Lightening and Growing Your Stromatolites: Draw and Dive into Nature

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Abstract. This demo is centered on a nature-centered perspective, providing individuals with the opportunity to explore the evolution of stromatolite phenomena in the natural world. The installation allows users to manipulate two key natural conditions: water dynamics and light exposure, using acrylic panels, which can control the morphological transformation of simulated image. When user interact with the device, the unique image generated. The experience is further enriched through external projection onto a large screen, creating an immersive simulation of natural evolution.

Keywords: nature-centric perspective · stromatolite · interactive experience

1 Introduction

This project is a design project based on the phenomenon of stromatolites in nature. Stromatolites are laminated biosedimentary structures usually attributed to the trapping and binding as well as chemical action of non-skeletal algae in shallow-water environments [4]. The device aims to create an interactive experience where people can control the growth of stromatolites by interacting with the environmental conditions. The fucntion allows users to witness the process of stromatolites formation, which is influenced by sunlight and water flow, resulting in different patterns. Stromatolites is a layered growth structure formed by the combination or precipitation of ancient microbial mats or biofilms (mainly composed of cyanobacteria) with sediment, possibly accompanied by non-biological surface precipitation [1]. Stromatolites records the interaction between microorganisms, sediment, and flowing water throughout Earth's history, provides only a small fraction of the structures preserved in Ordovician and Paleozoic carbonates [2], potentially shedding light on the long-term history of life and the environment.

2 System Design

The growth of stromatolite is closely related to the environmental conditions in which it exists, with key morphological factors including light exposure, water

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dynamics, and surface microbial presence. [3] Under different environmental conditions, stromatolite exhibits distinct growth patterns. In this demo, we primarily focus on the impact of light exposure and water dynamics on the growth of stromatolite. By using different lighting ways and predefined water dynamics, the interactive process generates stromatolites models with different shapes. Our system involves three acrylic panels, light-dependent resistors, Processing for graphics generation, and a projection device, showed in Fig. 1.

Fig. 1. The hardware setup of the entire interactive system consists of several components.

2.1 Water Dynamics Control - Three Acrylic Panels

The research team has created three acrylic panels using laser cutting, with graphical cues on the panels indicating the magnitude of water dynamics which can be seem in Fig. 2. Users can select an acrylic panel, which then links to the algorithm program associated with their chosen water dynamics condition. These water dynamics conditions are broadly grouped into three levels, each representing a unique longitudinal cross-sectional shape of stromatolites. And the algorithm generates shapes based on abstract representations of these natural stromatolite forms.

2.2 Light Exposure Control - Light-Dependent Resistors

Since the growth of stromatolite depends on light exposure, the position, direction, and intensity of light, the driving force behind stromatolite growth in this system is generated by user-controlled lighting. We have set up four light-dependent resistors at specific positions on the acrylic panel to sense the intensity, position and the duration of light.

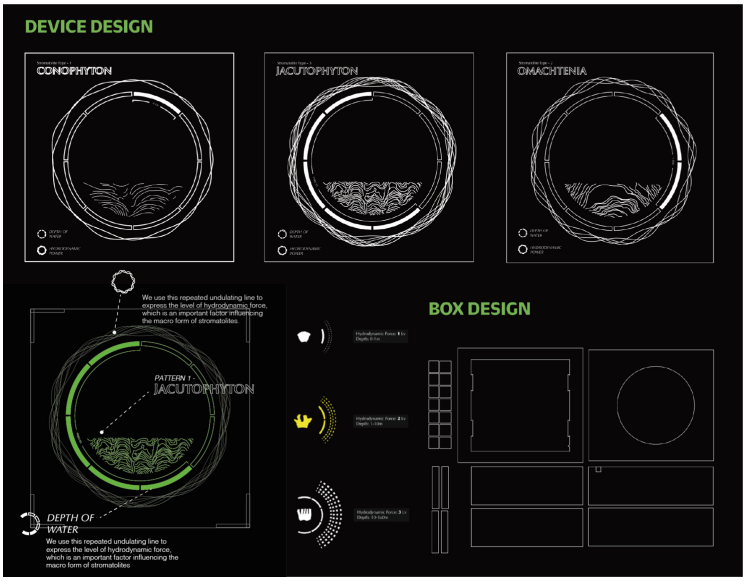

Fig. 2. Hardware device design sketches.

2.3 System Implementation - Arduino and Projection

Various acrylic panels can trigger distinct circuit connections, and these circuits from multiple panels run in parallel. These signals are then directed to an Arduino board, which subsequently transmits them to the Processing software on the computer. Based on the input parameters, diverse stromatolite graphics are generated. Ultimately, the visuals created in Processing are projected onto a large screen for display.

3 Algorithm Implementation

The algorithmic graphics for this project are developed in Processing, utilizing the Java programming language. In the algorithm, we leverage data from four light-dependent resistors to establish a coordinate system and ascertain the light source's position from the flashlight. These visuals are generated through an agent class, which draws line-shaped graphics with different colors, thickness, and movement patterns along predefined trajectories.

4 User Experience

The foremost value of this project lies in its ability to transition individuals from a human-centric perspective to a nature-centric one, highlighting the transformative processes that nature has undergone over millennia. Human actions and societal interactions are no longer central to this project; instead, it emphasizes

the presentation of natural evolution that has unfolded across millennia, achieved through the interplay of software and hardware components.

In this project, users act as controllers, influencing the environmental factors that impact stromatolite growth. Through their engagement with the interactive device, users can observe the gradual vertical development of stromatolites driven by light exposure. They also witness the alteration of growth patterns and rules when transitioning between water dynamics conditions, as illustrated in Fig. 3. This immersion allows users to genuinely experience the enchanting and large-scale transformations inherent in nature's long-term evolution. Our aspiration is for individuals to find inspiration in this interactive demonstration and cultivate a deeper respect and awe for the natural world.

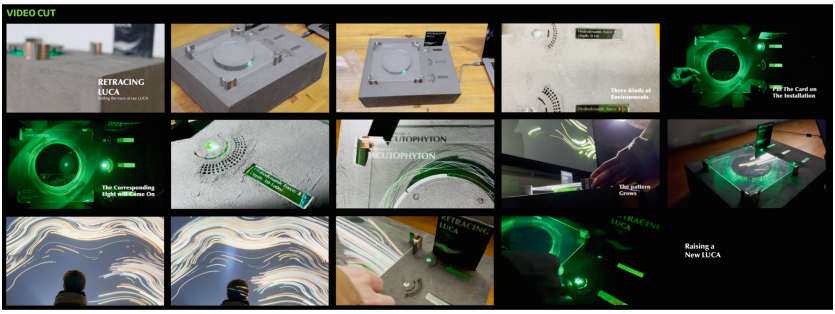

Fig. 3. Hardware device design sketches.

5 Limitations and Future Work

5.1 Incorporating the Influence of Microbial Conditions

At present, our interactive device primarily focuses on factors like light exposure and water dynamics, yet we acknowledge that the presence of microbes on layered rock plays a pivotal role in influencing growth. In our future endeavors, we aspire to integrate microbial conditions into the growth dynamics of the entire interactive device.

5.2 Improved Diversity of Stromatolites Growth Patterns

To enhance the distinguishability of stromatolites growth patterns, we aim to introduce greater diversity in the shapes of stromatolite growth under different water dynamics conditions.

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