Nature-Inspired and Nature-Relevant UI Models: A Demo from Exploring Bioluminescence Crowdsourced Data with a Design-Driven Approach

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Abstract. This demo project is an interactive design demo with a nature-centric perspective, focusing on bioluminescence in the natural world. We obtained a dataset related to bioluminescence from iNaturalist and performed data visualization to glean insights into the scientific classification, geographical distribution, and temporal patterns of bioluminescence. Based on the insights above, we designed a Bioluminescence World Clock, which demonstrates the flow of time by dynamically changing rhythmic processes of bioluminescence. Moreover, this interface is part of a public data collection service inspired by the Citizen Science model which contributes to the original data set through new data gathering and sharing.

Keywords: nature-centred perspective · bioluminescence · data-driven design

1 Introduction

Bioluminescence is the entry point of this design research that uses data-driven design as a method and focuses on the investigation of nature-based datasets. Although bioluminescence is not common in most organisms and the phenomenon is not readily observable, it usually occurs in many marine vertebrates and invertebrates, as well as some fungi, microorganisms, bacteria, and terrestrial arthropods such as fireflies. Bioluminescence is functionally essential for some of these organisms [1], so researchers are still exploring various aspects of bioluminescence, such as the luminescence mechanisms of different organisms, the differences in energy transfer processes, and the causes of varied luminescent colours [2]. In addition, the macroscopic aspects of bioluminescence are also worth investigating to understand lighting process. [3] Different Bioluminescence use luminescencing to achieve diverse physiological meanings, including courtship [4], attracting communicators, hunting, warning, and defence against predators (such as cuttlefish) [5].

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iNaturalist is a nature-related platform where users can upload their observations of organisms in the natural world. Therefore, on this platform, we were able to obtain data on bioluminescence observed by users, including the identified species, the latitude and longitude of the observation locations, and the time of the organism's discovery. After conducting data analysis, it was discovered that bioluminescence exhibit certain patterns in terms of species, geographic distribution, and occurrence time which serve as the inspiration for our demo research results.

Inspired by the findings above, we have created a demo which includes a world clock feature along with related alarm clock and stopwatch functions, as well as the discovering function in Apple Watch, which are inherently connected to time and geography. We harness the dynamic shifts in various bioluminescent phenomena to depict time, enabling individuals to alter their perception of time and cast the magical bioluminescence of the natural world as the central character.

2 Data Visualization

We used open-source software RAW Graphs[1] and Tableau[2] for the dataset analysis witch can be seem in Fig.1. They can support a large number of data formats, thus allowing us to explore multiple dimensions and configurations of the data quickly.

Firstly, we looked at the variety and diversity of species that showcase bioluminescence, and we visualised them in the sunburst map. The diagram shows that at the level of Kingdom, among bioluminescent organisms, Fungi is a unique type, followed by Animalia. In terms of geographical distribution, we employed Tableau to visualize the latitude and longitude data related to bioluminescence. Our data visualization revealed that bioluminescent phenomena are predominantly concentrated in forested regions, coastal areas, and near rivers.

Shifting our focus to the temporal distribution, we conducted an analysis of bioluminescence over time. This examination allowed us to discern that various bioluminescent species display unique temporal patterns and rhythms.

3 Design Output

Building upon the insights derived from our data visualization research, we gained a comprehensive understanding of the scientific classification, geographical distribution, and temporal distribution of bioluminescence. These findings were subsequently integrated into our data-driven user interface design, facilitating a more informed and data-centric approach to our interface development.

[1] https://www.rawgraphs.io/.
[2] https://www.tableau.com/.

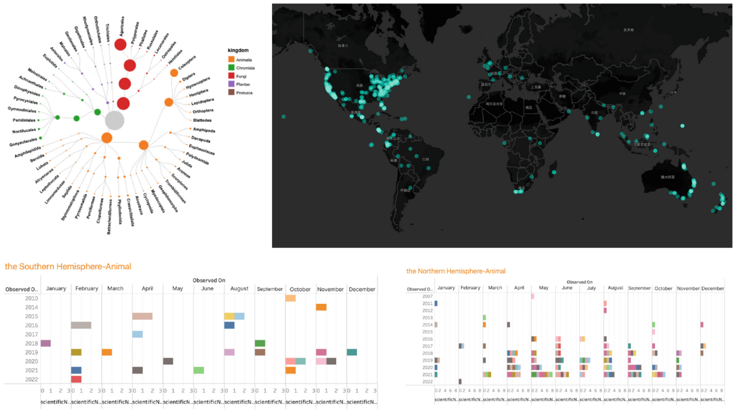

Fig. 1. The result of the visualization of the bioluminescence

3.1 Concept

Our intuition was to transform the data visualisation insights into a bioluminescence world clock that can work as a flexible and cross-platform widget integrated and embodied in daily-use devices such as the Apple Watch and mobile phones.

The data-driven UI design concept is represented by the Bioluminescence World Clock, which visually portrays the dynamic changes in bioluminescence to depict the passage of time. Our platform includes a user interface for locating natural bioluminescent events and uploading data to the cloud, thereby influencing the imagery displayed on the Bioluminescence World Clock.

3.2 Application Field

We employed Houdini as our prototyping software and specifically utilized the "particle system" function for visualizing dynamic bioluminescent imagery. The system in Houdini is defined by spatial position data and various adjustable parameters, while the carrier continually generates new particles. Within the interface, we have the capability to fine-tune the speed of particle generation and dissipation. Designers can manipulate particle movement by applying additional force around the carrier to influence the output's shape.

3.3 Visual Style

Since the luminescent effect of particles is a chemical reaction related to the function of luminophores in their bodies, we choose to use the visual effects of dynamic particles to reflect the repeated chemical reactions of bioluminescence.

By the particle system we mentioned above in Houdini, we can create visual style bioluminescence made up of different particles. Their movement can be shaped by particle parameters, external force system, external model, and node system in the Houdini system, which can reflect their endless vitality.

4 User Experience

As shown in Fig. 2, we finally generated the dynamics of 12 bioluminescence organisms expressing the time flow. Cyanophyta, Panellus, Polychaeta, Ctenophora, Omphalotus, Mycena, Lampyridae, Merulinidae, Sylliidae, Tubiporidae, Pocillopora and Alcyonacea are the most frequent categories in our datasets.

Our output includes a UI widget in a smartphone application and a wearable UI widget in the Apple watch: these two interfaces work together to implement our system. On the Apple watch, we designed functions including clocks, alarms, stopwatches and the function for users to encounter bioluminescence. The clock, alarm clock, and stopwatch will use the dynamic changes of the bioluminescence to display, remind, and calculate the time. The equipment can notice the user's closest bioluminescence to help them discover them. Hopefully, we can inspire more users to discover bioluminescence in this way.

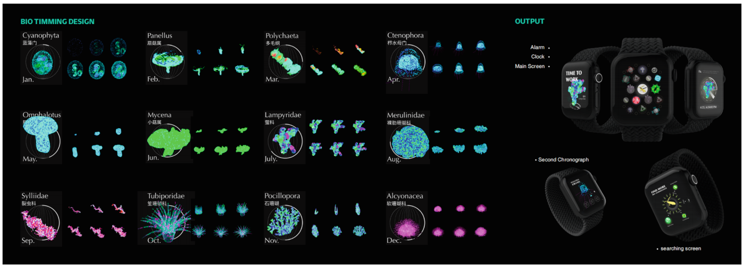

Fig. 2. The output of the interaction design

5 Limitations and Future Work

5.1 More Comprehensive Dataset

We focused on accessible bioluminescent areas but encountered limitations in regions like Asia and Africa where our platform is underutilized. This led to a dearth of data in less-explored regions. Collaborating with other datasets presents an opportunity for data enrichment.

5.2 Remote Interactive Graphics

Ideally, the bioluminescence types and particle movement in the World Clock could adapt based on continuously observed and uploaded data. As a future enhancement, we envision a seamless connection between the data used for World Clock outputs and the cloud-based data from platforms like iNaturalist, allowing real-time updates to influence the UI design. Houdini's node-based approach facilitates the incorporation of external data, making this a technically viable prospect. However, we acknowledge that implementing this may require additional project time.

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