BLOOM

An interactive indoor planter system

By

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Thesis Report

Bloom - An interactive indoor planter system

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Submitted in Partial Fulfillment of the Requirement for the Degree of Industrial Design

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National University of Science & Technology School of Art Design & Architecture, SADA

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Approved by the Guidance Committee

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June 2024

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Bloom

A Research Report

Maha Shahzad

A research report submitted for evaluation to School of Art, Design and Architecture on 7th June 2024, in partial fulfillment of the requirement for the degree of B.ID.

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Abstract

This study looks into the growing popularity of indoor plants and the trend of urban gardening, which are both influenced by urbanization and the resulting reduction in outside area. Because traditional gardens are out of reach for many people living in denser cities, indoor gardening is becoming more and more popular as a feasible alternative. According to the research that is currently available, indoor plants can boost general wellbeing, lower stress levels, and improve air quality. Notwithstanding these advantages, indoor gardeners frequently encounter difficulties like irregular maintenance schedules and inadequate understanding of plant requirements. These difficulties may make indoor gardening less successful and enjoyable. Furthermore, gamification may increase user motivation and engagement by adding enjoyment to repetitive chores and creating long-lasting habits, according to psychological research.

The Bloom plant care assistant was created as an inventive way to maximize indoor plant care while encouraging a deep bond between users and their plants in response to these discoveries. Inspired by classic terracotta pots, the design makes use of premium plastic that has been hydrophilic-treated to preserve a pleasing, natural appearance. The gadget has a tactile watering warning system, light and moisture sensors in the soil, and a fun smartphone application. The software incorporates gamification to increase user engagement by providing real-time monitoring, care reminders, and a virtual garden mini-game that connects in-person activities with virtual prizes.

Keywords: *Indoor gardening, plant care assistant, user-centered design,, light sensors, sustainability, virtual garden mini-game, urban gardening, gamification, urbanization.*

1. Introduction

The increasing need for locally produced, fresh vegetables due to urbanization has generated a great deal of interest in urban gardening solutions. Traditional soil-based gardening has a number of difficulties, such as space constraints, problems with the quality of the soil, and the high labor intensity involved in plant maintenance. A viable substitute is hydroponic and potting mix gardening, which is perfect for urban settings since it enables effective plant development in fertilizer solutions based on water.

Complexity, human involvement, and sustainability are the main issues facing modern hydroponic and potting mix systems. Many systems discourage inexperienced users because they demand a great deal of physical labor and skill. Furthermore, inadequate automation and real-time monitoring may result in less-than-ideal plant growth. Current planters contribute to environmental damage by frequently using non-sustainable materials.

By creating a hydroponic planter with integrated smart technology that is sustainable and easy to use, our project aims to address these problems. With the help of sensors, the planter seeks to enhance crucial aspects of plant maintenance, offer real-time monitoring, and involve consumers through an easy-to-use smartphone app. This method encourages environmental sustainability and improves user experience while streamlining the indoor planting procedure.

The proposed design is based upon the following problem statement:

Traditional gardening of Indoor plants requires consistency, time, knowledge but routinely commitments have made gardening a challenge for urban dwellers and disconnected them from nature even with a global push towards sustainability.

The suggested remedy is a cutting-edge smart planter that has been painstakingly created to handle the challenges of urban gardening by improving user involvement, real-time monitoring, and interaction. Using the most recent developments in sensor technology, this system offers a smooth, automated gardening experience that drastically lowers the frustration of ongoing human participation while maintaining ideal growing conditions for plants.

The incorporation of cutting-edge sensor technology forms the basis of this approach. Depending on the needs of the user, the system is available in two versions. Both hydroponic and potting mix variations are supported by the system. These sensors keep a close eye on important variables including light intensity, moisture content, and the potting mix and hydroponic solution. The technology can be precisely modified to maintain the optimal growing environment by giving real-time data. For example, the moisture sensors make sure the plants get just the proper amount of water, avoiding frequent problems in traditional gardening like overwatering and underwatering. Light sensors assist in controlling light exposure, ensuring that even in interior environments with little natural light, plants receive the illumination required for photosynthesis.

A simple mobile app that improves user engagement and interactivity goes well with the physical components. The hydroponic planter's monitoring and control system is centralized in the app. Users can access real-time data on their plants' health and state, including information on light exposure and moisture levels. Even individuals who are unfamiliar with hydroponic farming may effortlessly browse the app's capabilities and make knowledgeable decisions about plant care thanks to its user-friendly layout.

A variety of instructional materials, such as guides, advice, and best practices for indoor planting are also available on the mobile app. This instructional feature promotes a greater awareness and appreciation of sustainable gardening techniques in addition to helping users get the most out of their planters. In order to ensure that users can swiftly and effectively handle key issues like low water levels or nutrient shortages, the app also has the ability to deliver push notifications to users.

The suggested solution is a comprehensive system intended to make urban gardening approachable, effective, and pleasurable rather than merely a gardening equipment. The smart hydroponic planter gives customers the knowledge and resources they need to succeed while providing plants with the ideal growth environment through the integration of state-of-the-art technology and a user-friendly design. For experienced gardeners seeking to enhance their setup or novices venturing into hydroponics for the first time, this inventive planter provides a useful and eco-friendly answer for contemporary urban living.

User surveys and usability testing techniques were used to assess the design's success and validate the idea. Contextual inquiry was conducted after users of different demographics were briefed. This allowed users to dictate how they thought about using the product, which allowed researchers to gauge how easy it was to comprehend through its affordances. To acquire behavioral insight, participatory design techniques were conducted so that users may be monitored whilst interacting with the product to suggest areas of improvement. The tests' conclusions showed that because of their relationship to plants, people approached the product with confidence and engaged in positive behavior. Users used trial and error to completely understand the product, even though they were able to navigate its use with ease.

The contributions of the work include: (1) The design of the interactive planter system (2) The design of app and a virtual game to create an engaging experience (3) User testing results that helped develop the design (4) Potential outcomes of encouraging users to start pplanting (5) Long- and Short-term goals about creating interest in the younger generation of gardening within their homes.

The remainder of this study consists of the following components: literature review, case studies, research methodologies, design criteria and ideation, final proposed solutions, material research, and development of prototype.

1. Literature review

1.1. Rapid urbanization and Green Spaces

Even though the ex-secretary General of the United Nations stated that “Future of humanities lies in cities” (United Nations, 2002) and urbanization has led to many great inventions, it still remains the largest threat to the natural habitat and biodiversity in large cities (McKinney, 2006). Chan and Vu (2017) define urbanization as an “inevitable process” which involves developing an area that can accommodate a large and growing population.

It has increased across the world and one of its most prominent consequences is the constant interference of humankind with the natural plant communities (Schochat et al., 2006). Jim and Chen (2009) presented the case of China where massive urbanization led to widespread environmental degradation. Moreover, a blend of modern lifestyle with intensified developed

urban areas became a threat to natural plant communities by diverging humankind from traditional garden practices. Chan and Vu (2017) conclude in their study based on rapid urbanization in Klang Valley, Malaysia that urban green spaces have increased with increased levels of urbanization. However, as the cityscape expands, green spaces begin to fragment.

Urban population across the world is constantly increasing from 751 million in 1950 to approximately 4.2 billion last recorded in 2018 with Asia being the most densely urban populated continent (54%) (United Nations, 2018). Currently, it has become one of the largest global issues (Malik & Wahid, 2014). In South Asia, Pakistan has the highest urban population of 36.4% which has led to a decrease in its green spaces, especially in metropolitan cities, such as Rawalpindi, Lahore, Karachi, and Faisalabad (Pasha, 2018). However, green spaces play a critical role in promoting a sustainable urban environment (Arshad, et al., 2022).

Plants and trees play an important role in the everyday life of humans (Seth, 2004). Devi and Gupta (2019) state that plants and trees are a crucial source of survival for human beings. Presently, rapid urbanization has reduced the covered green area of the land in Pakistan which has led to many climate change-induced disasters, such as floods and droughts (Evseesa, 2021). Zia et al. (2022) in their study calculate the covered green area as opposed to urbanized area in Karachi, Pakistan and concluded that the industrial hub city's green spaces are being steadily destroyed by uncontrolled urbanization and industrialization. Similarly, Rehman et al. (2023) conclude that in accordance with the international standards, there are fewer green spaces in Lahore city as well.

1.2. Traditional gardening and urbanization

Green spaces through traditional means, such as houses with gardens and outdoor parks are strong social components (Schetke et al., 2016) which involves physical activities, such as sports, jogging, walking, etc. (Chiesura, 2003). Moreover, urban spaces, such as lawns and kitchen gardens provide a valuable and refreshing environment to people (Rehman, et al., 2023).

Rapid urbanization has reduced the opportunity to traditional gardening due to lack of space and resources, leading to an increased focus on vertical gardens (Mamun et al., 2023) and change in climate conditions, such as unpredictable precipitation patterns (Tomatis et al., 2023). Moreover, gardening requires in-depth knowledge of cultivation and rules of crop care, specialized skills, and

relevant material and equipment (Velibekova, et al., 2020) which also serve as major challenges due to which a decline in traditional gardening practices is seen.

Home gardening has proven to be highly beneficial for humans especially having many positive effects on their mental health and environment (Tuton, 2020). Small-scale gardening practices provide numerous benefits to the health and nutrition of individuals and also strengthen ties among communities (Fletcher et al., 2012). Since the outbreak of COVID-19 pandemic, gardening has been an effective way to overcome the negative impacts of social distancing and self-isolation. Even before that, gardening has helped overcome the negative effects of many historic wars, such as the World Wars, the Iraq War, and the Great Recession (Hannah, pp.1).

1.3. Barriers to traditional gardening

Okayama (2014) states that it is difficult for beginners to start gardening because they are often not familiar with the specifications, such as, the soil, weather, and pests. However, Wang and MacMillan (2013) concluded in their meta-analysis that gardening improves health and overall quality of life. It can also promote hand and body strength, especially in the elderly population and can help people with Alzhiemer's disease (D'Andrea et al. 2008).

Kolk (2018), in his study on motivations and barriers to gardening in older women, finds that health problems and pain have been the most common barrier for older women to garden. Moreover, weather conditions and accessibility to tools were also found to be amongst the major barriers. Even though nature is of utmost importance to mankind, it is a fact that almost 55% of the world population resides in cities. Rapid urbanization has resulted in a decrease in home-based gardening as well. This is because not many people leave space for green patches during the construction of their houses (Lee et al., 2023) which makes nature not easily accessible to them all the time. For this reason, the World Health Organization emphasized in their report "Urban Green Spaces and Health-A Review of Evidence" to advocate the importance of green patch spaces during construction in residential areas and its long-term impact on the mental and physical wellbeing of individuals (WHO, 2016).

Nowadays, in a modern society, people spend most of their lives indoors, especially the ones living in urban areas (Schweizer, et al., 2007). Hence, indoor plantation can be considered as an important aspect of a healthy society with a cleaner environment. Bringslimark et al. (2009) conducted a

systematic review of 21 articles and identified benefits of indoor plantation, including stress reduction. Similarly, Deng and Deng (2018) identified that indoor plantation improves the psychological wellbeing of individuals and results in better task performance as well. Whereas, Moya et al. (2019) found that indoor plants helped improve people's comfort and satisfaction with life. However, they could not find any significance between indoor plants and task performance. Min and Park (2018) suggest that indoor gardening also provide fresh kitchen ingredients which can improve the well-being of individuals.

Recent literature concludes that there is a connection between indoor green spaces and quality of life or individual wellbeing (Han et al., 2022). However, there must be afew factors to consider before planning an indoor garden, such as, moisture, air, sunlights, and variations in day and nighttime temperatures (Min & Park, 2018). This is why most people who choose gardening as a hobby sometimes find it difficult to monitor their plants due to insufficient knowledge and skills as gardeners.

Rahim et al. (2020) states that in the era of modernization, people demand that everything can become user-friendly through technology. Even though many people still use manual systems for gardening, it becomes difficult for them to monitor their progress and keep track of care instructions.

2. RELATED WORKS AND CASE STUDIES

2.1. Inclusion of technology in gardening practices

Okayama (2014) developed an advanced support system, Smart Garden, to support the decisions of gardeners. The program was ideal for beginners and supported gardeners through visualization, sensors to monitor plant growth, and using augmented reality to visualize plant care instructions.

Similarly, Rahim et al. (2020) used the Internet of Things (IoT) technology to create a "Smart App for Gardening Monitoring System". By using the app, gardeners could monitor their plantation progress and retrieve all related data on their smartphones. The most important aspect of gardening is irrigation. The app solved the problems of this aspect by providing a complete breakdown. Moreover, the app could be the most important tool to encourage indoor planting as well for beginners.

Cheema et al., (2018) used the IoT-based digital solution to track home garden projects as well. The technology was useful to retrieve real-time data on plantation progress and match it with the predefined requirements. On this basis, the app could generate suggestions on how to better take care of the plants. Min and Park (2018) also proposed a smart indoor gardening system with automated irrigation by using IoT technology. This system also used smart sensors to detect soil humidity and water levels.

Many related works have identified the need to integrate technology into gardening systems, especially indoors. However, the social aspect of said technology has been understudied by researchers. There are visible gaps in the literature between indoor gardening, modern lifestyle, technology-based solutions, and community building. For example, many studies have highlighted the importance of green spaces in rapid urbanization. Similarly, many researchers have identified the importance of technologies, such as IoT and smart gardening, to bridge the gap between modern fast-paced lifestyles and nature. However, the integration of a social aspect is still absent in recent literature. Community-building is an important aspect and a crucial component that can improve the effectiveness of the sustainability of technology-based solutions for indoor gardening.

2.2. Theoretical framework

The Bloom plantcare system is based on Puig de la Bellacasa (2017) framework for care as supported by Rajaveraja (2020). The approach is made of three dimensions: labor/work, affect/affections, and ethics/politics. The first dimension defines care in terms of working or maintenance. It requires putting in physical effort to care and maintain the life of plants. I refer to it as *doing* care which maintains life through physical efforts, such as watering the plants.

The second dimension, affect/affections, refers to care in terms of joy, boredom, and burden. It defines care in the form of feeling as opposed to the physical aspects. I relate this dimension with the reward system and the social aspect of the app. Community-building brings joy in the process of indoor plantation and can lessen the burden and boredom that comes with feeling alone in the process (Puig de la Bellacasa 2017).

The third dimension, ethics/politics, refers to the relationship between ethics and politics of everyday life. Personal ethics is closely related with the everyday decisions of individuals. Similarly, politics is related to the give-and-take relationship. I relate this dimension with certain

actions becoming obligatory as mutual care takes place between two things. If an individual is bringing in houseplants to take care of them, it will enhance the aesthetics of their house. A mutual relationship exists between the houseplant and the caregiver. Moreover, it is related to the first two dimensions. Ethics/politics is an internal thought. It is expressed in the form of feelings of joy or boredom through the action/work of caring for the plants (Puig de la Bellacasa 2017).

3. Research Methodologies

3.1. Data Organization

The project started by primarily secondary research about urbanization and indoor gardening trends, literature review, case studies and primary research regarding user behavior and relationship with non-human living entities i.e plants. Upon completing initial research, data was organized.

3.1.1. Five Whys

Fig 1 Showcasing Sequential Inquiry leading to root cause i.e traditional gardening is difficult to do in Pakistan's urbanized areas because of high maintenance

3.1.2. Empathy Map

A collaborative visualization called an empathy map is used to express our understanding of a specific user type. A conventional empathy map is divided into four quadrants. Doing, Thinking, Saying, and Feeling are these. Each of these quadrants will pose a different set of queries on the analysis of the user's viewpoint and daily tasks.

3.1.3. SWOT Analysis

A SWOT analysis shown in Figure 2 was conducted in order to analyze the market trends of users buying products for indoor planting to understand strengths, weaknesses, opportunities, threats.

Fig 2 Points Highlighted affecting Consumer

3.2. Field Study & Interviews

In-depth interviews and field research were used as research approaches in this study to provide a thorough grasp of the user demands and problems related to traditional gardening. In order to ensure a comprehensive understanding of the present practices and issues in urban gardening, a mixed-methods approach was crucial for the collection of both quantitative and qualitative data.

I interviewed a wide range of participants—including housewives and teenagers—one-on-one as part of the primary study approach to learn more about their perspectives on indoor plants. Understanding the distinctive viewpoints and difficulties encountered by various user demographics was made possible in large part by these interviews.

In the process of interviewing kids, I learned about their understanding of plant maintenance, their desire to include plants in their homes, and the obstacles they face, like lack of experience and restricted time. While many teenagers reported a strong interest in the aesthetic and environmental benefits of indoor plants, they also emphasized the need for easier-to-access materials and information to support them in taking good care of their plants.

Conversely, the interviews conducted with housewives centered on their everyday schedules and the role that indoor plants play in managing their homes. Housewives typically highlighted the decorative and therapeutic benefits of plants, emphasizing that although they valued the beauty and peace that plants brought into their homes, their hectic schedules and lack of gardening expertise frequently made it difficult for them to provide continuous care.

Rich, qualitative data from these interviews demonstrated the disparities in requirements and preferences between various user groups. The design and operation of the plant care helper device were greatly influenced by this knowledge, which made sure that it catered to the unique needs and preferences of both housewives and teenagers. Through customization of the solution to these findings, the project sought to establish a more supportive and engaged environment.

3.3. User Personas

Derived based on the results and interpretation of the interviews conducted, Two user personas were made.

A 25-year-old student named Ali symbolizes the younger generation, defined by a desire to use plants to adorn his home space, a hectic lifestyle, and little gardening skills. He is inspired by the aesthetic and psychological advantages of indoor plants and is tech-savvy, but He needs additional support and resources to properly handle plant maintenance.

A 35-year-old housewife named Saba represents a more responsible and domesticated persona. She appreciates the aesthetic and therapeutic qualities of indoor plants, but she frequently finds it difficult to care for them in the midst of her domestic duties. Saba wants to improve her living environment without requiring a lot of work or skill. She is looking for a dependable, low-maintenance solution that she can incorporate easily into her daily routine.

3.4. Research Deductions

In summary, the several research methodologies aided in providing insights and determining the ultimate design objectives and aims that would guarantee user pleasure and sustained engagement. Among these conclusions are the following:

1. **Diverse User Needs**

Varied user demographics have varied needs, according to the research. Like Ali, many teenagers and young people are primarily motivated by the aesthetic appeal and psychological advantages of indoor plants, but many also lack the time and resources to properly care for them. Housewives like Saba, on the other hand, seek a low-maintenance solution that works with their hectic daily schedules but still values the ornamental and soothing elements.

2. **Knowledge and Resource Gaps**

The two user groups identified notable deficiencies in the resources and knowledge pertaining to plant maintenance. There is a need for educational features and user-friendly technology in the plant care assistant device, since many users indicated a need for easier-to-access information and tools that make caring for indoor plants simpler.

3. **Importance of Community and Support:**

The lack of community support and shared knowledge emerged as a common pain point. Users indicated that having a community platform where they can share experiences, tips, and receive support would greatly enhance their gardening experience. This deduction points to the importance of incorporating community features into the solution.

4. **Customization and Personalization:**

Users expressed a need for devices that cater to their unique plant varieties and personal preferences, demonstrating the clear need for customization and personalization. This suggests that the gadget ought to provide individualized settings and suggestions based on the profiles of specific users and types of plants.

5. **Barriers to Entry**

Potential impediments to adoption were high initial costs and technological complexity. The plant care assistant gadget should be made to be affordable and easy to use in order to allay these worries and make it available to a wider range of people.

3.5. Solution Statement

Designing a plant care assistant device that involves the user throughout the plant care process, tracking progress and creating a community making it an interactive, engaging and learning experience for the user while fulfilling the needs of the plants.

4. Design Criteria & Ideation

4.1. Design Objectives

Before the ideation phase began, a list of design objectives was developed using the research findings as a basis. This allowed for the creation of a clear set of objectives and criteria that, in the best-case scenario, would enable maximum user satisfaction and the fulfillment of the previously mentioned solution statement. The following is a list of this set of goals:

1. Maximize User Involvement
2. Connecting user and the plant
3. Creating a sense of fulfillment
4. Fulfilling the needs of the plant
5. Maximizing Appearance
6. Cost Effective

4.2. Ideation Process

"Bloom," the plant care assistant gadget, was the result of a thorough and innovative ideation process that aimed to create a technologically advanced, user-friendly solution that specifically addressed the needs and challenges of indoor gardening. Here's a detailed look at the progression of the product idea from concept to well-executed design:

Initial Phase:

When the Bloom plant care assistant was first being designed, the goal was to create a completely automated process. The original idea focused on automation to reduce human interaction and simplify plant care. But when the design and research goals were more clearly defined, it became clear that this strategy did not support the main objective of encouraging a meaningful interaction between users and their plants.

The main study emphasized the value of user participation in the plant care procedure and the psychological and emotional advantages of active participation. The design goals, which sought to produce an engaging and engaged user experience as opposed to a strictly automated one, served as additional confirmation of this idea.

The design approach changed to put user participation first, inspired by the ideas of the Care Framework, which highlights the close and reciprocal relationship that exists between humans and the entities they care for. The Care Framework promotes a harmonious coexistence of automated support and human intervention, making certain care tasks nearly mandatory and strengthening the connection between the user and their plants.

A gadget that supports and improves human contact with plants was the main goal after this framework was incorporated into the design process. To help with this interaction, features like actionable reminders, real-time monitoring, and a community platform were included. The automated elements, such the light and watering sensors, were intended to complement rather than take the place of the operator in plant care.

Middle Phase:

Upon realizing that a wide range of plants and user preferences needed to be accommodated, the design shifted toward a modular structure. With its modular design, users can arrange plants in ways that best suit their individual aesthetic tastes and the unique requirements of each plant. This design was created to accommodate a wide range of plants. This adaptability was necessary to deliver a customized experience that could accommodate the various needs of various plant species and user preferences.

A reward system was also designed to improve user involvement and offer positive reinforcement. The intention was to include a lighting function that would turn on when a maintenance activity was finished by the user, signifying to the plant that all of its requirements had been met. This system was intended to provide instantaneous feedback.

But it became clear during the testing stage that there were issues with this reward scheme. A more subdued kind of feedback was preferred by some users who thought the illumination element was excessively bothersome and obtrusive. Some users did not find the reward system's loudness and visibility to be very acceptable, which emphasizes the necessity for a more widely accepted strategy. As a result, methods of user feedback and motivation that were less intrusive but still engaging were chosen over the idea of a prominent reward system.

The value of user-centered design and the necessity of continuing to be adaptable and receptive to user feedback were highlighted by this iterative approach. In order to better suit the requirements, the final Bloom device design changed to a modular design and rethought the incentive mechanism.

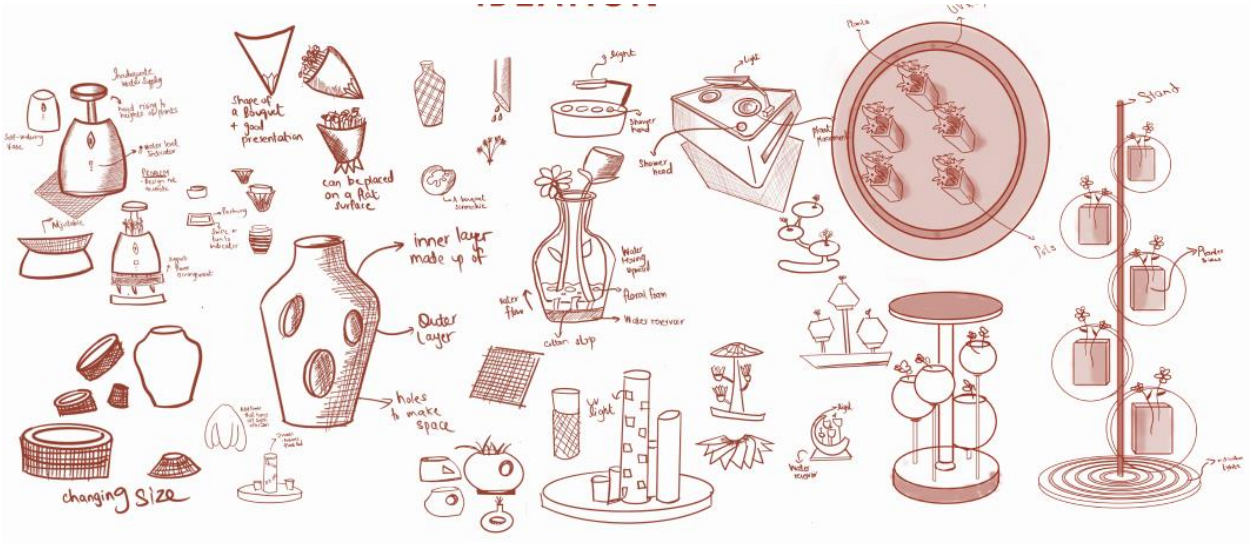


Figure 3 Development of Ideation Sketches

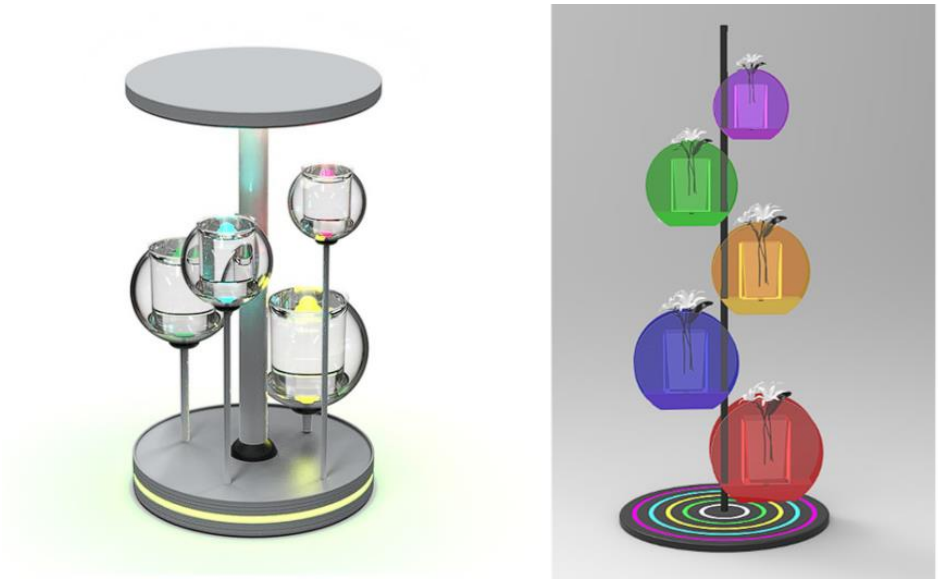


Figure 4 Development of 3D Visuals

Figure 5 More Development of 3D Visuals

5. Final Proposed Solution

5.1. Form

5.1.1. Aesthetics

The Bloom plant care assistant's aesthetically pleasing appearance is modeled after classic terracotta garden pots. Even though the gadget is made of premium plastic for longevity and user-friendliness, it yet has the traditional, rustic look of clay. This design decision offers a reassuring and recognizable visual aspect that harmonizes with the organic feel of traditional garden pots.

In order to improve the organic feel and ensure that water interacts with the surface in a manner that resembles natural terracotta, the plastic material is treated to be hydrophilic. By encouraging

better water distribution, this hydrophilic quality enhances the plant's aesthetic appeal while also benefiting its health.

The sleek, simple design of the Bloom gadget allows it to fit in perfectly with a variety of interior decor styles. Warm, earthy hues that go well with the natural feel and appearance of the product guarantee that it blends in with the organic qualities of plants while also lending a touch of sophistication to any space.

Figure 6 Final Design

Figure 7 Exploded view

Figure 8 3D Visualization in the dark

Figure 9 Scenarios

Figure 10 Scenarios

Figure 11 Scenarios

Figure 12 Scenarios

5.1.2. Intuitive Interaction:

The Bloom device's design places a strong emphasis on the user experience. It has an intuitive UI with unambiguous icons and indications that give consumers instantaneous status updates on their plants. Even individuals with little experience with technology may easily operate the device thanks to its easy controls.

5.1.3. Customization & Flexibility:

The Bloom device is offered in multiple sizes to accommodate a range of user requirements. Because of this flexibility, customers can choose the right size for their unique plants and space needs. Users are free to select the pot size that best suits their indoor gardening setup, whether it be a little pot for a single plant or a larger pot for more elaborate arrangements.

5.1.4. Engagement and Involvement:

The gadget promotes user participation that is active. By using the form and mobile application, customers can receive reminders for tasks like watering and caring for their plants, which helps to keep them involved in the process. The user's relationship with their plants is strengthened by this interaction, which improves gardening as a whole.

5.2. Features & Mechanism

5.2.1. Watering Indicator System:

One unique feature of the Bloom device is its watering indicator mechanism. The device physically pushes the glass pot up by one inch when it senses a decrease in the water level through the soil moisture sensor. The user is alerted when it's time to water the plant by this movement and blinking indicator lights. By providing consumers with timely information about their plant's requirements, our tactile and visual alarm system encourages regular and sensible watering practices.

5.2.2. Light Sensors:

Plants with integrated light sensors make sure they get enough light exposure for the best possible photosynthesis. To help maintain perfect lighting conditions, the device can notify users when a plant needs to be moved to a brighter or shadier position.

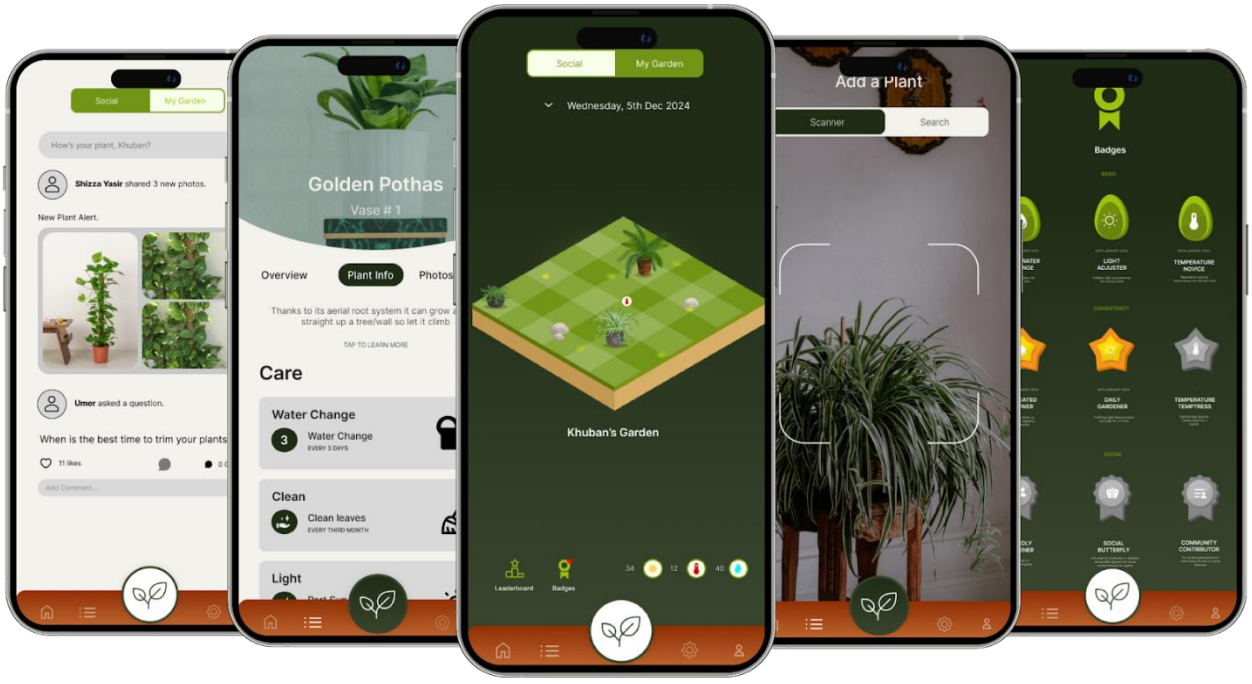
5.2.3. Moisture Detectors:

Real-time information on the moisture content of the soil is provided by soil moisture detectors. Through the mobile app, users may access this information, which improves their understanding of the demands of their plants and enables them to modify their care routines accordingly.

5.2.4. Subtle Feedback System:

The gadget now has subtle indicators that provide feedback on care duties in place of a conspicuous lighting reward system. To show that all requirements have been met, for instance, a tiny, soft light might glow, providing a sense of fulfillment without being bothersome.

5.3. Enhancing User Experience through the app



5.3.1. Real-Time Monitoring:

With real-time access to information on soil moisture, light exposure, and general plant health, users can keep an eye on the wellbeing of their plants. Better care practices and prompt interventions are made possible by this.

5.3.2. Care Reminders:

Depending on the individual requirements of each plant, the app sends out reminders for watering, feeding, and other maintenance tasks. By encouraging users to stick to a regular maintenance schedule, these reminders help users' plants flourish.

5.3.3. Virtual Garden Mini-Game:

The software has a virtual garden mini-game to add interest to the task of caring for plants. Users can cultivate a virtual garden that replicates their interactions with plants in the real world. Points are earned in the virtual garden by doing care duties in the real world, such watering and adjusting lighting. You can use these points to unlock garden expansions, decorations, and additional plants.

5.3.4. Rewards and Badges:

Users can obtain different badges and awards as they finish tasks and accrue points. Adding a gamified element to plant care makes it more engaging and enjoyable. Users can compare their progress with friends' and other plant enthusiasts' on a leaderboard, which promotes friendly rivalry and a sense of community.

5.3.5. Community Platform:

Through the app's community feature, users may interact with other plant lovers. This platform creates a friendly and active community around indoor gardening by offering a place for advice exchange, problem solving, and success celebration.

5.3.6. Educational Content:

The app provides instructional materials, such as videos, articles, and advice on taking care of plants. Users can increase their knowledge and sharpen their gardening skills by using this resource.

6. Material Research

Through careful material selection, the intelligent hydroponic planter is painstakingly created with an emphasis on longevity, sustainability, and aesthetic appeal. Recycled high-density polyethylene (HDPE) plastic was used to create the body and structural elements because of its high tensile strength, resilience to impact, and chemical resistance, all of which contribute to

long-term durability and lightweight handling. In addition to lowering energy use and plastic waste, this use of recycled HDPE promotes a circular economy. Because borosilicate glass is so strong, transparent, and resistant to heat, it makes it easy for users to keep an eye on the water level and preserve the reservoir's sleek, contemporary appearance. Because borosilicate glass is chemically inert and completely recyclable, it is safe for the environment and plants. The sensor and actuation parts are made of cutting-edge electronics and premium metals.

7. Prototype Development

Fig 14 3D Printing of Parts

Figure 15 Prototype Development

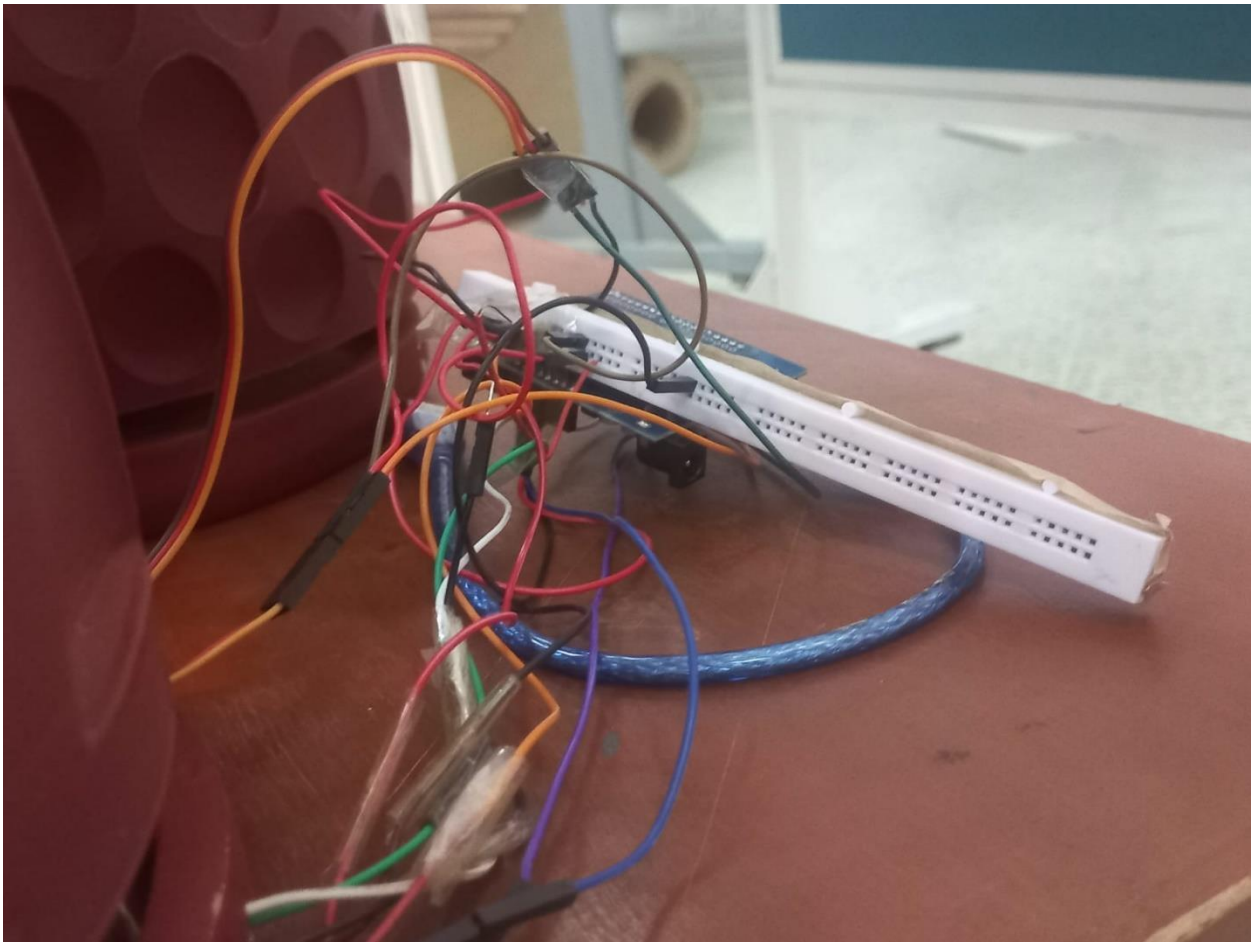


Fig 16 Electrical Component Closeup

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