

SymbioSip: Human-Plant Symbiosis through a Bidirectional Hydration System

Hong Luo
hong.luo@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Rusula Pathirana
rusula.pathirana@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Don Samitha Elvitigala
don.elvitigala@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Kenath Perera
Kenathkp@gmail.com
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Pankaja Balasooriya
Pankaja.Balasooriya@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Phoebe O. Toups Dugas
phoebe.toupsdugas@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Maria F. Montoya
maria.montoyavega@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Rakesh Patibanda
rakesh.patibanda@monash.edu
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia

Florian 'Floyd' Mueller
floyd@exertiongames.org
Exertion Games Lab, Monash
University
Melbourne, Victoria, Australia



Figure 1: SymbioSip, a novel bidirectional hydration system designed to facilitate awareness of human-plant symbiosis. In this photograph, the system has detected that the linked plant needs water and so is supplying a mist to the wearer.



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Abstract

Taking care of a plant can also foster care for oneself, offering mental and physical benefits, such as improved indoor humidity. While existing human-plant interaction designs aim to increase attention toward plants, automated care models may reduce sustained engagement in process-oriented plant care. We see an opportunity

for interaction design to raise awareness of this symbiotic relationship. To explore this, we designed SymbioSip, a novel bidirectional hydration system. SymbioSip monitors human dehydration with a wearable sensor, triggering a water pump to irrigate an indoor plant when the human is dehydrated. It also monitors plant dehydration via soil moisture to activate a fine mist spray worn on the human's head. The demonstration of this wearable benefits the DIS community by engaging them in a novel human-plant experience that raises awareness of human-plant symbiosis by amplifying both human and plant hydration needs. Ultimately, we aim to showcase the potential of interaction design to raise awareness of human-plant symbiosis, encouraging people to take better care of plants.

CCS Concepts

• **Human-centered computing** → **Interactive systems and tools.**

Keywords

Human-plant interaction, Bio-sensing, More-than-human, Bidirectional interaction

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1 Motivation and Background

Plant care, such as watering indoor plants, is associated with enhanced well-being [3] and an improved environment [5]. Research on indoor plant care has highlighted significant challenges in maintaining plant health, including inconsistent care practices [9]. Human-plant interaction (HPI) research, a subset of human-computer interaction (HCI), is increasingly interested in the role that technology can play in this relationship [15]. For example, researchers have aimed to detect soil moisture [21] or leaf water content [16] to share the physiological needs of plants and to drive targeted care behaviours. “*PlantiBot*” [8] maps plant sensor data to symbols representing emotions to promote HPIs, and “*Elowan*” [20] augments plants with robotic capabilities so they can autonomously seek better environmental conditions. Prior approaches often replace human care behaviours with automated functions; this automated approach reduces human involvement, which may lead to “plant blindness” [26]. Although the plant may benefit from automation, the human is no longer required to remember care tasks and thus forgoes the benefits of plant care.

HPI research has shifted from a human-centred to a more-than-human perspective [25]. This perspective acknowledges the materiality [18] and temporality [10] of plants, such as their ability to adjust their positions to track the sun [22], change the shape of their leaves to prevent being eaten [7], or emit measurable electrical signals in response to stimuli like touch or light [13, 19, 24]. This perspective positions plants as active interactors [25]. Our research is not the first to incorporate indoor plants into a mutual

care project (e.g., [14, 17]). Most prior research has been unidirectional – centring either the plant or the human (e.g., [8]) – while we design for bidirectional interaction. A noteworthy exception is “*Project Florence*” [23], which breaks through the traditional view of plants as passive objects by enabling people to converse with a plant by translating their text sentiment into a light frequency that the plant can recognise and respond to. Unlike previous unidirectional interactive projects [13, 24], this case provides new insights for rethinking symbiotic relationships with non-human entities [2], emphasising the equal status of cross-species relationships.

We rethink how interactive technologies can enable plants to be active participants in this symbiotic relationship. An opportunity exists to consider bidirectional interaction to promote deep connections between humans and plants [4]. However, these systems still face a common challenge: existing care behaviours depend on human will, making it difficult for plants to mobilise active human care responsibilities through technological mediation. Taken together, there is a gap in knowledge on how to design interactive systems that support mutual care for both humans and plants. In response, we aim to begin answering the question: ***How can we design bidirectional HPI to raise awareness of human-plant symbiosis?***

Designing for bidirectional interaction, and inspired by the effects of indoor plants in providing humidity in indoor environments [11], we see an opportunity for interactive technology to deepen the connection between humans and plants. We designed “SymbioSip”, a novel bidirectional hydration system for human-plant mutual care. Drawing on the more-than-human perspective [25], we mapped the physiological needs of one species onto the other and created mutual care loops: 1) monitoring human dehydration to trigger a water pump for plant irrigation; and 2) monitoring plant dehydration to drive a fine mist spray onto the human. Thanks to SymbioSip’s integration of sensors and actuators, we can demonstrate how an HPI system can raise awareness of human-plant symbiosis, encouraging people to take better care of plants.

2 Grounding: Autoethnography and Expert Discussion

We draw on *thing ethnography* [6] and cultural exploration to capture details that are difficult to notice when caring for plants. This perspective challenges the anthropocentric view common in ethnography, instead capturing phenomena and relationships from the perspective of “things”. Here, we extend it to plants. The first author conducted a four-week autoethnography, involving self-observation of personal hydration habits and plant care practices through diary studies and photography. This resulted in three observations. 1) Without digital notifications, the first author’s self-care and plant care failed to meet hydration needs. 2) There are fundamental differences between human and plant dehydration: human dehydration can quickly translate into perceptible discomfort, while plant dehydration is embedded within a longer growth cycle. 3) The caregiving relationship with the plant was reinforced by digital reminders, but quickly disintegrated when the first author focused on daily tasks.

After the autoethnography, we interviewed a botanist with nine years of experience. The interview focused on the physiological



Figure 2: Hardware components and wearable demonstration.

characteristics of plants and how these can be integrated into the experience of mutual care. We then invited three experienced HPI experts, all with over ten years of experience, to ideate and discuss the system design. We analysed these discussions and articulated the insights into the design we present in the next section.

3 Artefact Design: SymbioSip

Water is a fundamental resource for both humans and plants [12], so we focus on hydration needs and provide automatic hydration (Figures 1). The system features bidirectional interaction modes for mutual care: (1) **Human→plant**: If the system senses that the *human* body is dehydrated via a wearable sensor¹, it triggers a pump to irrigate the plant with 2 mL of water. Thus, the plant is watered when the human is thirsty. (2) **Plant→human**: If the system detects that the plant is dehydrated via a soil sensor², indicating a low moisture level, it sprays mist in front of the human’s face through a 3D-printed head-mounted wearable. When the plant is thirsty, the human is reminded by mist. Our design considerations (DCs) were as follows:

DC1: **Plant as active agent**. We use plant dehydration signals as the triggering condition for the system, reshaping plants as active caregivers. Traditional automated hydration sensing systems have aimed to address the problem of forgetting to water plants, but they typically treat plants as passive recipients of care. Here, we consider plants as active agents, creating a benefit mechanism that triggers mutual care based on shared physiological needs.

DC2: **Different human / plant paces**. Humans and plants require hydration at different rates. For example, conventional soil sensors only trigger irrigation notifications every other day, whereas interactive water bottles used to motivate drinking send reminders multiple times a day. By increasing the threshold at which the plant sensor is triggered, we aimed to make humans more aware of the changing moisture levels that the plant is experiencing. As a result, humans might

become more aware of the “slow pace” of plants compared to the “fast pace” of human activity.

DC3: **Non-intrusive trigger design**. Drawing on calm technology [27], we used water mist as a non-intrusive trigger mechanism for humans, in contrast to most current HPI systems that rely on digital reminders when sensors detect low moisture levels. The mist is not only visually perceptible but also alters air humidity, which may engage people’s senses to receive information from plants. Humans can move their heads forward and experience the mist directly on their skin, which facilitates a calming experience that might increase awareness of the mental benefits of human-plant care.

DC4: **Aesthetics**. We developed a head-mounted form, which is convenient to wear and does not impose an additional burden during daily activities. Inspired by biomimetic design [1], we created a 3D-printed crown resembling leaves, which also accommodates the mist humidifier.

DC5: **Material**. We chose silicone for the strap because of its biocompatibility and softness, reducing pressure and friction during wear. The arm strap measures 6cm by 25cm with a thickness of 1mm, intentionally wide to help distribute weight evenly. Regular perforations allow for width adjustment to accommodate participants with different arm circumferences and help prevent sweat buildup on the skin during prolonged use.

3.1 Physiological Data Calibration

Based on the botanist’s advice, we monitored the plant moisture levels for a week. From 09:00 on the first day until 09:00 on the eighth day, we collected soil moisture data every 10 minutes using custom Arduino code. The final fixed humidity threshold was set by averaging the daily minimum baseline over 7 days. When the soil moisture level falls below the baseline threshold, the plant enters a state of primary water stress, which serves as the biological basis for triggering the humidifier. We use wearable sensors¹ to detect human dehydration signals in real time and perform an initial calibration based on baseline hydration parameters (height, weight, and gender).

¹hDrop sweat-monitoring sensor: <https://hdrotech.com/>.

²Core Electronics Capacitive Soil Moisture Sensor (v2.0): <https://core-electronics.com.au/capacitive-soil-moisture-sensor-v20.html>

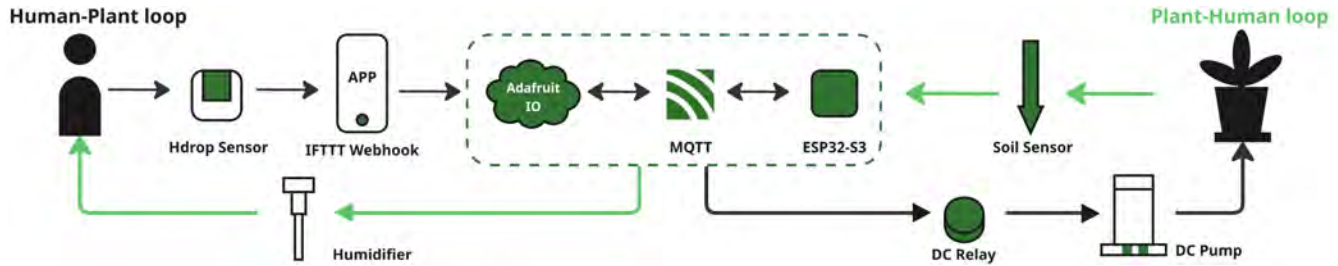


Figure 3: Bidirectional interaction modes to achieve mutual care.

3.2 System Configuration

This system achieves coordinated water regulation through a human–plant mutual care coupling loop (Figures 2, 3): plant dryness can trigger mist and provide environmental cues to humans, while human dehydration can also trigger watering required by plants.

Detection: In the human→plant mode, the human body moisture status is sensed by a sensor worn on the forearm by the user and reported to the hDrop mobile application. When dehydration is detected, the event is forwarded to Adafruit IO (the MQTT broker) via an IFTTT webhook. In the plant→human mode, plant dehydration status is measured locally using an Adafruit STEMMA capacitive soil sensor on the embedded microcontroller (XIAO ESP32-S3), connected via an I²C bus. The data are synchronised to the Adafruit IO cloud every 10 minutes for subsequent threshold adjustments and sensor stability monitoring.

Processing: The system’s central processing unit comprises three integrated components working as a unified hub: Adafruit IO (cloud server), MQTT (communication protocol), and ESP32-S3 (microcontroller). This processing core exchanges messages through three main information flows: (1) operating mode selection, (2) storing periodic soil readings for plants and water loss readings for humans, and (3) triggering water-related events. In the human→plant mode, the processing hub automatically captures data and detection information from the hDrop mobile application via an IFTTT webhook. Upon receiving a trigger signal, it processes the data and drives the actuation chain on the plant side. In the plant→human mode, when the soil sensor determines that the soil is dry (below a threshold), the processing hub issues an instruction to drive the humidifier on the human side.

Actuation: In the human→plant mode, the system starts with a 20-second initial water injection process that fills the pipes. When the processing hub detects a dehydration signal from the human (via the hDrop sensor), it executes a command, and a relay-controlled DC pump delivers a metered volume of water (2 mL each time) to the plant, with a 1-hour “absorption cooling period” to simulate the natural process of water osmosis. In the plant→human mode, the humidifier, driven by the processing hub, initiates a 5-second mist spray to alleviate dryness through sensory compensation.

4 Demonstration

HPI has previously called for more work on human-plant interactions [4]. We respond to this call by presenting our system. A preliminary field study involving six participants demonstrated

SymbioSip’s suitability for public demonstration. With brief instructions to help users set up the system, attendees were able to easily experience bidirectional interactions between humans and plants.

Through the demonstration of our system, attendees are introduced to the concept of human–plant symbiosis and the more-than-human design perspective. They will learn about the sensing mechanisms, the types of data being collected, and the non-medical framing of the hydration feedback. They will experience bidirectional interaction modes: (1) how an attendee’s dehydration may benefit the plant through watering, and (2) how the plant’s dehydration is communicated back to the attendee through mist. Attendees are then invited to attend to their own bodily sensations and the presence of the plant during the session. They are also encouraged to briefly reflect on the experience, particularly on how responsibility and care are negotiated across species.

We have built two identical systems, enabling us to showcase the prototype with concurrent demonstrations. We can further adjust trigger parameters to enhance throughput during the demo session. In addition, SymbioSip has been demonstrated informally over an extended period of time. We will purchase plants locally to comply with import restrictions. Overall, the public demonstration offers an opportunity to showcase how people, technology, and plants can be integrated to create an engaging cross-species interactive experience.

5 Conclusion

We see an opportunity for interaction design to draw attention to the human-plant symbiosis. In order to explore this opportunity, we designed SymbioSip, a novel bidirectional hydration system that playfully highlights human-plant symbiosis by amplifying both human and plant hydration needs. The demonstration of this wearable benefits the DIS community by engaging attendees in a novel HPI that facilitates the transformation of care practices through integrated sensing and actuation. Demonstrating SymbioSip offers an opportunity to discuss novel bidirectional systems while providing a unique experience with plants. Ultimately, our work emphasizes the potential of interaction design to raise awareness of human-plant symbiosis, encouraging people to take better care of plants.

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