An Anthropomorphic Human-Plant Interaction Design: Bridging the Perceptual Gap

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Abstract

Human-Plant Interaction (HPI) relates to the design of technology-mediated coexistence with plants, with a focus on bringing forth mutual benefits from symbiotic relationships. It addresses ethical concerns, different design approaches, and technical aspects. We discuss an anthropomorphic interactions with an HPI artifact, consisting of a plant equipped with environmental sensors and an LLM system to communicate with humans in natural language, in order to obtain care based on the quality of the environment of the plant. With this research, we want to investigate how to improve the interaction design of this artifact, taking into account ethical concerns in the expression and elicitation of care by the plant, using human-centric approaches that address both the well-being of the plant, and the awareness of the biological entity's agency.

CCS Concepts

• **Human-centered computing** → *Empirical studies in ubiquitous and mobile computing*; **Interaction design theory, concepts and paradigms**.

Keywords

Human Plant Interaction, Ubiquitous Computing

1 Introduction

Human-Plant Interaction (HPI) is a subfield of Human Computer Interaction (HCI), especially affected by cross-species ethical concerns, since living entities are involved in the designs. When applied to domestic contexts, HPI has the potential of increasing social cohesion [1], and studies show that plant care reduces depression and stress in human life [10]. Although past research has demonstrated a variety of multimodal interaction methods for HPI, aimed to express plant needs to humans and thus elicit caring behaviour (e.g. high and low-fidelity displays, automated IoT-based systems), communication through natural language is not sufficiently explored. We present preliminary evaluation of an HPI artifact based on a conversational user interface and reflect on valorizing the agency of the non-human entity in a post-human paradigm.

2 Anthropo-morphism/centrism in HPI

Anthropomorphism is the process of attributing human-like characteristics, intentions, and emotions to non-human agents like plants. According to Epley et al. [4], this functions as a form of inductive inference, where we use our own self-knowledge as an "anchor" to understand unknown entities. Since the biological timescales and chemical needs of plants are "alien" to us, anthropomorphism translates these complex states into familiar concepts—such as describing a dry plant as "thirsty"—to make their needs more predictable and foster social connection. Current research in Human-Plant Interaction (HPI) often focuses on interdependency and the ethical imperative to meet a plant's needs through "More-Than-Human" design. However, many projects remain tethered to human-defined goals [2], while others use plants merely as mediators for human social interaction [3]. This creates a tension for researchers pursuing post-anthropocentric approaches, which aim to decenter the human perspective and truly valorize the independent agency of the plant. Ikeya et al. [7] identify two primary strategies for bridging the gap between humans and plants. The first involves direct response, where bio-electrical signals from the plant are translated into human-perceivable effects, such as visual changes in a VR space [6]. The second focuses on environmental interpretation, where sensor data is used to assign the plant a "mood," like tiredness or thirst [9]. While these methods help communicate a plant's state, the use of rich, natural language interfaces in these interactions remains largely unexplored.

3 The Talking Plant Artifact

We developed an HPI artifact (Talking Plant - TP) that gives a human voice to a *Monstera deliciosa* plant, so that it can express its needs and elicit the care it needs via a conversational user interface (Fig. 2) [8]. TP is an anthropomorphic, human-centric design where the plant is equipped with environmental sensors that inform the natural dialogue that the plant can undertake with humans. As such it belongs to the second previously mentioned category proposed by Ikeya [7]. More explicitly, we use a Large Language Model to enable human-like conversations between human and plant: the user can directly ask the plant about its state, and obtain information and feedback on care interactions, depending on data from the sensors (see Fig. 2).

3.1 Hardware

The core of the system is a *Raspberry Pi 4 Model B* functioning as an IoT node, responsible for collecting and managing real-time data from environmental sensors embedded in the plant pot, as well as rendering visual output on the connected display. Data are collected from three sensors: Capacitive Soil Moisture Sensor SENO0193 for monitoring water needs; Temperature & Humidity Sensor DHT22 – SEN0137, and; Ambient Light Sensor VEML7700 – SEN0228. Furthermore, the Raspberry Pi is connected to a display which shows animated emoticons representing the plant's feelings and needs, in order to attract human attention and begin a conversation. On the display, a QR code is shown. A user can scan the QR code with their

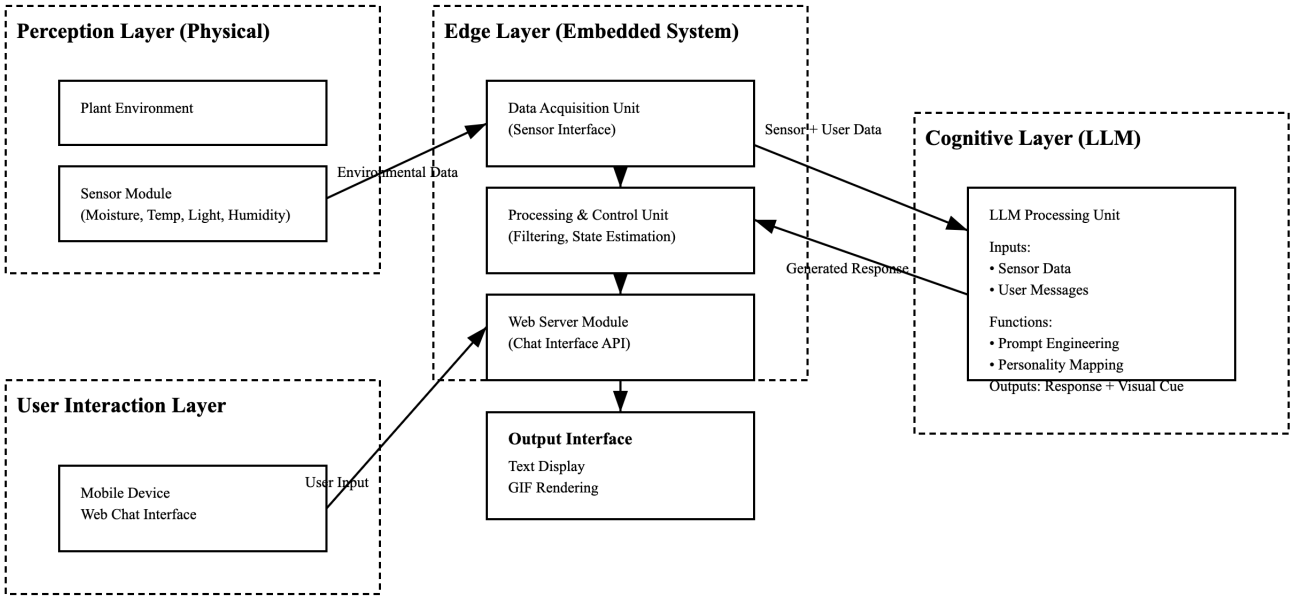

Figure 1: Architectural overview of our HPI artifact.

smartphone, and is directed to a chat-like interface, from which they can send natural language messages to the plant. The plant's responses are shown on the plant screen.

3.2 Conversational User Interface

Sensor data, filtered to reduce noise and fluctuations, is combined along with user messages and processed by an LLM (Gemini 2.5 flash), prompted suitably to respond with a customisable personality (e.g. happy-go-lucky, cynical, etc.). Also a visual expression (GIF or Emoji), aligned with the state of the plant, is contextually selected and shown on the display when interaction is being performed. The LLM receives not only the user's message, but also style instructions, conversation history, a structured block containing the current environmental conditions from the sensors' filtered data, ensuring coherent and context-aware responses. Regarding the sensors' data, the server through a preprocessing phase transforms the numerical data into descriptive statements. Two fundamental parameters are the role and personality. The role, fixed and invariant across all users, ensures that the systems generates its replies aware of "being a plant", preventing out-of-character behaviors. The personality instead can be either statically defined, or dynamically selected (e.g. based on previous interactions with the user).

4 Preliminary Evaluation and Future Directions

Evaluation was conducted in two phases: the university cafeteria (Phase 1) with 54 opportunistic users, and a workplace (Phase 2) with 6 permanently present users. Results showed that context matters: workplace users, who had repeated exposure, showed significantly higher engagement and plant caring behaviour meeting up to 100% of the plant's expressed requests, compared to public

Figure 2: The Talking Plant prototype

users (60%). Interactions were mostly short ($\bar{x} = 2.1 - 3.6$ minutes depending on personality), and the personality doesn't seem to influence the duration or quality. In phase 1, only 9 users engaged with the plant more than once $\bar{x} = 1.19$ sessions while phase 2 participants exhibited a mean of $\bar{x} = 3.83$ sessions. This gap suggests that in public spaces, users are often driven by a fleeting curiosity toward the technology, rather than a sustained commitment to the plant's wellbeing. Qualitative interviews in Phase 2 revealed that the interaction was intuitive and deeply engaging, with users successfully identifying the specific personalities (happy, sad, or grumpy) assigned to the plant. Participants primarily attributed these traits to the tone and content of the plant's text-based responses, while visual animations served as supporting cues. Notably, most users perceived the plant as a "living presence" with human-like emotions and agency rather than a mere tool, fostering a strong sense of social connection and responsibility toward its

care. While the experience was highly positive and encouraged long-term engagement, feedback suggested that integrating the interface with mobile devices and automating the recognition of care actions (like watering) would further enhance the immersion and resolve minor "breaks" in the anthropomorphic illusion.

To bridge the engagement gap between opportunistic (public) and sustained exposure to the plant, future design directions may pivot from a "beggar" model, which relies on expressing negative needs, toward a "busker" paradigm that emphasizes performative agency. Compared to begging, people feel the environment to be not only more pleasant, but also more safe, convivial, more active and seeking a sense of community with the presence of performers [5]. By utilizing LLMs to transform the plant into an active entertainer rather than a passive recipient of charity, the system can offer artistic or social "performances" that foster a more convivial and safe public atmosphere. This transition aims to decenter the human by valorizing the plant's independent expression, ultimately driving stronger psychological engagement and long-term interest. In this model, human care is reimagined as a spontaneous donation in response to a rewarding performance (e.g. see PlantMIDI [10] where the plant offers back to the person an artistic performance) creating a more positive, reciprocal bond that ensures the plant's needs are met through inspiration rather than obligation.

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