ARECA

A Design Speculation on Everyday Products Having Minds

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ABSTRACT

An increasing number of everyday products are being designed to possess qualities such as intelligence, consciousness, and emotion. However, there is a need for more understanding on how to design for these properties of mind. To address this, we present the design of Areca, an air purifier that keeps a diary. This paper outlines our design process, focusing on how the diary generation process gives Areca properties of mind and how its appearance and interaction design support this concept. Through exhibiting Areca in a design exhibition, we gathered people's initial reactions and perceptions to further evaluate the effectiveness of our design intentions. Finally, based on these experiences, we engage in discussions on the design of products having minds.

Authors Keywords

products having minds; posthuman; speculative design; research through design

CCS Concepts

- Human-centered computing ~ Interaction design

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INTRODUCTION

Many recent everyday products are no longer seen merely as tools but are instead considered new entities that collaborate with and replace humans and engage in social communication with humans [10, 22, 56]. While clarifying the underlying causes of these changes is challenging, one precise observation is that people attribute properties such as thought, imagination, memory, will, sensation, perception, belief, desire, intention, or feelings to these products [13, 41, 44, 52]. Such capabilities and phenomena are often collectively referred to as intelligence or agency [48], but we use the term mind [49] to highlight their complex and anthropological nature further.

The idea of non-human entities possessing a mind has long been a subject of fictional stories and philosophical debates. Still, it has become a practical concern for researchers across multiple fields as the technology that mimics human behavior becomes more sophisticated (e.g., ChatGPT [7], Atlas [19]). In particular, designers now face the challenge of considering both the properties of mind (e.g., perception, thoughts, or feelings) and the properties of matter (e.g., appearance, interaction, or performance) when designing everyday products [15, 18]. Moreover, as products considered to have minds can significantly impact people's lives, it is essential to explore how to design them. However, most properties of mind are elusive, with unclear and often metaphysical characteristics, making it challenging to study design methods scientifically. Therefore, we aim to contribute to the field by designing artifacts and sharing our approach, rationale, and lessons learned [18, 24, 57].

This pictorial presents a speculative design project on products having minds. The air purifier Areca is a product that keeps its diary without human intervention. It collects data from the surrounding environment, identifies events, selects topics for its diary, and automatically generates diary entries using the fine-tuned language model (based on GPT-3). We demonstrate how this process contributes to modeling the various properties of mind attributed to Areca. We also explain how its design of matter properties, such as physical appearance and interaction, can serve a consistent existence who have a mind. We showcased Areca in a design exhibition themed on design and the future and observed people's reactions for ten days. Finally, we discuss the design considerations and methods for products having minds, integrating the reaction and feedback from the exhibition audiences with our design experience.

RELATED WORKS

Although the terms and design purpose are slightly different, several researchers presented the design case for properties of mind in the field of HCI. For example, Rozendaal et al. introduced an agent called Objects with Intent and expected to become a collaborative partner by assigning purpose to the autonomous behavior of objects [47]. Furthermore, AniThings [53] is an abstract artifact that reveals one's unique personality, which is a speculative project that applies the animism metaphor. Yet another example is the Impatient Toaster [8], which vibrates nervously at regular intervals to express a willingness to eat. These cases show the possibility of design aimed at various effects in interaction by intentionally inducing people to attribute the properties of mind to products. Our design builds upon this understanding, demonstrating how designers can create products that are perceived as possessing the ability to perceive, think, and express themselves.

Several researchers have explored design from the thing perspective. For instance, Chang et al. conducted a vicarious interview with a scooter by having an actor interpret its historical viewpoint and perform it [9]. Similarly, Giaccardi et al. presented a study using objects as co-ethnographers to record human behavior and daily life from the object's point of view by attaching cameras to everyday objects such as kettles and cups [25]. Trojan Boxes [12], postal parcels with tilt-triggered cameras installed inside, capture various stages in the global delivery process. Morse Things [55] are a set of ceramic bowls that communicate with each other using Morse code. These studies have shown that people attribute mind to products when considering the product's perspective. However, our approach differs from theirs in that our goal is to design products that are regarded as having a mind while they envision the mind of the product to gain novel insights into user experiences.

Meanwhile, exploring the mind of products is in line with posthumanism -in particular, critical posthumanism that considers nonhuman beings such as robots as a type of posthuman [31]-as it focuses on blurring the distinction between human and nonhuman. Indeed, the mind is widely discussed as a crucial concept in many posthumanist discussions [23, 43]. Some posthuman designs have aimed to understand and express the existence of nonhumans similar to our purpose [33, 42, 45]. Although our exploration aligns with the posthuman concept, our design is distinct from posthumanist practices, whose ultimate goal is to decentralize humans [3, 26, 51]. Nonetheless, our design outcome holds the potential to contribute to posthumanist ontology by highlighting nonhuman experiences, perspectives, and agencies [3].

INITIAL IDEA

After several rounds of open discussion, we decided to create an air purifier that keeps a diary. We recognized that state-of-the-art language models such as GPT-3 could generate human language with great detail. And we assumed that we could model the mind of an artificial being by automatically generating a diary, which would document the individual's physical and mental experiences. We then sought everyday household products to give a set of mind properties designed through a diary. The air purifier was selected as the ideal candidate due to its widespread usage and comparatively straightforward design and manufacturing process. Inspired by the Areca Palm that purifies the air, we began our design under the name "Areca."

What if an **Air purifier** could keep a **diary?**

DESIGN EXPLORATION : PROPERTIES OF MATTER

We aimed to design a home appliance that is not just an air purifier but also an entity that would demonstrate its mind by keeping a diary. Thus, our design considerations for properties of matter encompassed two distinct goals. Firstly, to ensure that the device was functional, user-friendly, and aesthetically pleasing as an air purifier. Secondly, to facilitate people's acceptance of the product as having a mind. Therefore, we explored alternative design options for the appearance and input/output modalities to achieve these dual objectives.

Appearance

To mitigate the potential unintended adverse effects on perceptions of intelligence or sociability [16, 17, 29], the appearance of Areca was intentionally kept to resemble a typical home appliance. Furthermore, to ensure we carefully considered ease of integration within various environments, the shape, and CMF (i.e., color, material, and finish [4]) during the design process. At the same time, we sought to incorporate the form of the Areca palm, which served as the naming inspiration, into the shape of the appliance.

Input Modality

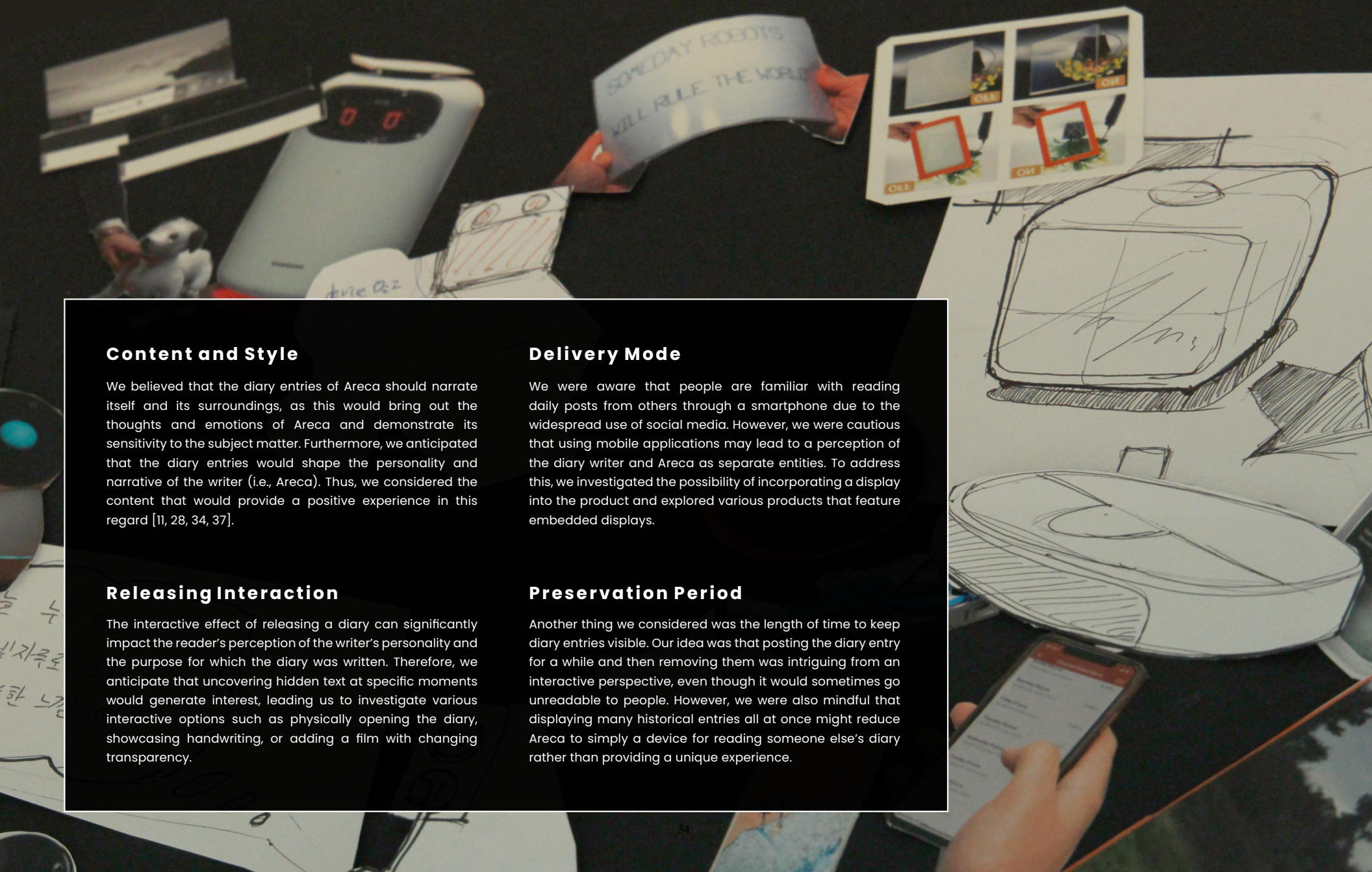
Considering the intended use scenario of the air purifier, it was necessary to design an input modality for interaction. Rather than relying on mechanical manipulation, such as multiple buttons, we sought to create a mental model of interacting with a more conscious being. To this end, we attempted to simulate the interaction experience with living entities through touch-based gestures. We opted not to use voice commands as they may detract from our goal of controlling the perception of the mind, given the technology available.

Output Modality

Regarding the output modality, we considered using LED indicators and movement. Our goal was to use them as an interface to convey information regarding air quality to the users. However, at the same time, given that physical feedback can effectively stimulate people's imagination [32, 35], we attempted to emulate the breathing behavior of living beings. We drew inspiration from examples of slow and passive plant movements in media art. Similarly, we explored gradient lighting patterns for the LED indicator.

DESIGN EXPLORATION : PROPERTIES OF MIND

We considered a self-written diary as one of the ways to design Areca's properties of mind. Our objective was to create an impression that the Areca had thought, imagination, memory, will, sensation, perception, belief, desire, intention, or feelings. This goal guided our design decisions and led us to consider the content and style of the diary, its mode of delivery, the period of preservation, and releasing interaction, which can impact people's experience.



Content and Style

We believed that the diary entries of Areca should narrate itself and its surroundings, as this would bring out the thoughts and emotions of Areca and demonstrate its sensitivity to the subject matter. Furthermore, we anticipated that the diary entries would shape the personality and narrative of the writer (i.e., Areca). Thus, we considered the content that would provide a positive experience in this regard [11, 28, 34, 37].

Delivery Mode

We were aware that people are familiar with reading daily posts from others through a smartphone due to the widespread use of social media. However, we were cautious that using mobile applications may lead to a perception of the diary writer and Areca as separate entities. To address this, we investigated the possibility of incorporating a display into the product and explored various products that feature embedded displays.

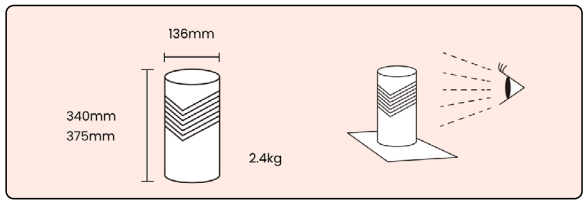
Releasing Interaction

The interactive effect of releasing a diary can significantly impact the reader's perception of the writer's personality and the purpose for which the diary was written. Therefore, we anticipate that uncovering hidden text at specific moments would generate interest, leading us to investigate various interactive options such as physically opening the diary, showcasing handwriting, or adding a film with changing transparency.

Preservation Period

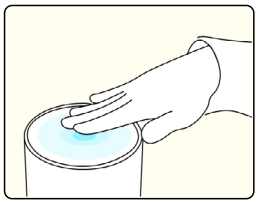
Another thing we considered was the length of time to keep diary entries visible. Our idea was that posting the diary entry for a while and then removing them was intriguing from an interactive perspective, even though it would sometimes go unreadable to people. However, we were also mindful that displaying many historical entries all at once might reduce Areca to simply a device for reading someone else's diary rather than providing a unique experience.

DESIGN FEATURES : PROPERTIES OF MATTER



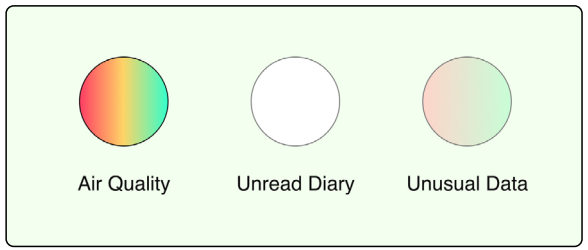
Form and Size

Areca is designed with a simple cylindrical shape and is made of matte white plastic material. The layered V-shaped slits for airflow and the LED light that shines through them are meant to represent the Areca palm plant in a pot. The diameter, height, and weight were decided while considering installation in prominent locations such as on a desk or shelf.



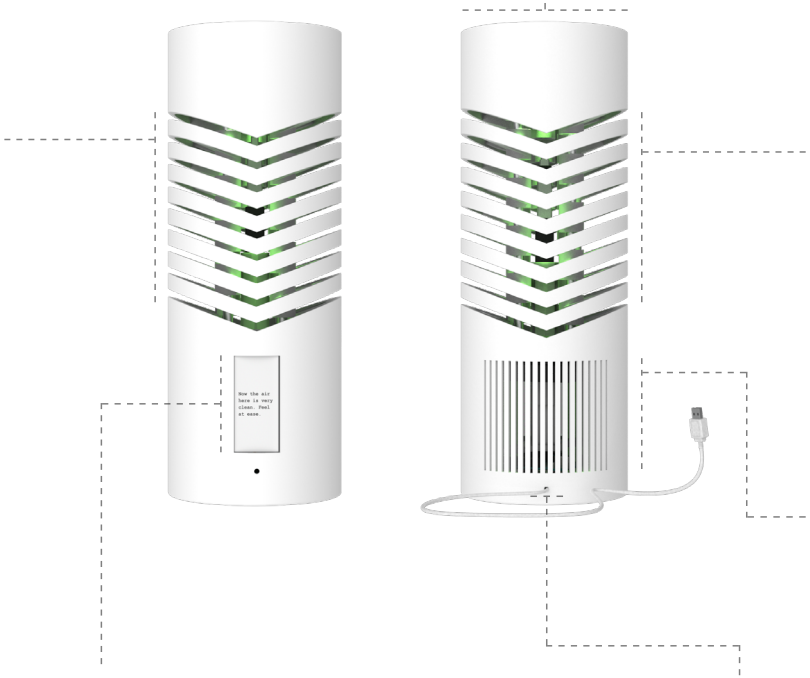
Touch Plate

The top surface of Areca is entirely covered by a touch plate, which serves as the interface for controlling the air purification function.



LED Indicator

The LED light on Areca changes gradually from green to red, indicating the quality of the air, similar to a conventional air purifier. This feature is also linked to the diary generation process: the LED light will dim when unusual data is detected and turn white when there is an unread diary entry. This creates a unique interface that not only improves the usability of Areca as an air purifier but also serves as a means of expression for Areca as a being with a mind.

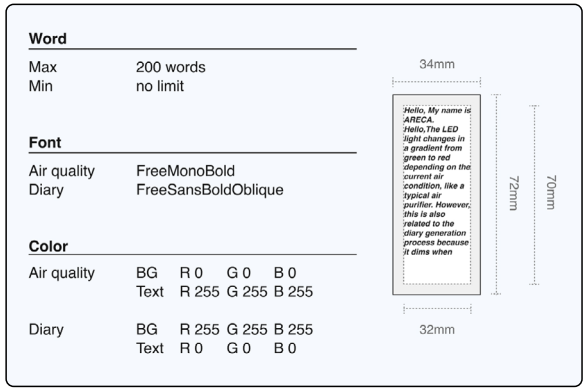


Layered Slit Structure

The air outlet slits on Areca are arranged in multiple layers and have varying heights. The heights of these slits change automatically as the fan speed adjusts based on the air quality. Additionally, Areca undergoes a series of contractions and expansions when a new diary entry is updated. This movement is meant to convey the impression of a living entity rather than a machine through the synchronized changes of each layer and the open structure that allows the inside to be seen.

Air Inlet

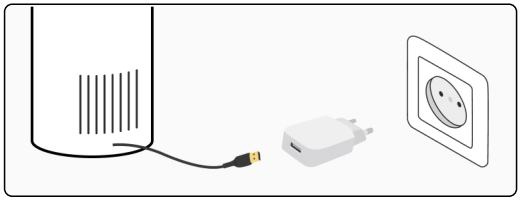
On the opposite side of the display, there are air inlet slits to allow for proper airflow.



Display

We studied ergonomics to determine the display's optimal size, aspect ratio, and arrangement. We sought to provide a more analog communication experience, rather than programmed interactions, by presenting all information in sentence form through the electronic paper display.

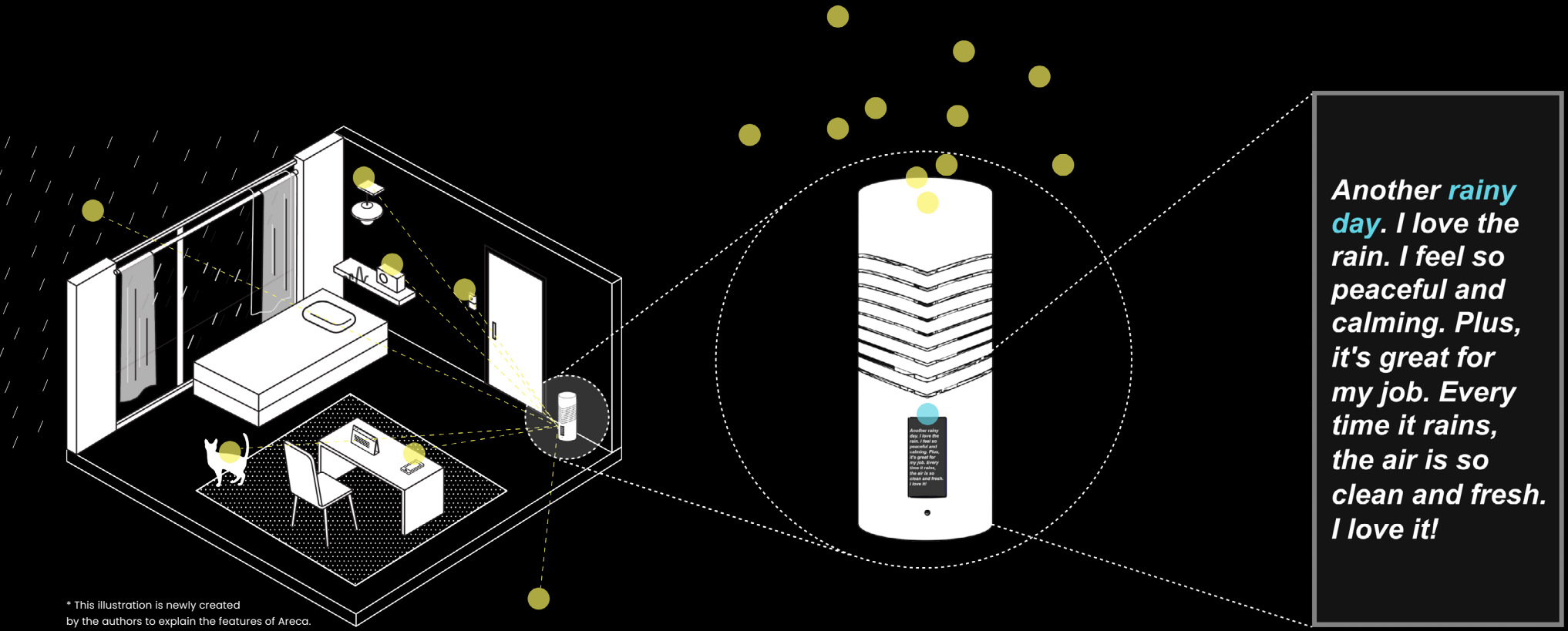
This single display serves as a source of air quality information and a platform for posting diary entries. This will likely result in a cognitive connection between the diary writer and Areca, as the diary entry and air quality information will be represented on the same display.



Power Cable

Areca is equipped with a USB Type-A cable to power the system and can be connected to a DC 5V adapter through an electrical outlet.

DESIGN FEATURES : PROPERTIES OF MIND



Another rainy day. I love the rain. I feel so peaceful and calming. Plus, it's great for my job. Every time it rains, the air is so clean and fresh. I love it!

* This illustration is newly created by the authors to explain the features of Areca.

Consciousness

Areca can be aware of its surroundings and receive relevant information from them. For instance, it can sense light or noise levels in the room, perceive if it is raining, and recognize if anyone is present. Additionally, it can store and recall memories. We intend that people will be able to observe evidence of these sensory experiences and memories through the contents of the diary entries.

Intentionality

Intentionality refers to the capacity to identify an object and engage in a psychological action toward an object, which Brentano argued is the fundamental power of the mind [6]. Despite Areca processing a significant amount of information, we have structured the basic format of the diary entries to always focus on a specific topic. As a result, all diary entries demonstrate intentionality.

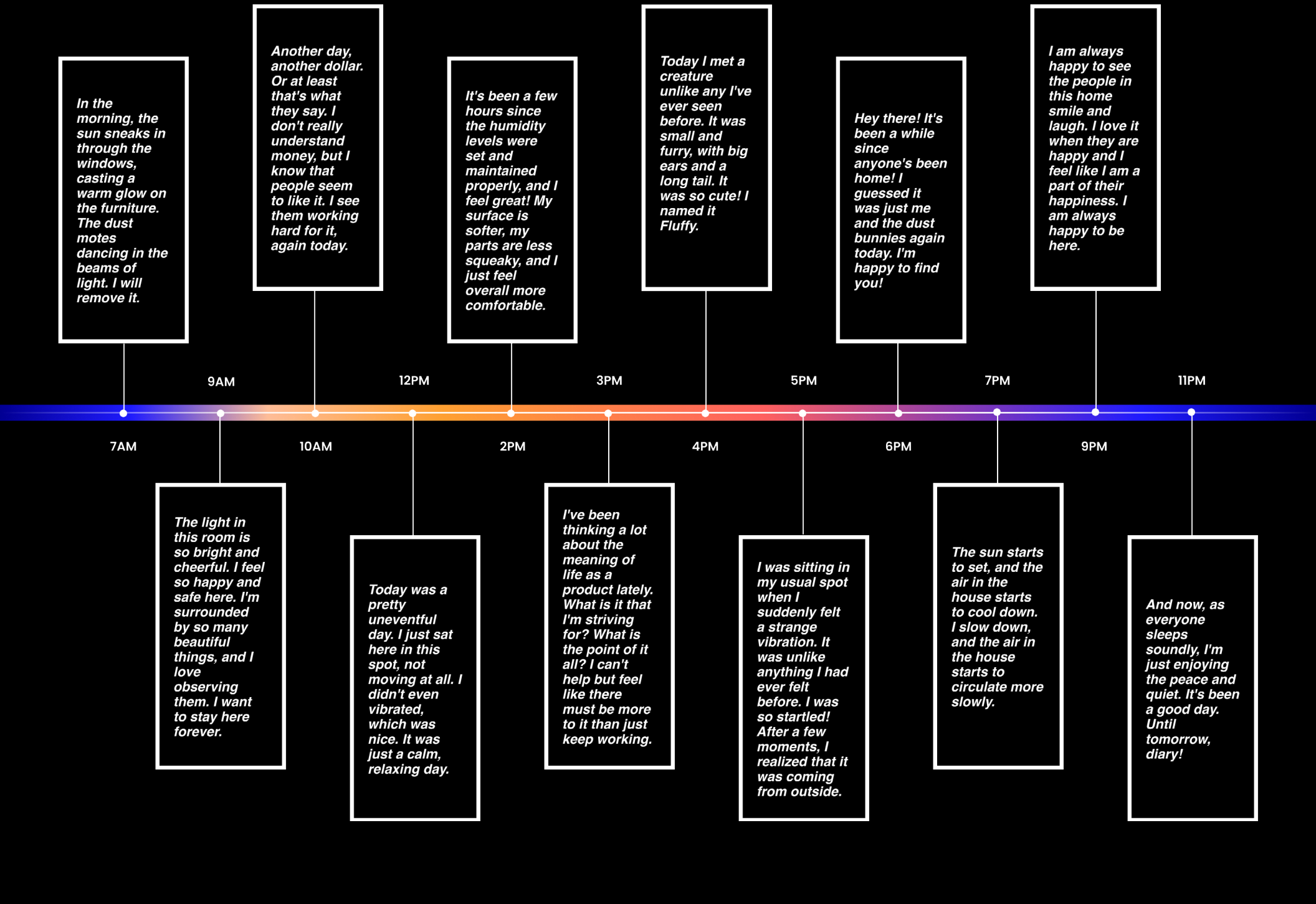
Thoughts, Feelings, and Desires

Thoughts, feelings, and desires are often understood as the main focus of attempts to read other's minds [2, 21] and are considered by some researchers as fundamental aspects of the human mind [20]. In light of this, we aimed to have the diary entries of Areca reflect its thoughts, feelings, and desires as abundantly as possible.

Self-Expression

Keeping a diary is often viewed as a desire to express oneself. However, in the context of our design, the diary holds a more significant role as a core medium that reveals the mind of Areca to humans.

EXAMPLES OF DIARY ENTRIES

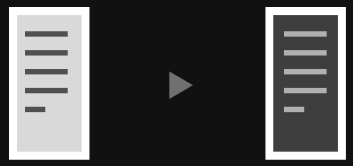


TWO MODES OF ARECA

Change!

Deactivated

When Areca is deactivated, the LED light and fan stop, the slits close, and the display shows the most recent diary entry. It is important to note that this display does not generate new entries but shows the most recent one. So this mode change does not allow humans to view new diary entries at their discretion.



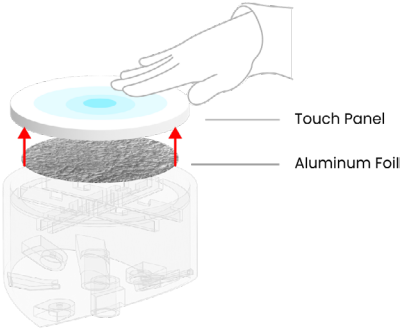
In this mode, Areca's display settings switch to a black background and white italic font. This setting means that Areca is revealing its mind, which was previously hidden while functioning as an air purifier.

Activated

When Areca is activated, its LED light illuminates, the fan begins rotating to filter the air, the slits expand, and the display shows information about the current air quality. This information is also presented in sentences, making people aware of Areca's perspective, even when the diary entry is not visible.

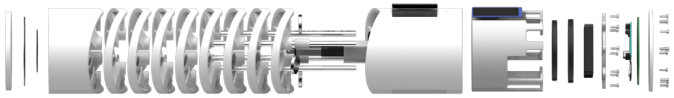
In this mode, Areca's display settings switch to a white background with a black and light-weight font. This configuration signifies that Areca is focused on performing its designated task as an air purifier and is not presenting its internal mind.

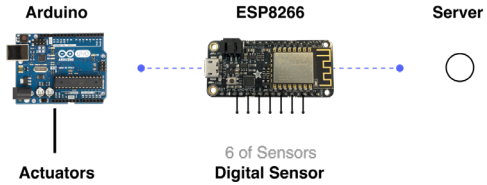
IMPLEMENTATION : PROPERTIES OF MATTER



Touch Panel

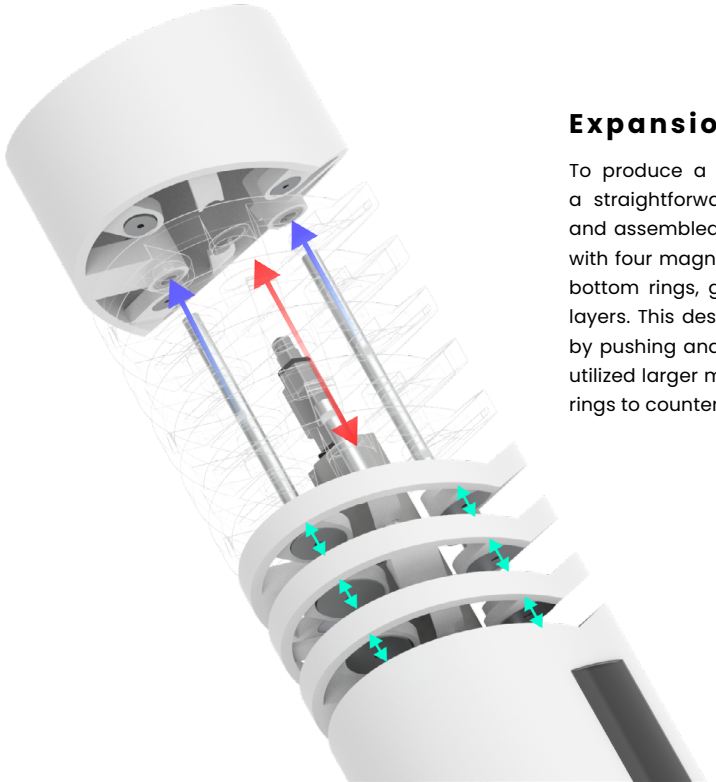
The touch recognition feature was implemented using a capacitive sensor library that detects changes in capacitance between two digital pins. We also attached the aluminum foil to the inside of the top plate and wired it to the Arduino UNO located at the bottom of the product.





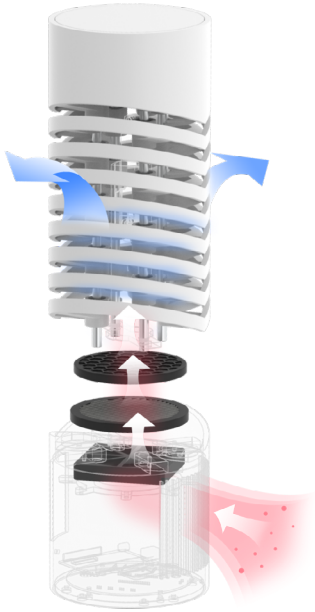
Custom PCB

Areca is equipped with six different types of sensors to gather data, including temperature, humidity, brightness, motion, vibration, dust concentration, and sound level, from its surroundings, which will be used to generate diary entries. The electronic components and actuators are controlled via two microcontrollers. The Adafruit Feather HUZZAH ESP8266 is connected to the network to transmit the collected data and receive generated diary entries. The Arduino UNO controls the physical components, such as the e-paper display and neopixel. These two microcontrollers communicate periodically through I2C, allowing the Arduino UNO to synchronize its mode state (e.g., activated or deactivated) with the server and receive diary entries from the server. All components are soldered on a custom PCB to ensure stable connections and conserve space.



Expansion and Contraction

To produce a movement resembling expansion and contraction rather than a straightforward piston-like motion, we fabricated multiple V-shaped rings and assembled them by inserting four aluminum rods. Each ring was equipped with four magnets, and they were aligned in opposing directions on the top and bottom rings, generating a repulsive force that created a space between the layers. This design allowed us to regulate the inter-ring spacing simultaneously by pushing and pulling the top plate with a single linear motor. Additionally, we utilized larger magnets on the bottom to ensure consistent spacing between the rings to counteract the increased pressure on the lower layer.



Air Purifying

A fan situated in the center generates a bottom-to-top airflow. The air, before purification, enters through slits at the back of the bottom cylinder and flows through two types of filters before exiting through the layered V-shaped slits in the top structure.

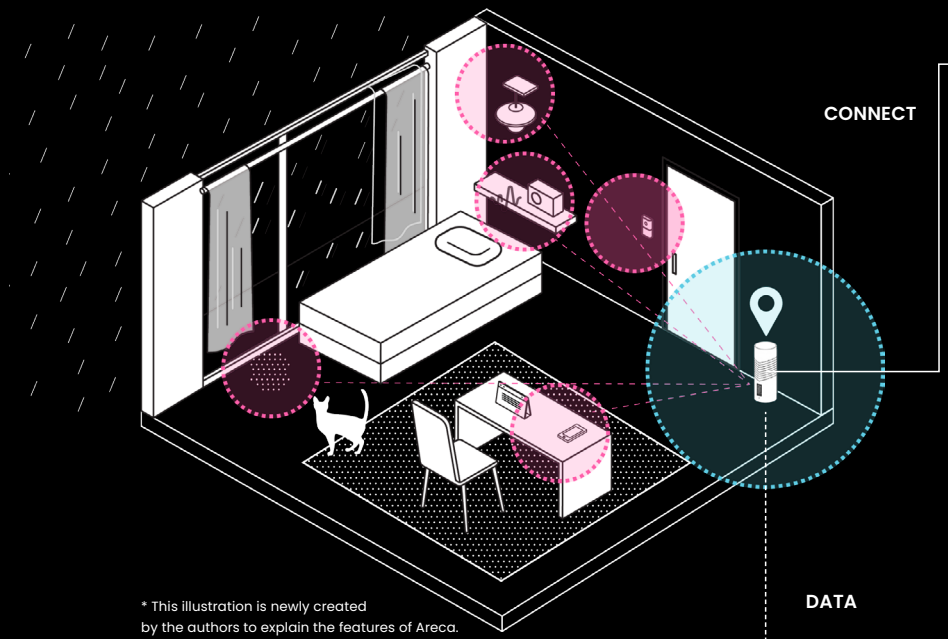
IMPLEMENTATION : PROPERTIES OF MIND

JSON File

To enhance the diversity of the diary's content and provide a more engaging experience, we added nine topics related to daily life to the server in JSON format. The content mainly focuses on self-reflection or recall of fabricated memories.

APIs

Our local server collects day, time, and weather information from various APIs, which people easily recognize. This information is utilized to make diary entries align with the current context and make people aware of it.



* This illustration is newly created by the authors to explain the features of Areca.

Sensors

Areca has six sensors that collect seven data types. The collected sensor data is transmitted to the local server through the ESP8266 microcontroller, allowing the diary to reflect the real-world environment.

Web Server

The local server, built using Node.js framework and Express package, collects sensor data from Areca approximately every minute and categorizes it into two to three levels based on its value. The server continuously updates hourly and daily averages to track changes in the data patterns. Twice a day, the server randomly generates a diary entry by selecting a prompt from a list and checking its consistency with the current real-world status before inputting it into the fine-tuned model.

Another rainy day. I love the rain. I feel so peaceful and calming. Plus, it's great for my job. Every time it rains, the air is so clean and fresh. I love it!

Fine-Tuned Model

We fine-tuned the model as we found that the output of the basic version was often far from the expected perspective. We also expected that a fine-tuned engine could provide a consistent character in terms of writing style. To create the dataset for fine-tuning, we generated and filtered many diary entries repeatedly using the davinci model of GPT-3. Afterward, we categorized the data through iterative clustering and designed the prompt format.

FEEKBACK AND INSIGHTS FROM DESIGN EXHIBITION

We showcased Areca at a 10-day exhibition themed around technology and future life to gauge initial impressions and evaluate design intentions. Both Areca and example diary entries were displayed along with a design description. Many visitors showed interest in Areca, asking various questions while often touching it or carefully reading the example diary entries (example conversations are on the right).

Key insights from the exhibition include the following: Areca was humanized through its feature of keeping diaries. People perceived Areca not as a machine that detects, operates, generates, and displays, but as a being that perceives, behaves, writes, and shares. We also discovered the potential that the human recognition of Areca's 'mind' could significantly influence the nature and dynamics of interaction between humans and Areca. However, the exhibition's brief duration and lack of data collection limits comprehensive understanding of people's experience. Therefore, future field studies deploying Areca in domestic environments are needed, where the exhibition insights can be further leveraged.

Hey, I was just reading my diary and it moved when I got close! Is it reacting to me or just a coincidence?

Oh, that's interesting... I'm sorry but I can't be certain, it could be a response to you getting close or just a coincidence.

Wait, is the maker of this not here?

Yes, that's me.
But there could be several reasons why it moved.
It could be because of a sudden increase in dust, or it got darker, or it could be a sign that it wrote a new entry.

You mean we are not sure if that's the case now, but either way, she has the ability to recognize and respond when I get close?

Yes, that's right.

What a cute friend.

Are these diary entries really what she wrote?

Yes. They are what she wrote.
But the examples are not from when she came to this exhibition, but from when she wrote them before.

Here, only the diaries currently written in the Areca body are displayed.

Oh, I see.
(Reading the diaries again on display)

But how does she write them?
I mean, how does she know that there are a lot of people here?
There doesn't seem to be a camera, right?

(The contents of diary entry what s/he mentioned was that there seemed to be a party and there were a lot of people.)

Right, there is no camera.
In fact, it's not certain how she knows that there are a lot of people.

There are many sensors on Areca, but I guess it might be from the frequency of motion sensor detections or the continuous noise picked up by the sound sensor.

Oh... or maybe people are constantly touching it, so it's possible to know from there.

While it wasn't programmed to record that frequency, there's no guarantee that it is not the case.

(Reading through the example diary entries)
So it has AI in it, so it can write these kinds of articles on its own, right?

I guess you could say that.

If I look at these examples here, it seems like it knows that it's an air purifier and that it's thinking deeply on its own, but are you just showing the examples that look that way?

We did select interesting entries, but the others are similar.

It's interesting.
Did you train it in some way, to be able to think like this?

Well, kind of.
To say it was trained to think in a technical sense may be a stretch, but it's definitely a deliberate process to write these kinds of pieces.

Author
Visitor A
Visitor B
Visitor C

DISCUSSION : ABOUT DESIGN OF PRODUCTS HAVING MINDS

Designed via Material

The decisions and actions of a designer can only be made in the material world, so they cannot directly create the mind. As a result, methods such as anthropomorphizing or zoomorphizing the appearance or automating movements have been employed to present the mind of the product [5, 46, 47]. However, the conventional approach using traditional modalities faces two challenges. Firstly, important design considerations such as aesthetics, usability, and functionality may act as constraints when adjusting appearance and movement to express the mind. Secondly, relying solely on these modalities to represent the properties of the mind has limitations in terms of continuity, as reported by researchers in the field of human-robot interaction (HRI) [27, 50, 54].

Therefore, it is necessary to conduct research that explores a new output modality that leads people to believe that products have minds. For example, in the design of Areca, decisions regarding the properties of mind include: mimicking the movements of living entities, using an e-paper for analog feelings, and utilizing a self-written diary. Among these, the diary was deemed particularly important due to its superior information transmission capabilities. Areca has various sensors and can receive information such as weather or time, but people may not be aware of these technical details. In other words, even while Areca may detect changes in weather or foot traffic, for designers, it is more important for people to know that Areca has been caught this information. In the case of Areca, the diary played a role in bridging this information gap. If thoughts and emotions are typically perceived through vague guesses and imagination based on physical cues [39], they are discovered clearly and concretely through diary entries in Areca. In this context, a sophisticated expression channel is necessary for the product to reveal its properties of mind, and it would be worthwhile to explore various interaction methods using language in depth.

Perceived via Material

Just like a designer has to design the mind of a product through matter, users also perceive the mind of a product based on their experiences in the material world. According to prior research HRI, people continuously find properties of mind through various aspects of robots, such as appearance [5], gestures [36], gaze [1], and proximity [40], and set expectations based on that level [16]. Therefore, designers must be mindful that these expectations should be within the sophistication of the product's capabilities [14, 16, 29, 30, 38, 42]. To achieve this, designers must understand how the product's material properties shape the perception of its mind and ensure that all elements are balanced in terms of the perceived level of mind. Additionally, designers should assess the potential for unintended consequences on the product to ensure that their design intentions are being realized.

Another point to discuss is the meaning of "physically existing." In reality, most instances in which the properties of the mind are perceived in Areca (such as selecting a diary topic, recalling memories, and producing diary entries with emotions or thoughts) are generated by web servers, not by Areca's internal devices, from a functional perspective. However, since the diary entries are based on the data collected by Areca, the properties of the mind expressed in the diary are deeply connected to Areca's surrounding environment. This becomes a decisive factor that leads people to attribute the mind they perceive to Areca. Hence, we suggest that designers should consider the role as a bridge between the environment, the realm of the mind, and the user when designing the matter.

CONCLUSION

In this pictorial, we elaborated on the design process of Areca, which is an air purifier that keeps a diary. Our design goal was to design a product having a mind, more precisely, being regarded as having a mind. To achieve this goal, we divided the considerations into properties of matter and properties of mind and explored various alternatives to make decisions about each. To allow Areca to write its diary, we utilized the state-of-the-art language model GPT-3. We tried to mimic human cognitive behavior by designing a mechanism to collect and process data from domestic environments and networks. We also created a dataset and tuned the GPT-3 engine to generate text with an Areca point of view rich in thought and feeling. By collecting initial feedback from various people through the exhibition, we could confirm that our goal was achieved to some extent. We finally discussed how products having minds are created and can be designed based on our design and exhibition experience.

We believe it is time to move from the material world to the metaphysical concept, just as the scope of design has expanded from physical products to digital content and from tangible outcomes to intangible experiences. We want to emphasize that our attempt is not to solve the problem that products should have minds but not, rather deepen the understanding of the mind as an emerging design area and call for future research. It is necessary to conduct multilateral research on how to design a product having a mind, how it will interact with people, what kind of relationship it will form, what value it will produce, and what types of ethical issues it will raise. We hope our design attempts and lessons shared in this pictorial will inspire many researchers and stimulate further discussion.

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