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"Chloe": Empathetic Design for Smart Houseplant Care Systems

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Abstract. This study endeavors to introduce an innovative smart plant care system, denoted as "Chloe," which seeks to enhance the symbiotic relationship between individuals and their indoor flora. The system comprises both a physical product and a corresponding application, collectively tasked with monitoring critical soil and light parameters while offering tailored maintenance recommendations. By utilizing the "Chloe" system, users gain deeper insights into plant requirements, thereby elevating their plants' likelihood of thriving. Furthermore, the platform facilitates the exchange of experiences among like-minded enthusiasts. This research represents a pioneering venture into the design and implementation of modern intelligent plant care systems, effectively integrating human-computer interaction technology into everyday domestic activities. It also examines the pivotal role of emotional design in augmenting plant survival rates and user experiences within the realm of home plant cultivation.

Keywords. Empathetic design, houseplant, smart product-service system

1. Introduction

1.1. Houseplant

In urban areas of China, there is a remarkable prevalence of home plant breeding, with a staggering 95%[1] adoption rate[2].This surge in popularity underscores the substantial commercial and research potential associated with domestically cultivated plants. A div erse array of domestic plant species exists, necessitating a nuanced understanding of ho rticulture. Unfortunately, many individuals, grappling with either time constraints or a d earth of expertise, frequently encounter difficulties in tending to their plants, resulting i n their untimely demise. A 2020 Article and OnePoll study on millennials and housepla nts found that the average plant parent has killed seven indoor plants they have brought home. And 67% of them call themselves plant murderers[1].Research indicates that a su bstantial 77% of young and middle- aged individuals possess less than five years of pla nting experience, with the majority sourcing their plant-related knowledge from the Inte rnet or social circles. Notably, approximately 83.2% of respondents reported acquiring plant-related insights through online platforms, with a prevailing need for guidance on c rucial aspects such as soil composition, lighting regimens, and growth patterns[1][2].

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A houseplant, alternatively known as a potted or container plant, is an aesthetically pleasing botanical specimen cultivated indoors, typically in residences or office spaces, primarily for decorative purposes.Tending to domestic plants yields manifold advantages, encompassing the enhancement of interior aesthetics, oxygenation of indoor environments, and the purification of air quality[4]. Furthermore, the presence of greenery exerts a positive influence on individuals' moods, engendering a mild yet efficacious alleviation of stress and concomitant augmentation of productivity [5][6]. Engaging in gardening activities can also confer psychosocial benefits, particularly among cohorts experiencing heightened levels of stress and anxiety.

Nonetheless, it is imperative to underscore that guidelines for the care of indoor plants must be tailored to specific species and contextual factors. Paramount considerations encompass moisture levels, light exposure, soil composition, temperature, ventilation, humidity, fertilization, and potting techniques. Adopting a one-size-fits-all approach, such as over-irrigation, excessive fertilization, or suboptimal lighting, can be deleterious, potentially leading to the demise of the plants in question[7]. Simultaneously, successful plant rearing necessitates the judicious application of appropriate fertilizers to furnish the various essential elements requisite for robust plant development[8]. In sum, the effective maintenance of household plants demands a certain proficiency in horticultural practices, coupled with a accrued investment of time, in order to ensure the flourishing vitality of these botanical specimens[3].

1.2. Empathic Design

Emotional design theory posits that products or services should possess the capacity to evoke emotional responses in users. It endeavors to elicit positive emotional reactions through design components including the product's visual aesthetics, interactive features, and auditory cues. This, in turn, serves to bolster user contentment and allegiance. Emotional design places emphasis on both the outward presentation and the establishment of an emotional rapport with the product, with the overarching goal of fashioning an enjoyable and gratifying user encounter [9][10].

1.3. Aim of The Study

During the epidemic era, marked by reduced outdoor activities and an increasing need for spiritual engagement, items that offer "spiritual sustenance" become particularly valuable. In this context, the demand for pets in the market, especially plants, has witnessed a steady rise. Many individuals, unable to accommodate domestic animals, turn to plant cultivation as an alternative. Generally, plant-type pets incur lower expenses and time commitments compared to their animal counterparts.

Among young and middle-aged demographics, the primary concern regarding plants revolves around their maintainability and ease of care, surpassing considerations of aesthetics and functionality. Unfortunately, in modern society, instances of plants languishing due to neglect or inadequate care are not uncommon.

Simultaneously, contemporary society places an increasing emphasis on mental health. Gardening activities, identified as a natural therapeutic intervention, are gaining recognition. Research demonstrates that home cultivation of plants not only enhances the psychosocial well-being of various urban groups, but also exhibits heightened therapeutic benefits for individuals grappling with elevated levels of stress and anxiety.

With a surge in demand for intelligent and user-friendly plant care systems, this research endeavors to develop the "Chloe" intelligent plant care system. Grounded in extensive theoretical and market research, "Chloe" is designed to address the evolving needs of modern society for more accessible and compassionate plant care. "Chloe" acts as a communication platform, transforming plant care from an isolated personal endeavor into a social experience, enabling users to exchange experiences and insights.

This research introduces several innovations. By integrating empathic and emotional design principles, the system can better comprehend user requirements and simulate an emotional bond between individuals and plants, ultimately delivering more personalized and compassionate plant care advice. Thus, plant care evolves from being a mere task to an enjoyable experience.

One prevailing issue in the current market is the limited functionality of existing monitoring equipment, often unable to measure a diverse array of data. Additionally, such equipment may be cumbersome and primarily tailored for horticulture professionals. Alternatively, it may lack playability or interest. Consequently, this study strives to create an intelligent plant care system that aligns with user needs and reflects market trends. The "Chloe" system comprises both physical products and a corresponding application.

2. Design of Chloe – A Smart Houseplant Product-service System

The "Chloe" system encompasses two integral components: physical products and applications. The physical product assumes the pivotal role of monitoring critical soil parameters, encompassing moisture levels and light exposure, subsequently relaying this data to the application platform. Registration of an account within the application is a prerequisite for users, followed by the insertion of the physical product into the plant's soil, thus initializing the utilization of the intelligent plant care system. The application, in turn, undertakes the responsibility of processing and presenting the transmitted data in a visual format.

Upon entry into the application, users are prompted to capture images of their specific cultivated plants. Subsequently, employing algorithmic processes in the background, the application generates corresponding cartoon representations of the plants. Further, the application boasts a diverse array of interfaces and functionalities. For instance, the primary interface predominantly features the real-time status of plants. Additionally, it offers tailored care recommendations based on the unique characteristics and preferences of the plant species in question (see Figure 1).

2.1. Design of Chloe - Smart Product

Screen: The display screen is a pivotal component synchronized with the expression units in the associated application.

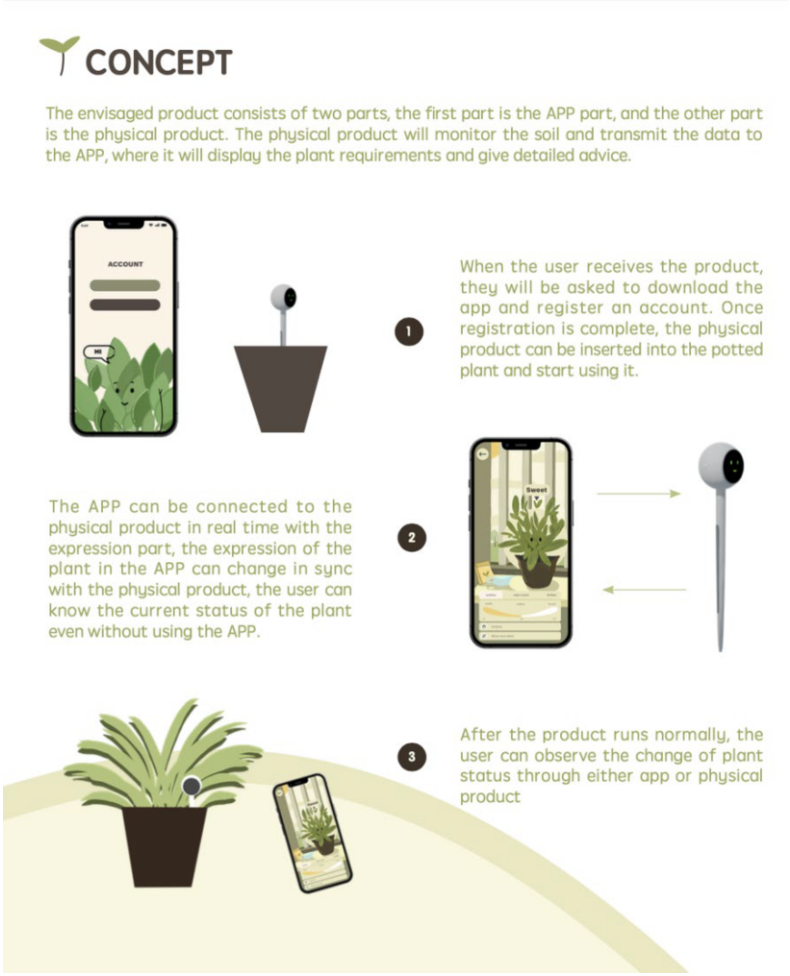

Figure 1. Chloe design concept.

Indicator Lights and Components: This segment comprises a working indicator light, facilitating users in verifying the product's operational status. The spherical section encompasses the operational elements of the product, housing the chip, power supply, and data components.

Sensing Area: Directly interfacing with the soil, this region monitors key soil parameters such as moisture levels, nutrient content, and light exposure. Sensor strips traverse the entirety of the soil layer, ensuring data precision.

Light/Temperature/Humidity Sensors: This plant monitor integrates a temperature and light sensor for precise monitoring and analysis of light intensity and temperature. It can measure light intensity up to 100,000 LUX with an accuracy of up to 100 LUX. Temperature detection accuracy reaches 0.5 ℃/32.9 ℉. Additionally, the elongated sensor aids in rapid determination of soil moisture levels, ensuring accurate assessment of watering requirements, meeting the EC5 standard of professional soil probes.

EC Sensors: Equipped with four stainless steel EC sensors, this soil testing kit records soil nutrient levels and translates them into precise data accessible via your mobile device.

Bluetooth Connection: Seamlessly connect to your smartphone through efficient Bluetooth 4.1 technology. Take full control using the "Chloe" app, compatible with Android and iOS, readily available on Google Play and the APP Store.

Real-time communication between the system and the physical product is facilitated through Bluetooth technology. A Bluetooth Low Energy (BLE) module has been integrated into the system, ensuring a stable and efficient communication link between the smart flowerpot and the mobile application. This technology not only guarantees real-time data transmission but also conserves energy, extending the system's operational lifespan.

Figure 2. Design of Chloe Product.

2.2. Design of Chloe Service System

Named after the Greek term for 'green shoot', "Chloe" embodies the aspiration for every plant to thrive in optimal health. The accompanying application serves as a knowledgeable companion, providing users with tailored suggestions to nurture their plants effectively. Through the app, users gain access to comprehensive plant data, engage with virtual plant avatars, and acquire valuable insights into their plants' requirements. Additionally, the application fosters a community of like-minded plant enthusiasts, allowing for meaningful interactions and the potential to earn achievement rewards for one's cultivated plants.

Initial Interface: Upon installation, users are greeted with the welcoming interface, prompting them to register their account and embark on their plant care journey. This interface sets the stage for users to establish a personalized connection with their plants.

Identification Interface: A unique feature of "Chloe" is its plant identification capability. Users can capture an image of their plant, and the app, utilizing advanced algorithms, will generate an endearing cartoon representation based on the captured image.

Main Interface: The central hub of the application, the main interface, grants users entry into their virtual garden, offering a panoramic view of all their cultivated plants. This feature provides a convenient overview of the user's plant collection.

Detailed Data Interface: For in-depth insights, users can select any specific plant from their garden, leading them to the detailed data panel. Here, a wealth of current plant metrics is readily available, empowering users with accurate and timely information.

Plant Data Analysis: The analysis panel elevates the user experience, allowing for a deeper exploration of plant data trends. Users can select a specific month to visualize fluctuations in plant metrics, while the app provides tailored breeding suggestions based on the observed data.

Popular Science Interface: This interface serves as a botanical encyclopedia, furnishing users with comprehensive knowledge about their plants. Details regarding appearance, habits, and more are provided, fostering a deeper understanding of each plant in one's collection.

Moments: The 'Moments' feature facilitates social engagement within the "Chloe" community. Users can connect with friends, observe their progress, and extend helpful reminders if a friend's plant requires attention.

Setting Interface: The settings panel offers users an array of customizable options, including notification preferences, achievement medals, and product configurations, ensuring a tailored and seamless user experience.

Figure 3. Chloe system design.

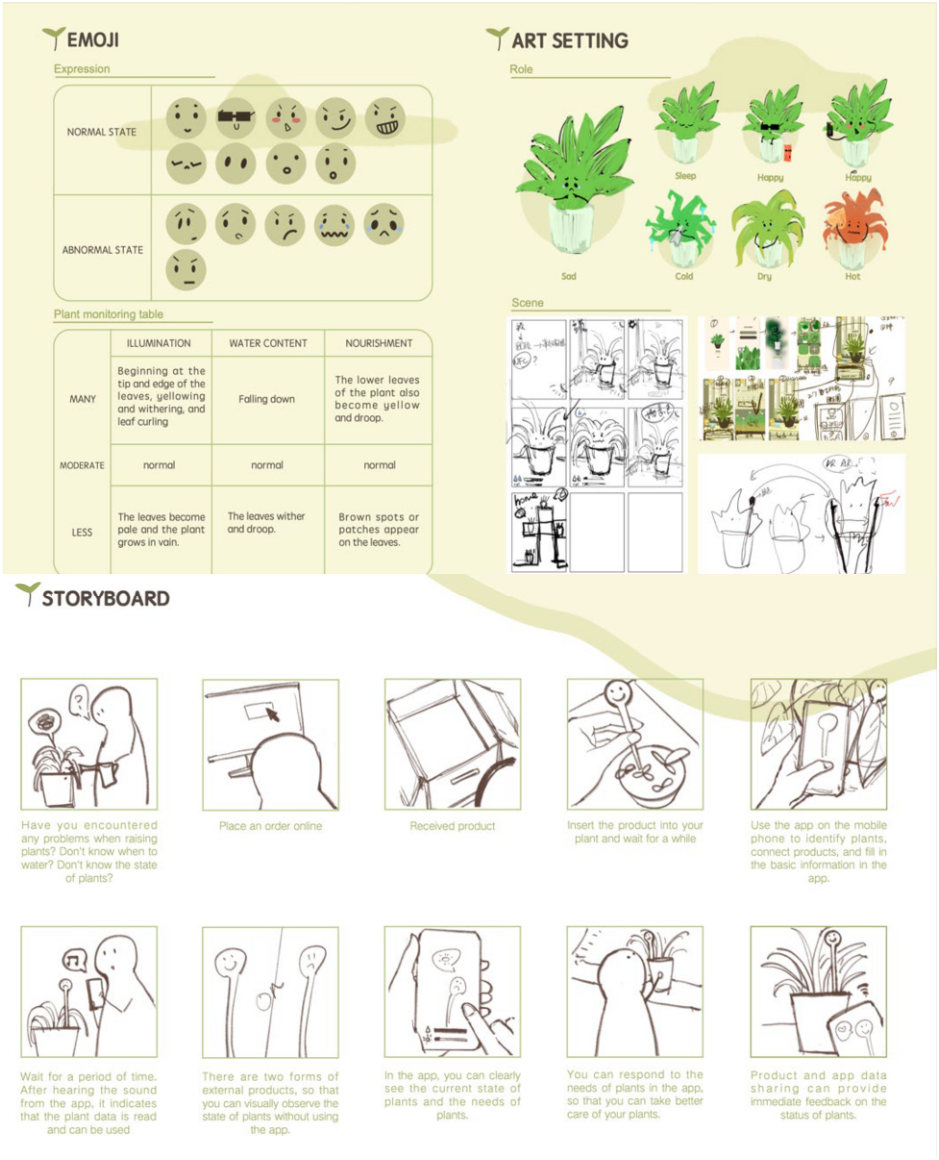

Figure 4. Art setting and Storyboard.

To begin, carefully insert the designated product into the soil of your chosen plant, allowing for a brief period of time. Next, download the "Chloe" application from your respective app store. Once installed, proceed to register and subsequently sign in with your designated account. Connect the product to the app and proceed to input basic plant information within the application interface. Allow for a brief duration. Upon hearing a distinct notification from the app, this signals the successful retrieval of plant data, rendering it ready for use.

Two distinct external products have been designed to offer an alternative means of visually assessing your plant's condition, sans the app interface. Within the application, you will find comprehensive visual representations of your plant's current state and its specific requirements. You may then respond to these needs directly through the app, ensuring optimal care for your plants.

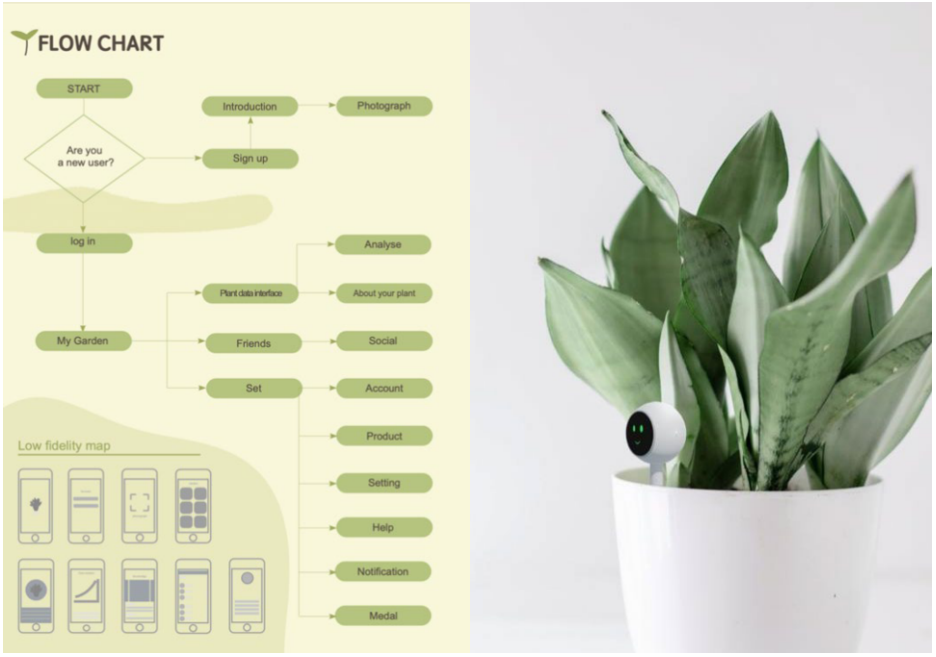

Figure 5. Flow chart and Product Scenario.

Figure 6. Application Scenario.

Furthermore, the seamless integration of product and app data sharing facilitates immediate updates on your plant's status. Upon successful connection, the indicator light will flash twice, signifying readiness. Now, embark on the gratifying journey of nurturing plants with the assistance of Chloe. For Optimal setup, ensure that your phone and the designated product are within 10 cm proximity.

3. Conclusion

This research endeavors to develop the "Chloe" system, an intelligent plant care system that ingeniously melds empathetic and emotional design theories. By leveraging visual representations, immersive soundscapes, and personalized recommendations, the system endeavors to forge a deeper emotional bond between users and their cherished home plants, all while furnishing robust scientific plant care support. This endeavor has not only achieved technical success but has also made substantial strides in elevating the emotional experience of users. Moving forward, our focus remains on refining the "Chloe" system to further augment its user experience and maintenance capabilities. To this end, we plan to introduce an expanded range of supported plant species, broadening the system's versatility and applicability. Concurrently, we are committed to actively engaging with user feedback, iteratively refining both the design and functionality of the system to adeptly meet the evolving needs of our user base. Through these concerted efforts, we are poised to continue advancing the "Chloe" system and further fortify the connection between users and their cherished plants.

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