Slime-Molder: Fabrication System for Human–Slime Mold Co-Creation

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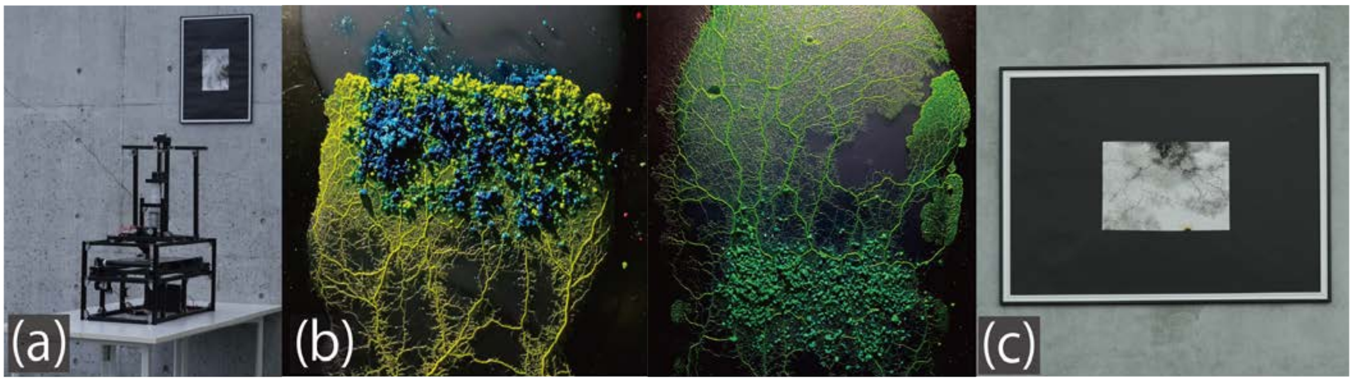

Figure 1: The Slime-Molder outline: (a) External view of the automatic slime-mold fabrication system. (b) Slime mold being cultivated and dyed on the device (12 hours elapsed). (c) Slime-mold painting created with the dyed organism.

ABSTRACT

In this study, we propose an automatic cultivation system that enables slime mold to be grown easily in everyday settings and used for expressive experiments—laying the groundwork for "slime-mold fabrication", a practice that leverages the organism's unique abilities. Slime mold can alter its growth pattern in response to environmental conditions and stimuli, making it a promising material for HCI research and artistic expression: it can serve as a living medium whose appearance changes over time for painterly work, or operate as a conductive "wire" that forms part of an electronic circuit. Cultivation, however, is challenging in daily environments because humidity and temperature must be controlled and food and substrate must be refreshed appropriately. To address this, we present a prototype automatic cultivation device, investigate its mechanisms for both growth and pigment uptake, and showcase a bio-art piece as an application example of slime-mold fabrication. This work represents an initial step toward a slime-mold fabrication platform that could support a wide range of interactive and creative domains.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**.

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KEYWORDS

digital fabrication, slime mold, post anthropocentric design, co-creation

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1 INTRODUCTION

Recent years have seen a surge of HCI research that purposefully involves living organisms. Movements such as bio-HCI and DIY-bio [8] [4] promote a post-anthropocentric worldview, arguing that creating novel interactions between humans and non-humans—animals, plants, and microbes—can open pathways toward more desirable futures [5]. Interactions with non-human life forms generate experiences that cannot emerge from conventional human–computer or human–human interaction alone. In response, a wide range of studies has explored interfaces with diverse species and fabrication techniques that leverage biological capabilities: conversational systems with fermentative microbes [1]; three-dimensional structures spun directly by silkworms [3]; and mycelium-based composites integrated with electronic components [2], among others. In this context, slime mold (Physarum polycephalum) is not widely used in HCI; one example uses it merely as a conductive trace in a smartwatch circuit[6]. yet its role is limited to conductivity. Slime mold moves in response to food, light, and other external stimuli, leaving tubular networks in its wake; it can solve mazes by optimizing nutrient transport [7], and when fed differently dyed nutrients it adopts corresponding colors [10].

Owing to its shortest-path network formation, electrical conductivity, and pigment uptake, slime mold is a promising bio-derived sensor or actuator. Despite this potential for HCI and artistic expression, cultivating slime mold in everyday settings is challenging: humidity and temperature must be controlled, nutrients supplied, and substrates replaced regularly. To address these hurdles, the present work builds a prototype of an automatic cultivation system for slime mold. Through its development, it sketches the contours of a new domain we call "slime-mold fabrication", which treats slime mold as a fabrication material. This study presents a proof-of-concept prototype and its design narrative.

2 DESIGN

Slime mold is constantly on the move in search of fresh substrate and food, and it leaves behind extracellular slime along its path [9]. While this slime makes the mold's migration trace immediately visible, it is detrimental to cultivation; if culture continues with the extracellular slime left in place, the slime mold's condition worsens and its movement slows. Consequently, traditional cultivation follows three steps: (1) prepare an agar medium in a container and place the slime mold on it; (2) every few hours check the mold's progress and supply food; (3) when the container becomes filled with slime mold, transfer it to a new container. However, this method depends heavily on the cultivator's experience and know-how and is not easily reproducible by everyone. To solve this, we designed a cultivation system in which the slime mold travels continuously on a conveyor belt; the belt removes extracellular slime while supplying the necessary substrate (agar) and food (oatmeal) at fixed intervals1a. This eliminates the need for humans to monitor the mold's advance in detail, add food manually, or replace the substrate, making cultivation far simpler than conventional methods. Easier cultivation ensures both the quality and quantity of slime mold, making it more practical as a fabrication material and paving the way for slime-mold fabrication.

3 IMPLEMENTATION

The device is a belt-conveyor-type cultivation system built on an aluminum frame and comprises three main mechanisms: (1) the conveyor, (2) the agar printer, and (3) Colored Feeding Attachment (Figure 2).

(1) The conveyor is designed so that the belt advances approximately 1 cm per hour, matching the slime mold's migration speed. Its drive section uses a gearbox made of 3D-printed parts coupled to a stepper motor (28BYJ-48). Mounted directly above the conveyor are the agar printer and the feeder.

(2) The agar printer consists of a 550 mL syringe and a stepper motor (ST-42BYH-1004). Each time the stepper motor rotates, roughly 20 mL of agar is extruded every five hours, forming a continuous substrate on which the slime mold can keep advancing. To prevent the agar from solidifying inside the syringe, aluminum-foil film heaters are attached to the syringe barrel and the nozzle. Powered by a stabilized supply, the syringe body is maintained at 65–75 °C and the nozzle at 40–50 °C (11 V, 2.8 A).

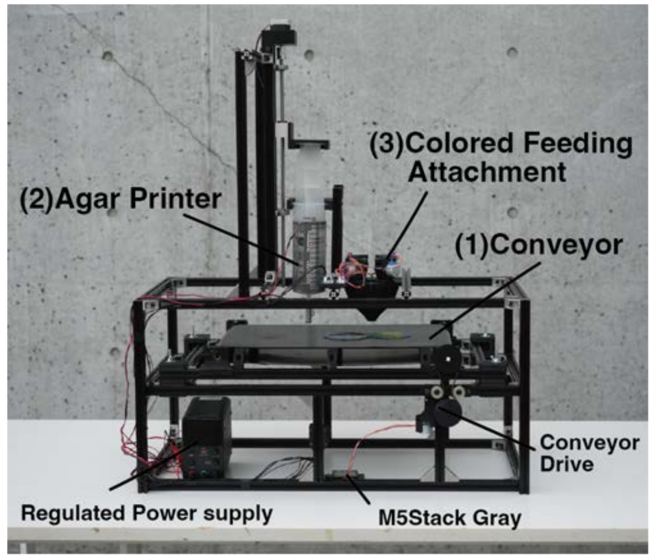

Figure 2: Functions of the Slime-Molder.

(3) Colored Feeding Attachment is a hopper-type mechanism assembled from 3D-printed parts. It has four slots, each holding food of a different color, allowing the system to dispense a specified color on demand. The Attachment is driven by a total of four bipolar stepper motors (28BYJ-48) to output not only RGB colors but also black. These motors are controlled via two motor drivers. The rotation amount of each attachment, corresponding to the desired output color, is determined based on control signals received from the M5Stack Gray through shift registers.

This enables the slime mold to be stained, so color changes on the device can be observed and directly exploited for fabrication purposes(Figure 1b).This piece is an example of bio-art created by allowing black-dyed slime mold to crawl across paper, inspired by traditional ink wash painting (Figure 1c).

4 SUMMARY AND FUTURE WORK

Our conveyor-based prototype automatically cultivates and stains slime mold, showing that it can supply bio-fabrication material with virtually no manual labor. At present the system only adds color, but by experimenting with flavored feeds to explore edible uses of slime mold and by adding stimulation attachments that exploit its memory capability, we aim to generate organisms with diverse properties directly on the device, thereby broadening the scope of bio-devices and bio-art.To improve stability we will introduce image-based and thermo-hygrometric feedback and run month-long trials to monitor contamination and clogging. Finally, to help establish a culture of slime-mold fabrication, we will hold workshops with artists and engineers to examine how co-creating with living organisms transforms design practice and audience experience.

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