flower characteristics, and images. In addition to plant info, users can also access detailed care guides for each plant, providing information on temperature, sunlight exposure, watering frequency, soil requirements, and common problems associated with each plant type.

5.3. Web Application

5.3.1. Real-Time Monitoring

Users can monitor their plant's conditions, such as temperature, humidity, soil moisture, light intensity, and weather in real-time through the web app from anywhere and on any device. The web app compares the optimal conditions for the plant with real-time data and alerts the users about their plant's health.

5.3.2. Plant Health Assessment

The Plant Health Assessment feature on the web application generates a customized report on the plant's health based on the provided conditions. The assessment is created by analyzing data using AI and provides a detailed report including suggestions, causes of the problem, and steps to avoid the issue. Additionally, it includes a complete care guide specially designed for the user's plant based on the current conditions.

5.3.3. Plant Info and Care

Plant Info provides users with comprehensive information about a plant, including its common name, scientific name, family, specifications, and varieties. It also covers plant care, detailing the maximum and minimum values for temperature, humidity, sunlight, soil pH, frequency of watering and fertilizing, care guides, and common problems.

6. DETAILED DESCRIPTION

The present invention, herein referred to as "Tars Portable," is a revolutionary advancement in smart plant care technology, designed to address the shortcomings of traditional indoor gardening methods by providing a compact, portable, and comprehensive solution for monitoring and optimizing plant health. Tars Portable seamlessly integrates into any planter without the need for repotting, offering users unprecedented flexibility and convenience in plant care management. By harnessing the power of advanced sensors, wireless connectivity, artificial intelligence (AI), and sustainable energy sources, Tars Portable empowers users to monitor, analyse, and improve their indoor plants' growth conditions with unparalleled precision and efficiency.

6.1. Design Overview

Tars Portable comprises five intricately designed and integrated components aimed at delivering superior functionality, durability, and user experience. These components encompass the display unit, outer casing, main unit/chassis, solar panel enclosure, and charging module.

The display unit features hollow grooves tailored to accommodate the OLED Display[4.6.], seamlessly integrating with the outer casing.

The outer casing serves as the primary enclosure, providing physical protection and housing internal components, while also enhancing the device's modern appearance. Equipped with a capacitive touch sensor[4.12.] and a slide switch[4.14.], the outer casing enables effortless user interaction and functional toggling. Additionally, it incorporates three mounting holes for securing it to the main unit/chassis.

The main unit/chassis hosts pivotal electronic components, including the microcontroller[4.1.], soil moisture sensor[4.4.], voltage booster[4.8.], and battery[4.10.]. Strategic positioning of temperature and humidity sensors[4.3.], a light sensor[4.5.], and mounting hardware within the sensor unit chamber optimizes performance and reliability.

The solar panel enclosure, an integral part of the charging module, accommodates the solar panel array[4.11.], harnessing solar energy to recharge the device's battery and fostering sustainable energy practices.

The charging module housing houses the charging board[4.7.] and step-up boosters[4.9.], facilitating efficient battery recharging. Its innovative gear shaft mechanism allows for a 110-degree rotation, ensuring convenient access to the solar panels for maximum sunlight exposure. The housing is designed for secure mounting into the sensor array chamber mounts.

Figure 8 depicts the exploded view from perspective top view of 3d rendered parts that includes display unit, outer casing, main unit/chassis, soil moisture sensor, m3x6mm bolts[4.15.], solar panel enclosure and charging module.

Figure 9 depicts the exploded view from perspective bottom view of 3d rendered parts that includes display unit, outer casing, main unit/chassis, soil moisture sensor, m3x6mm bolts[4.15.], solar panel enclosure and charging module.

Upon assembly, these components collectively form the "Tars Portable" device. Prototype images of the product are included below.

13A 13B 13C

Figure 13

Figure 13:
- [13A] Front view of the Tars Portable
- [13B] Back view of the Tars Portable
- [13C] Tars Portable with the charging module opened, exposing the solar panels

14A 14B 14C

Figure 14

Figure 14:
- [14A] Front view of Tars Portable inserted into a planter
- [14B] Back view of Tars Portable inserted into a planter
- [14C] Side view of Tars Portable inserted into a planter

6.2. Tars Portable Functionality

Tars Portable integrates sensors, microcontrollers, and wireless connectivity to gather real-time data on crucial environmental parameters such as temperature, humidity, soil moisture, and light intensity. Tars Portable operates through a series of synchronized processes, beginning with initialization upon power-up. During this phase, the device configures its hardware components and establishes connectivity with external networks. Upon initialization, Tars Portable enters a continuous monitoring mode, periodically sampling sensor data and transmitting it to designated endpoints via Wi-Fi communication protocols. Tars Portable offers seamless user interaction through intuitive interfaces, including capacitive touch sensors and OLED display, allowing for effortless monitoring and customization. To ensure reliable operation and extended battery life, Tars Portable incorporates efficient power management features, including low-power sleep modes and options for both USB and solar panel charging. This enables sustained operation in diverse indoor environments while minimizing the need for frequent manual intervention.

Figure 10 illustrates the sequential steps involved in the Tars Portable Arduino code. The flowchart begins with the initialization of system components and proceeds through various decision points, conditional branching and loops to execute specific functions based on input conditions and sensor data.

The following steps outline the method of operation for Tars Portable:

6.2.1. Initialization and Setup

Upon power-up, Tars Portable initializes its hardware components, including the microcontroller, sensors, OLED display, and wireless connectivity modules.

The device enters setup mode, indicated by an OLED display prompt, prompting the user to connect to its Wi-Fi access point.

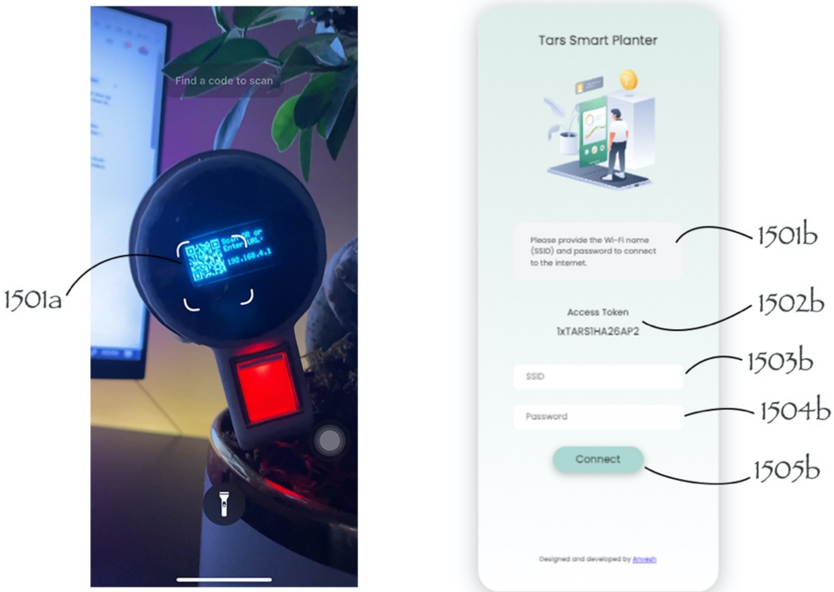
6.2.2. Wi-Fi Configuration

Users connect to the Tars Portable Wi-Fi access point using their mobile device.

Once connected, by scanning a QR code displayed on the OLED screen users are redirected to a web page hosted by the device, where they can configure Wi-Fi settings and a tars portable unique access token is displayed.

This access token is an tars portable unique device id and is used later to add the device in the web application, user has to copy this access token and should not share it with others.

The device captures the Wi-Fi credentials and stores them in its non-volatile memory (EEPROM)



15A 15B

Figure 15

Figure 15:
- [15A] refers to a image of a user scanning the QR code displayed on the OLED display of the Tars Portable.
- [15B] refers to a screenshot of the webpage where user provides the Wi-Fi credentials.
    - [1501b] Prompting user to enter Wi-Fi credentials
    - [1502b] Access Token is an unique device id
    - [1503b] Wi-Fi SSID input field
    - [1504b] Wi-Fi Password input field
    - [1505b] Connect button

6.2.3. Data Acquisition

Tars Portable begins collecting data from its array of sensors, including temperature, humidity, soil moisture, and light intensity.

Sensor readings are sampled at regular intervals, typically every few seconds, to ensure accurate and up-to-date data collection.

6.2.4. Display and User Interaction

Real-time data is displayed on the OLED screen of the device, providing users with their plant's environmental conditions.

Users can interact with the device using capacitive touch sensors or physical buttons to wake-up display, reset Wi-Fi credentials or initiate specific actions.

6.2.5. Data Transmission

Real-time sensor data is transmitted to the user's designated endpoint, typically a cloud server or web application, via Wi-Fi connectivity.

The device utilizes HTTP requests or web sockets to transfer data securely and efficiently over the internet.

Data transmission occurs at regular intervals or in response to predefined thresholds.

To optimize data transfer, the system compares the most recent data with the previous data. If there is a difference, only the latest data is uploaded to the cloud server. This optimization reduces the frequency of HTTP requests.

6.2.6. Power Management

Tars Portable employs power-saving techniques to optimize battery life and energy efficiency.

The approximate battery life of Tars Portable when operating without any power-saving techniques. Here's a rough breakdown of the components and their power consumption:

NodeMCU D1 Mini: Around 70mA when active.
DHT11: Around 1-2mA when actively measuring.
Soil Moisture Sensor: Depending on the circuit, let's estimate around 1-2mA.
BH1750: Consumes around 0.5mA during operation.
OLED Display: Roughly 10-15mA when active.
Capacitive touch sensor: Negligible power consumption.

Total average current consumption = 70mA (NodeMCU) + 2mA (DHT11) + 2mA (Soil Moisture) + 0.5mA (BH1750) + 15mA (OLED Display) = ***89.5mA***

So, Tars Portable would consume approximately 89.5mA on average.

Battery capacity = 400mAh
Average current consumption = 89.5mA

Runtime = Battery capacity / Average current consumption
= 400mAh / 89.5mA
≈ 4.47 hours

The estimated battery runtime would be approximately **4 hours and 28 minutes**

The OLED display is turned off after a specified period of time to minimize power consumption. So, with the added feature of turning off the display after 5 minutes, the device's runtime would increase to approximately **5 hours and 21 minutes**, assuming the same battery capacity and no other significant changes in the system.

The device enters a deep sleep mode between sensor readings and data transmissions to conserve energy only when low power mode is enabled.

Here's the average power consumption and runtime:

The device wakes up every 15 minutes to take readings and transmit data, and then goes back to sleep. This implies a duty cycle of 1 minute of reading, every 15 minutes.

The device is active for a short duration to take readings and transmit data, and spends the rest of the time in deep sleep mode.

Active power consumption = 89.5mA
Sleep power consumption = Negligible (assuming a few 179 microamps i.e. 0.179mA)
Active time = 1/15 hours (1 minute)
Sleep time = 14/15 hours (14 minutes)

Average Power Consumption = (Active Power x Active Time) + (Sleep Power x Sleep Time)

Average Power Consumption = (89.5mA x 1/15) + (0 x 14/15) ≈ ***5.97 mA***

So, the average power consumption over an hour with this duty cycle is approximately 5.97mA.

Battery capacity = 400mAh
Average current consumption = 5.97mA

Runtime = Battery capacity / Average current consumption
= 400mAh / 5.97mA
≈ 66.99 hours

The estimated battery runtime with low power mode enabled would be approximately **66 hours and 59 minutes**, or about **2.79 days**. However, please note that this is a rough estimation and the actual runtime may vary based on factors such as variations in component power consumption and battery degradation over time.

6.2.7. Solar Powered Charging

Although the device can be recharged through the micro USB port provided in the charging module, solar panels can also be used to utilize solar energy as an alternative method to recharge the battery, minimizing the need for frequent manual recharges.

The maximum charging current achievable with a single solar panel is approximately 100mA, assume that there are a total of three solar panels connected parallel which gives approximately a current of 300mA. These calculations are based on ideal conditions and may vary in real-world scenarios due to factors such as solar panel orientation, shading, weather conditions, and efficiency losses in the charging circuitry. So, the time required to charge a 400mAh LiPo battery with a charging current of approximately 0.23A (230mA) is:

Charging Time = Battery Capacity (in mAh) / Charging Current (in mA)

Charging Time = 400mAh/230 mA

Charging Time ≈ 1.74 hours

So, it would take approximately **1 hour and 44 minutes** to charge a 400mAh LiPo battery with a charging current of 0.23A. This is a rough estimation and actual charging time may vary due to factors such as charging efficiency and the state of the battery.

6.2.8. Maintenance and Troubleshooting

Users periodically check the device's battery level and recharge as needed using either the micro USB port or solar charging option.

The device undergoes routine maintenance, such as cleaning sensor surfaces or calibrating sensors, to ensure accurate and reliable operation.

In the event of technical issues or malfunctions, users can troubleshoot the device using provided documentation

6.3. Web Application

The Tars Dashboard web application represents an integral component of the disclosed invention, facilitating remote monitoring, analysis, and management of indoor plant health metrics. Operating in tandem with the Tars Portable device, the web application provides a user-friendly interface accessible via internet-enabled devices, facilitating seamless interaction and data retrieval for users seeking to optimize their indoor gardening experience.

6.3.1. Real-Time Monitoring and Data Visualization

The Tars Dashboard provides users with dynamic visualization tools for real-time tracking of plant health metrics, including temperature, humidity, soil moisture, light intensity and weather. These metrics are graphically represented with radial/circular bar charts, enabling users efficiently monitor environmental fluctuations and assess plant well-being trends over time.

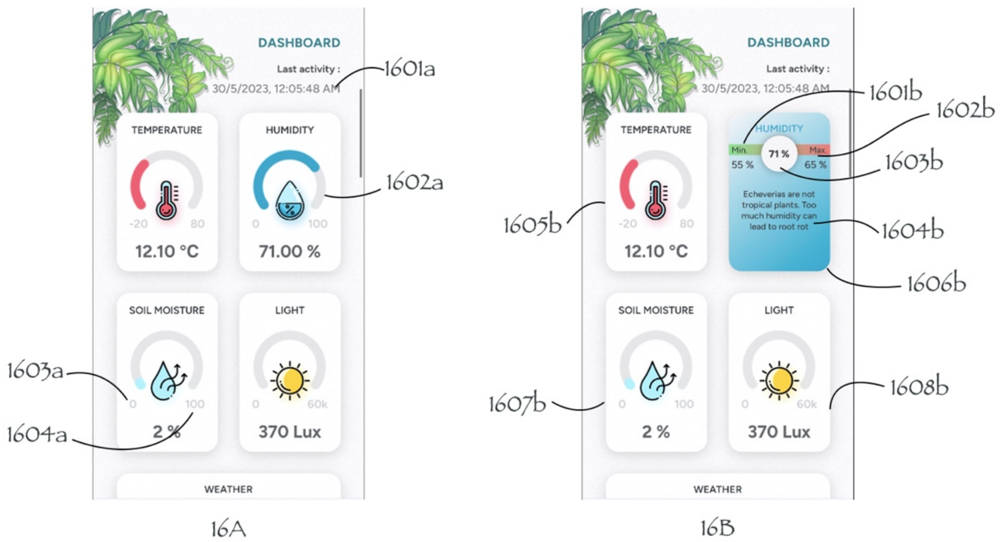


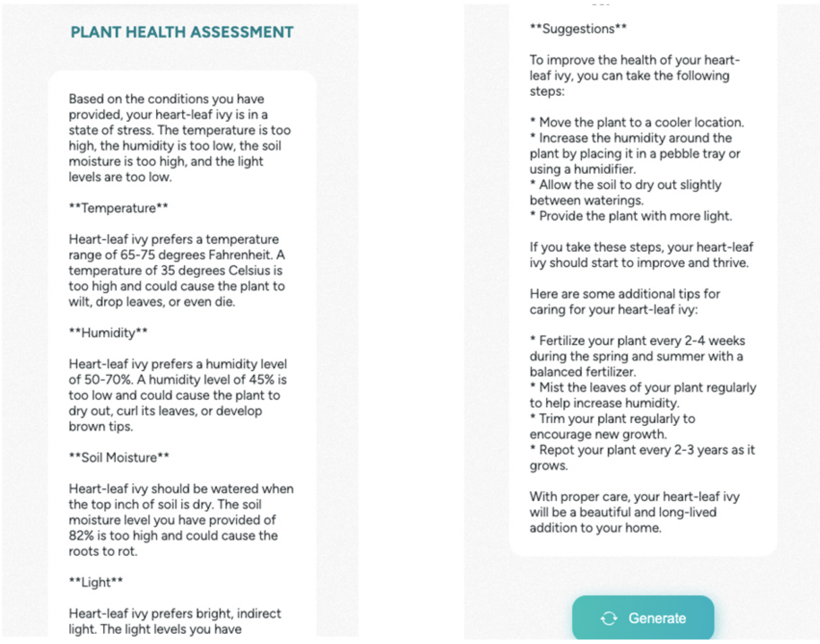
Figure 16

Figure 16:
- [16A] shows a screenshot of the Tars Dashboard section, where users can monitor real-time data of the plant conditions.
    - [1601a] Shows last activity i.e. time when the data is fetched
    - [1602a] Radial/circular bar chart
    - [1603a] Minimum value
    - [1604a] Maximum value

- [16B] shows a screenshot of the Tars Dashboard section, depicting the user tapping on the humidity card, causing it to flip and show the minimum[1601b] and maximum[1602b] values of humidity for the plant. This feature allows users to track whether the values are within the optimal range. Users can tap on any of the cards, such as temperature[1605b], humidity[1606b], soil moisture[1607b], and light intensity[1608b], to track the optimal range and gain instant insight[1604b].

6.3.2. Plant Health Assessment

Employing advanced artificial intelligence (AI) algorithms, specifically Google's language model, Gemini (formerly known as Bard), the Tars Plant Health Assessment conducts a comprehensive analysis of collected plant data. The data includes temperature, humidity, soil moisture, light intensity, and weather conditions. This analysis results in the creation of customized plant health reports, complete with actionable recommendations to optimize plant care practices. These recommendations cover adjustments to watering schedules, light exposure, temperature regulation, and soil management, tailored to the specific requirements of each plant species. Taking into account weather conditions allows for more detailed reports, such as suggesting users move the plant indoors in windy and thunderstorm conditions or in case of freezing temperatures at night, which can cause frost damage.



17A 17B

Figure 17

Here, Figure 17 shows screenshots of the tailored plant health report generated by plant health assessment.

6.3.3. Plant Database API

The Plant Database API hereinafter referred to as “Tars Plant Database API” is a central component of the Tars Dashboard application, designed to offer users access to a vast repository of plant information and care instructions. This details the integration of the Tars Plant Database API within the Tars Dashboard, facilitating seamless access to plant-related data and guidance.

This is a RESTful API built with Flask and SQLAlchemy that provides plant data from a PostgreSQL database. The API allows for the retrieval of a complete plant data dump, a list of all plant names with their ID, and the ability to retrieve individual plant data by ID.

Here are few endpoints for the Tars Plant Database API,

GET /plants
GET endpoint for retrieving complete plant data dump

GET /plantslist
GET endpoint for retrieving all plant names and their ID

GET /plants{id}
GET endpoint for retrieving a plant by ID

POST /plants
POST endpoint for adding a new plant

PUT /plants{id}
PUT endpoint for updating an existing plant by ID

DELETE /plants{id}
DELETE endpoint for deleting an existing plant by ID

POST /plants/token
POST endpoint for generating an access token

Note that the ***PUT /plants/{id}*** and ***DELETE /plants/{id}*** endpoints require authentication.

Users have access to a wide variety of plant types in the Tars Plant Care Database API. Once a plant type is selected, users can obtain detailed plant data from the API, including common and scientific names, family information, growth specifications, foliage and flower characteristics, as well as images. Within the Tars Dashboard, users can access in-depth care guides for their chosen plants, sourced from the Tars Plant Care Database API. These guides contain information on temperature, sunlight exposure, watering frequency, soil requirements, and common problems associated with each plant type.

The figure 11 depicts a structured representation of the database schema. This schema serves as the backbone of the application, facilitating the organization and retrieval of essential plant information and care guides. Each field within the schema corresponds to a specific aspect of plant data, ranging from common and scientific names to growth specifications, care Instructions, and associated images. Below is an explanation of each field within the schema:

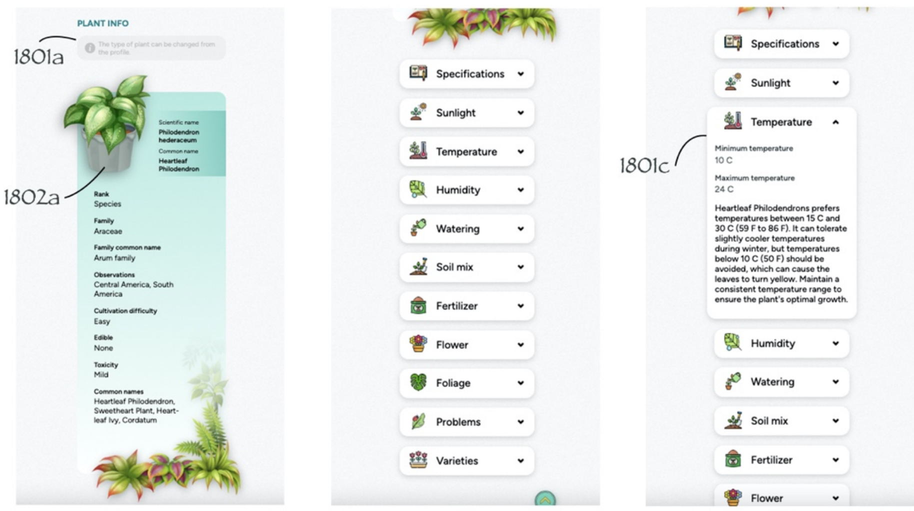
id: A unique identifier for each plant entry.
common_name: The common name of the plant.
name: The scientific or botanical name of the plant.
scientific_name: The scientific name of the plant.
rank: The taxonomic rank of the plant.
family: The taxonomic family of the plant.
family_common_name: The common name of the taxonomic family.
observations: Native area the plant.
cultivation_difficulty: Difficulty level associated with cultivating the plant.
vegetable: Boolean indicating if the plant is a vegetable.
image_url: URL(s) pointing to images of the plant.
duration: The lifespan or duration of the plant.
edible_part: Parts of the plant that are edible.
edible: Boolean indicating if the plant is edible.
images: Various images of the plant categorized by flower, leaf, habit, fruit, and other.
common_names: Other common names of the plant.
flower: Characteristics of the plant's flowers, including colour and conspicuousness.
foliage: Characteristics of the plant's foliage, including shape, texture, and colour.
specifications: Specifications related to the plant's growth, including habit, growth rate, bloom and growth months, spread, height, shape, and toxicity.
care: Care instructions for the plant, including temperature, sunlight, watering, humidity, soil mix, pH levels, sun exposure, sunlight duration, temperature tolerance, watering frequency and moisture levels, fertilizer requirements, and soil texture.
common_problems: Common problems or issues associated with the plant.
varieties: Varieties or cultivars of the plant.
sources: Sources or references for the information provided.

Figure 12 presents a database schema tree diagram outlining the structure and relationships within the database utilized by the system. The tree diagram illustrates the hierarchical organization of database tables, with parent-child relationships depicted through connecting lines. Each node in the tree represents a database table, while the branches indicate the relationships between these tables. The schema tree diagram provides a visual representation of the database architecture, facilitating understanding of data organization and query relationships within the system.

6.3.4. Plant Info and Care

Upon user interaction within the Tars Dashboard, requests are made to the Tars Plant Database API to retrieve specific plant data and care guides. The API responds with the requested information, which is then displayed to the user in an organized and user-friendly manner.

The Tars Dashboard empowers users with comprehensive access to plant information and care guides, facilitating informed decision-making and optimized plant management. Users can explore detailed descriptions, growth specifications, and care instructions for a wide variety of indoor plant species. This comprehensive resource equips users with the knowledge necessary to cultivate thriving indoor gardens, including insights into temperature preferences, light requirements, watering schedules, and common problems encountered by specific plant species.



18A 18B 18C

Figure 18

Here, Figure 18 shows the screenshots of the plant info and plant care section within the tars dashboard web app

6.3.5. User Account Management

The Tars Dashboard prioritizes user account management functionality, facilitating the creation of personalized profiles and the management of multiple plants within a single interface.

7. ADVANTAGES

The Tars Portable represents a significant advancement in indoor plant care, offering numerous benefits that can transform the way individuals engage with and nurture their indoor greenery. Below are the key advantages provided by the Tars Portable system:

7.1. Seamless Integration with Existing Plant Setups

Unlike traditional smart planters that necessitate repotting, the Tars Portable system seamlessly integrates into existing plant setups, eliminating the need for transplanting. This allows users to maintain their preferred plant containers while still benefitting from advanced monitoring and care functionalities.

7.2. Compact and Portable Design

The compact and portable design of the Tars Portable system enhances its versatility and usability, enabling users to effortlessly move the device between different plant pots or locations. Its lightweight construction and minimal footprint ensure unobtrusive placement within indoor environments, enhancing user convenience and flexibility.

7.3. Comprehensive Plant Monitoring and Analysis

Tars Portable offers comprehensive monitoring of key environmental parameters crucial to plant health, including temperature, humidity, soil moisture, and light intensity. By providing real-time data and actionable insights, the system empowers users to make informed decisions and optimize plant care practices for optimal growth and vitality.

7.4. AI-Powered Plant Health Assessment

Leveraging AI algorithms, Tars Portable conducts sophisticated plant health assessments based on collected sensor data. Through machine learning models, the system generates personalized recommendations and tailored care guides, enabling users to address potential issues and proactively manage plant well-being with precision and efficacy.

7.5. Efficient Power Management and Solar Recharging

Tars Portable incorporates advanced power management features, including low-power sleep modes and touch-to-wake functionality, to optimize energy consumption and extend battery life. Additionally, the device supports solar panel recharging, harnessing renewable energy sources for sustainable operation and minimizing reliance on traditional power outlets.

7.6. User-Friendly Interface and Remote Access

The intuitive interface of Tars Portable facilitates effortless interaction and control, allowing users to access real-time plant data, customize settings, and receive alerts remotely via the companion Tars Dashboard web application. This remote accessibility enhances user convenience and ensures continuous monitoring and management of indoor plants from anywhere, at any time.

7.7. Integration with Plant Care Database API

The integration of Tars Portable with the Tars Plant Database API provides users with access to a wealth of plant-specific information, care guides, and recommendations. This comprehensive database empowers users to make educated decisions regarding plant selection, cultivation techniques, and fostering a deeper understanding of indoor gardening practices and promoting successful plant care outcomes.

In summary, the Tars Portable offers unparalleled advantages in terms of flexibility, functionality, and usability, empowering users to cultivate thriving indoor gardens with confidence and ease. By combining advanced technology with user-centric design principles, Tars Portable represents a paradigm shift in indoor plant care, enabling enthusiasts of all levels to achieve optimal plant health and vitality.

8. FUTURE WORKS

We are committed to continuously innovating and improving the Tars Portable system, providing users with cutting-edge tools and functionalities for effective indoor plant care and monitoring. These advancements will not only enhance user experience but also contribute to the overall sustainability and success of indoor gardening endeavours.

8.1. Development of Mini Version

In future iterations, we aim to introduce a mini version of the Tars Portable device, catering to users with limited space or those seeking a more discreet monitoring solution. This mini version will retain all essential functionalities while reducing size and weight for increased portability and versatility.

8.2. Data Logging and Analysis

Future developments will focus on storing historical data for users to track trends over time and identify patterns or anomalies in plant behaviour. Additionally, the implementation of machine learning models will enable predictive analysis, allowing users to anticipate and mitigate potential plant health issues proactively.

8.3. Advanced Data Visualization

We plan to incorporate modern interactive graphs and visualizations into the Tars Dashboard web application, providing users with intuitive tools for interpreting and analyzing their plant data effectively. These visualizations will offer insights into trends and patterns, facilitating informed decision-making for optimal plant care.

8.4. Indoor Garden Theme UI

To enhance user experience and flexibility, future iterations of the Tars Dashboard will feature an indoor garden theme UI. This UI will enable users to seamlessly add and manage multiple Tars Portable devices within a single interface, eliminating the need for device reassignment and streamlining the monitoring process.

8.5. Power Optimization

Continued efforts will be dedicated to further optimizing power consumption to prolong device runtime and reduce the frequency of battery recharging. This will involve refining power management algorithms and exploring energy-efficient hardware components.

8.6. Weather-Based Animated Backdrops

To provide users with a more engaging and immersive experience, we envision integrating weather conditions-based animated backdrops into the Tars Dashboard web application. These dynamic backgrounds will reflect real-time weather conditions, enhancing the overall aesthetic appeal and usability of the platform.

8.7. Alerts System

A robust alert system will be implemented to notify users of critical environmental changes or plant health issues in real time. These alerts will enable users to take timely action to address emerging concerns and ensure the well-being of their plants.

9. CLAIMS

I claim,

1. A portable plant care device comprising:
    a. An outer casing enclosing internal components, a main unit housing electronic components such as a microcontroller, sensors for monitoring environmental data, wireless connectivity modules, a display unit for presenting real-time environmental data, a solar panel enclosure facilitating solar energy utilization for battery recharging, and a charging module housing charging board and step-up boosters for efficient battery recharging.

2. The portable plant care device of claim 1, further comprising a solar panel enclosure within a charging module housing charging board and step-up boosters for efficient battery recharging, includes a gear shaft mechanism allowing for rotation to optimize sunlight exposure.

3. The portable plant care device of claim 1, wherein said display unit features hollow grooves tailored to accommodate an OLED Display, and said outer casing further comprises a capacitive touch sensor and a slide switch for user interaction.

4. The portable plant care device of claim 1, wherein said main unit/chassis includes strategic positioning of temperature, humidity, and light intensity sensors within a sensor unit chamber.

5. The portable plant care device of claim 1, further comprising a D1 Mini NodeMCU, DHT11 temperature and humidity sensor, capacitive soil moisture sensor, BH1750 light intensity sensor, OLED Display 1.3 Inch I2C, TP4056 1A Charging Board, DC-DC 1.8V ~ 5V to 3.3V Booster and Buck Power Module, Mini DC-DC Boost Convertor 0.9V ~ 5V 600mAh Module, Rechargeable Li-Po Battery 400mAh 3.7V, Polycrystalline Mini Epoxy Solar Panel, Capacitive Touch Switch, Tactile Push Button Switch, SPDT Slide Switch, and M3x6mm Bolt.

6. The portable plant care device of claim 1, further comprising means for initialization and setup upon power-up, including configuration of hardware components and establishment of connectivity with external networks, means for Wi-Fi configuration through a user-accessible web page, means for real-time data acquisition from sensors including temperature, humidity, soil moisture, and light intensity, means for user interaction through capacitive touch sensors or physical buttons, means for data transmission to designated endpoints via Wi-Fi connectivity, and means for efficient power management including low-power sleep modes and options for USB or solar panel charging.

7. The portable plant care device of claim 6, wherein said means for power management includes power-saving mode and turning off the OLED display after a specified period of time to minimize power consumption, and said means for data transmission optimizes data transfer by comparing recent data with previous data and transmitting only the latest data if a difference is detected.

8. The portable plant care device of claim 6, wherein said means for solar-powered charging utilizes solar panels to recharge the battery, thereby minimizing the need for manual recharges.

9. A web application operatively associated with the portable plant care device, comprising means for real-time monitoring and data visualization of plant health metrics including temperature, humidity, soil moisture, and light intensity, means for plant health assessment utilizing AI analysis based on collected sensor data, means for plant database API integration providing access to plant information and care instructions, and means for user account management facilitating personalized profiles and management of multiple plants within a single interface.

10. The web application of claim 9, wherein said means for real-time monitoring and data visualization presents dynamic visualization tools for tracking plant health metrics with radial/circular bar charts, and said means for plant health assessment generates personalized recommendations and tailored care guides based on collected sensor data and AI analysis.

10. Conclusion

Tars Portable represents a significant advancement in smart plant care technology, offering users a compact, portable, and comprehensive solution for monitoring and optimizing plant health. Through innovative design, cutting-edge hardware components, and advanced software features. Furthermore, its intuitive user interface, coupled with remote accessibility via the Tars Dashboard web application, ensures a seamless and immersive experience for users of all skill levels, empowering them to cultivate vibrant and thriving indoor gardens with confidence and ease. As the demand for smart and sustainable solutions continues to rise in today's rapidly evolving world, Tars Portable stands poised to redefine the landscape of indoor gardening, offering enthusiasts and horticulturalists alike a powerful tool for monitoring plant health, promoting environmental stewardship, and enhancing overall well-being. This patent application encompasses the design, utility, and functionality of Tars Portable, demonstrating its potential to revolutionize indoor gardening practices worldwide.

11. Drawings

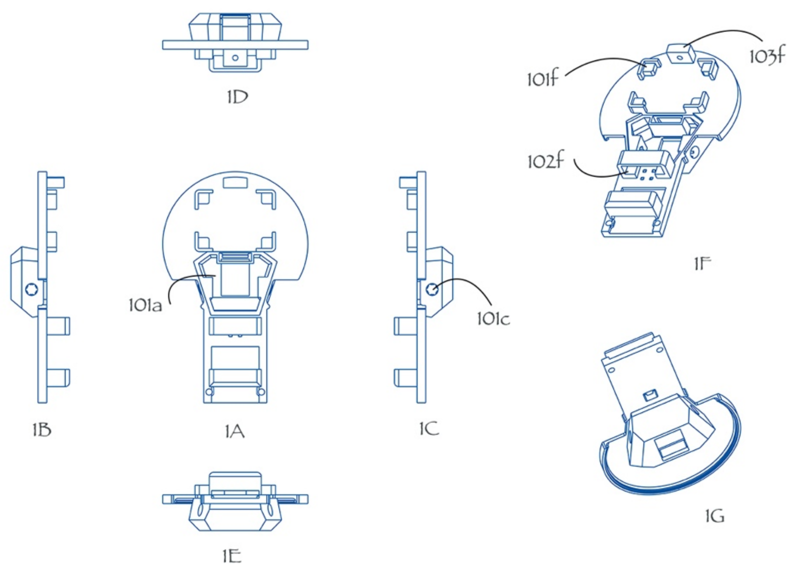


Figure 1

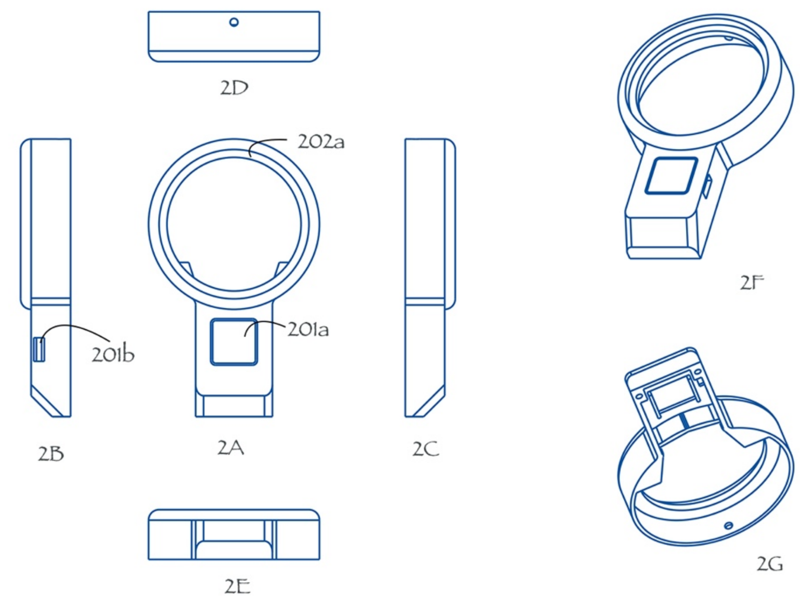


Figure 2

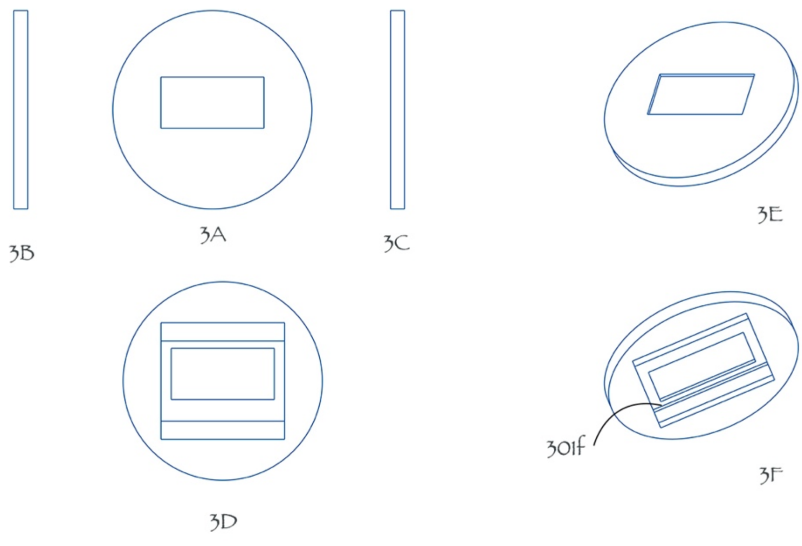


Figure 3

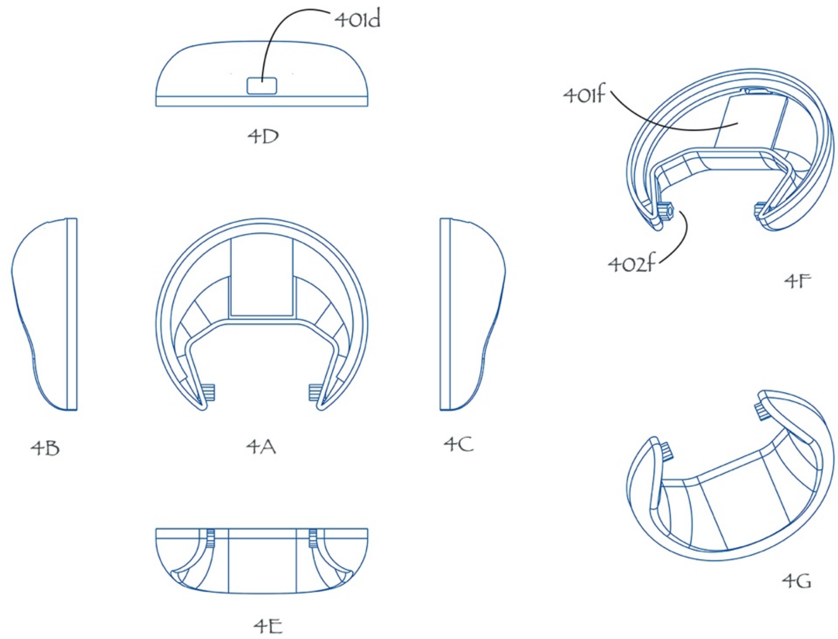


Figure 4

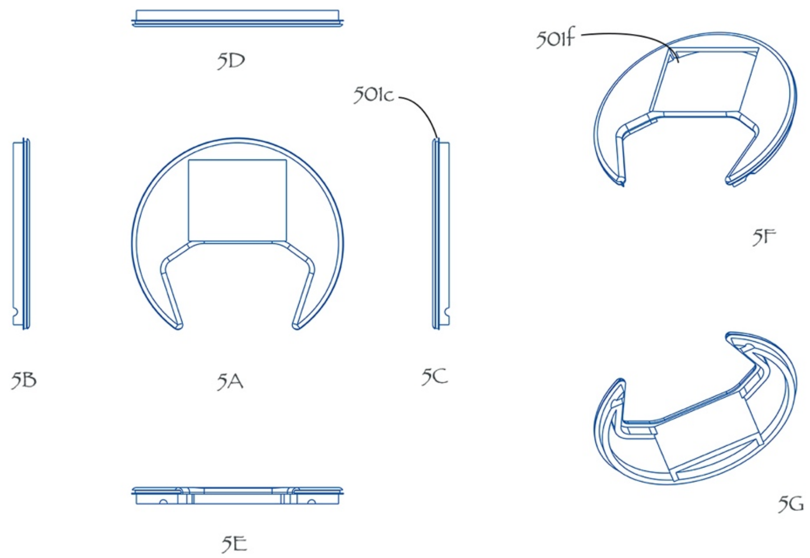


Figure 5

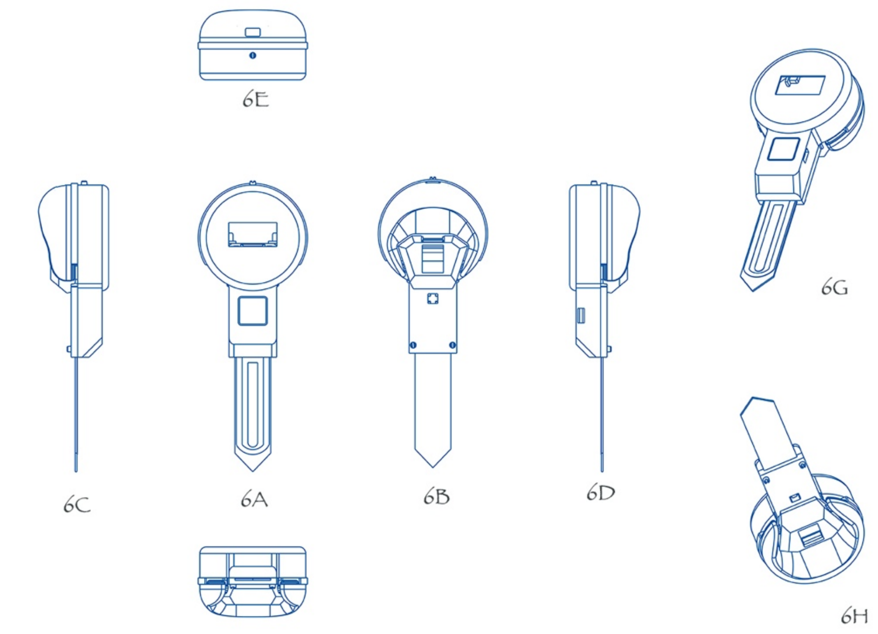


Figure 6

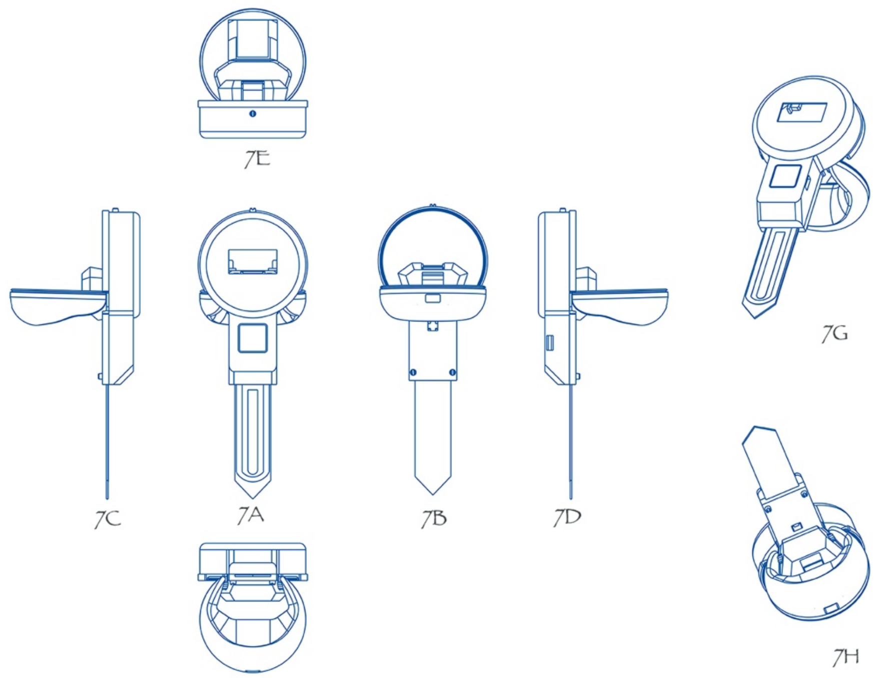


Figure 7

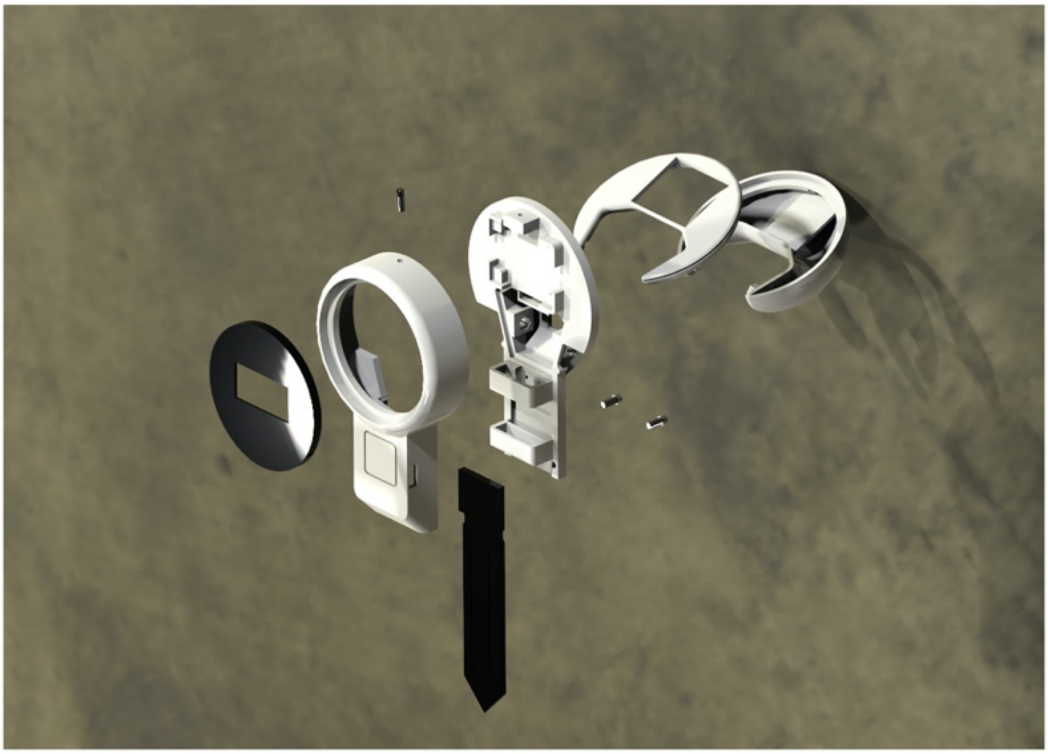


Figure 8

Figure 9

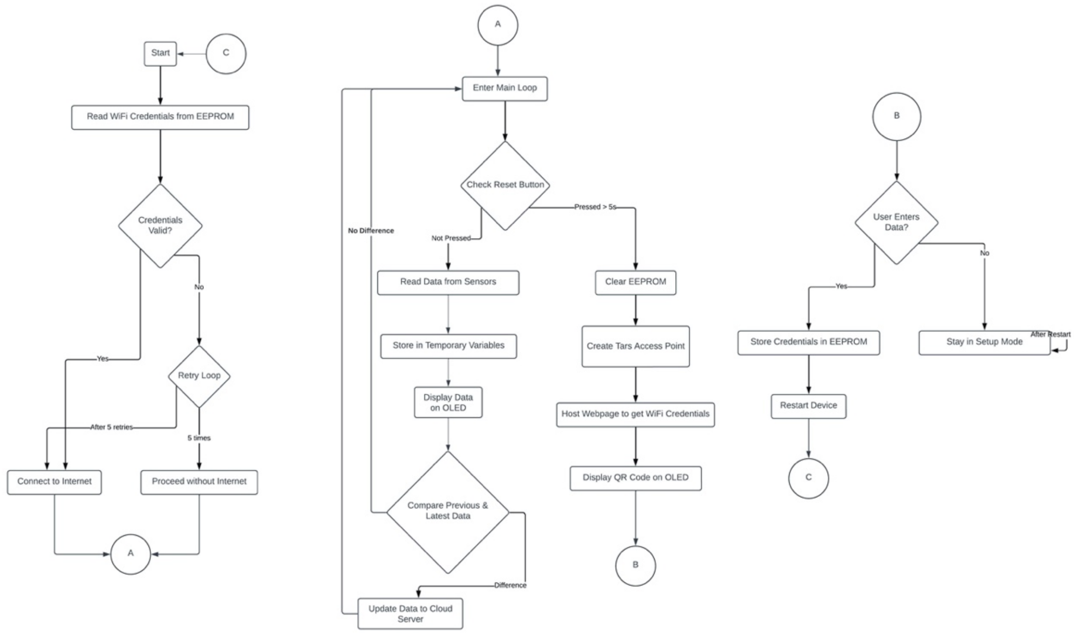


Figure 10

Figure 11

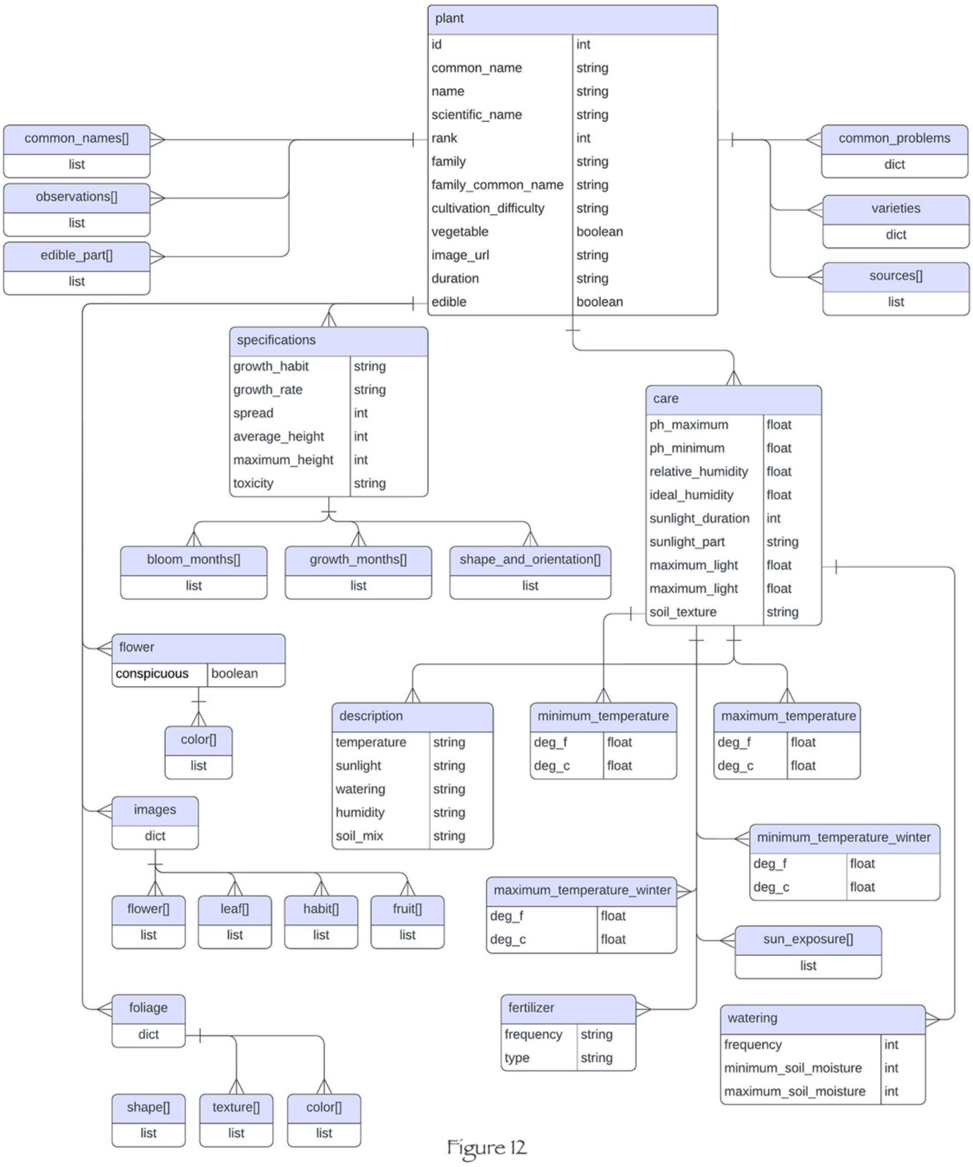


Figure 12

(Anvesh Padamata)
16-March-2024