Sensing Change: A Creative Journey into Climate Awareness with GaiaSenses

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Abstract

This article presents the GaiaSenses project, a research project that joins science and art to raise awareness about Climate Change. Based on environmental media and art-research literature, it argues that climate change is not only a scientific and political issue, but also an aesthetic issue. Thus it demands new aesthetic responses so non-expert people can make sense of the more-than-human scale of these new phenomena. GaiaSenses tries to answer to this demand by presenting its users with custom audio-visual compositions created using weather data and rendered in real time. Through the conceptual and technical challenges of its implementation, we suggest that a main challenge of raising awareness about climate change is the scale gap between the geological scale of event and the human scale of perception. In this sense, GaiaSenses is part of an increasing movement of multimodal artists that uses scientific informed art-research to produce artworks that blend aesthetic experiences, climate awareness and critical reflection.

Keywords

Climate Change; Climate Art; Algorithmic Art; Data Art; Processing; Pure Data; Real-time Rendering;

Introduction

Climate Change might seem an issue concerning mostly the natural sciences and decision-makers, especially considering the usual international instances of discussion, such as the IPCC Reports and the UN Panels. But Climate Change is, of course, something that concerns us all. As [1] observe, more importantly, Climate Change is a matter of aesthetics. Aesthetics in the Greek sense of "*aesthesis*" - a matter of capacity of perception, or a matter of "making oneself sensitive to something"[2].

Be it from the sciences, politics of the arts, the challenges that Climate Change poses is how we can attune to changes that happen in scales, temporal and spatial, that transcend the scale of our human sensorium. The climate sciences have approached this question by deploying a vast network of weather stations around the globe, research institutes to develop computer models of environmental processes and international protocols for collecting and sharing climate data [3, 4]. How can the arts respond to the aesthetic challenge that Global Climate Change poses, how can the arts contribute in creating the capacity to sense, and the capacity to make sense of, such new phenomena?

At least since the 1990s artists have been working with the theme of the changing environment, often in partnership with scientists in an attempt to bridge the gap between the abstract statistics about climate change and the experiential daily lives of people affected by these changes. These engagements have taken many names like: climate art, eco art, environmental art, atmospheric art, and many others. Famous artworks such as "Ice Watch", by Icelandic artist Olafur Eliason [5] presented at COP in Paris, or "Oceans in Transformation" [6] by Territorial Agency, recipient of the European Union S+T+ARTS Prize in 2021, are examples of artists using various media to try and make the abstract experience of Global Climate Change into a more tangible one. Despite the multiple designations and different materials, artworks relating to climate change seem to share a commitment to raise awareness about the climate crisis and to foster an inquiry into the roles that the natural environment has in the human creative processes. Computational systems and numeric data have been crucial in these still early explorations. Whether by using computer systems to produce new media art exploring climate change issues, or using scientific data about the environment as material for artwork, artists dealing with climate change seem to have no option but to use computers as interaction and inspirational devices.

In this paper, we present the GaiaSenses project, an art-science initiative that aims to make climate change more tangible for non-expert people. GaiaSenses is an application that presents its users with visual animations and soundscapes based on the user's geolocation and the weather conditions of their surroundings. It is developed using web technologies and the sound processing language Pure Data. The animations and soundscapes are driven by weather and climate data, like vegetation constitution, fire and rainfall, derived from NOAA multiband satellite images and made available by the Center for Meteorological and Agricultural Applied Research at University of Campinas - (CEPAGRI). By repurposing scientific environmental data into novel aesthetic compositions, the project aims to provide people with novel forms of engaging with important aspects of climate change that are not usually part of our weather experience, in the hope that it fosters more public engagement towards climate action. GaiaSenses is being developed at the Center for Information Technology - Renato Archer (Brazilian

Ministry of Science, Technology and Innovation) by an interdisciplinary team of researchers.

By presenting and discussing the GaiaSenses project this text aims to inquire into the capacities that computational creative systems can have in helping us make sense of climate change and reshape the ways we relate to the environment.

Sensing Change with GaiaSenses

GaiaSenses is a project that tries to answer the urgent demand of connecting the perception of atmospheric phenomena to everyday experience. And act in the gap between scientific knowledge about weather and climate and its effective transmission to those who need this information the most [7].

GaiaSenses emphasizes the humanization of technology within an e-Ecological network, interconnecting planetary data platforms with an automated system for generating audiovisual content. The Gaia Paradigm posits that living organisms interact with their inorganic surroundings on Earth, creating a complex, synergistic, and self-regulating system that sustains and perpetuates life conditions on the planet [8]. GaiaSenses aims to establish a network of emotional, and thus aesthetic, connections to the planet.

The project works by periodically presenting its users with audio-visual compositions based on their local weather and environmental conditions. Thereby instigating its users to experience the usually dry numeric data about the weather as more aesthetic experiences. It works by collecting the Latitude and Longitude data of the user in the client application, sending it to our servers, which access different planetary data platforms to gather, filter and compose environmental data, and send it back to the client that automatically creates and renders in real-time an animation and an audio-track powered by the weather data, as it is described in FIGURE 1. This means that different users that are located in different places, will receive custom compositions.

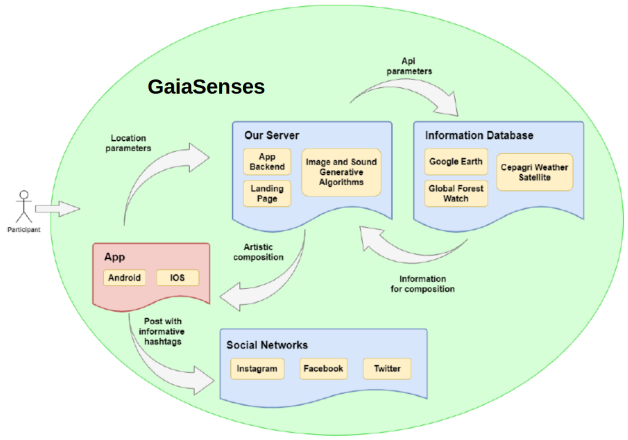

Figure 1. GaiaSenses Operation Architecture.

We call these periodic compositions "Gaia Pulses" as a reminder that the environmental processes do not only occur when a user is interested in accessing weather information, for example, but are always running in the background. We intend that these autogenerated nudges remind the users that the planet is in constant change and in constant need of attention and care.

Animating Environmental Data

The data products that the GaiaSenses projects currently use are the usual data products derived from weather systems: temperature, precipitation, wind, humidity, radiation, etc. These data are collected from weather services like OpenWeather through its web API and are updated hourly. GaiaSenses also uses data on fire occurrences and lightning occurrences, data that are collected from Brazilian Data Services and demands more filtering and processing than data collected using global weather services. These data are used as inputs for animation algorithms implemented in the P5.JS library, a Web version of the famous Processing Programming environment for art and creative coding. Some of the resulting animations can be seen on Figure 2, alongside with the client application interface..

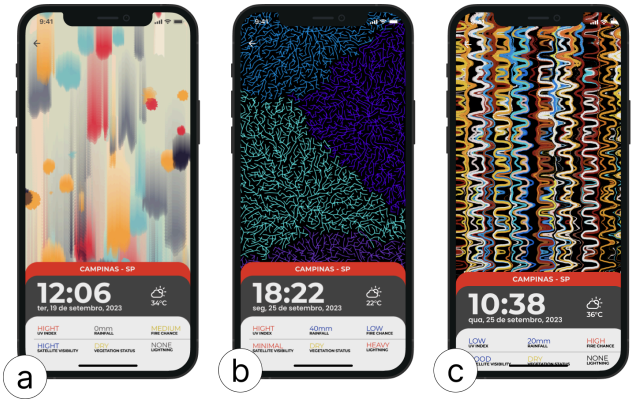

Figure 2. GaiaSenses Interface running different compositions..

Most animation algorithms used in GaiaSenses were collected in the Open Processing platform, a website that showcases creative coding projects made with P5.JS library. To be incorporated at our platform, the code is carefully analyzed and adapted so its behavior can be altered based on input data. In our case, the input data is the environmental data collected from planetary platforms. This input data alters the intended behavior of the animation, causing noises, sometimes failures and usually unexpected variations.

The conceptual decision to adapt pre-existing animations and not exclusively creating news ones was a way to distribute the creative agency, usually relegated to the author, into a more distributed system of agencies, much like what climate change causes. In this sense, the environmental data input affects the pre-existing animations much like the way climate changes alter our pre-existing environment. The changes that different weather conditions cause to an animation can be seen on

Figure 3, where the arrangement of lines is dependent on temperature, wind speed and wind direction.

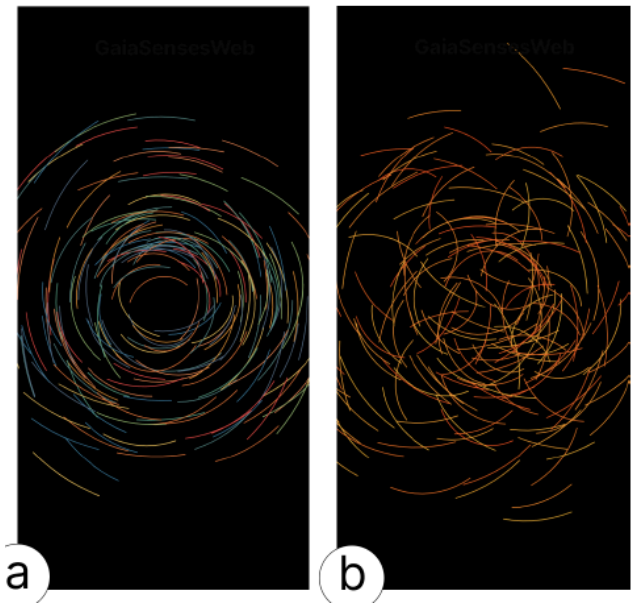

Figure 4. Storm Eye animation in two different weather conditions. a) temperature: 24°C, wind speed: 4m/s, wind direction 20°; b) temperature: 32°C, wind speed: 14.2m/s, wind direction 271°.

By using already made animation, we wanted to escape the representation impulses of over-relying on established data visualization affordances, like raising lines to depict temperature increase, or small lines over maps to depict wind and rain. Since the aim of the composition is not simply to create a visualization of certain weather data, but to make sensible to the user, the patterns of change that arise from a repeated aesthetic experience.

The arbitrary definition of animations to represent particular natural phenomena, like Figure 4 to represent wind changes, helps us understand that the scientific visualizations of data is also enmeshed in the aesthetic research that is often only attributed to the arts, but plays analogous roles in these different knowledge fields.

Sounding the Climate

The same data products used to create the animations are used in the GaiaSenses project to generate audio compositions. The logic works similarly: once the client application gets the weather data relative to the user's location, it creates a soundscape for the animation based on the same data parameters. As with the animation, the sound also runs in real-time based on algorithms that react to input changes. These sound algorithms are developed using PureData, a visual programming language for audio processing [9], and it is integrated with the web client application by compiling the Pure Data program, called Patch, as a Web Assembly Module, so it can run in the Browser.

A visual audio algorithm works by receiving a series of numerical data as inputs, transforming these inputs into waves and applying modifications like low-pass filters, delays and reverbs. An example of a Patch can be seen on Figure 5. Each box represents a specific transformation that the input will continually pass through until it is told to stop.

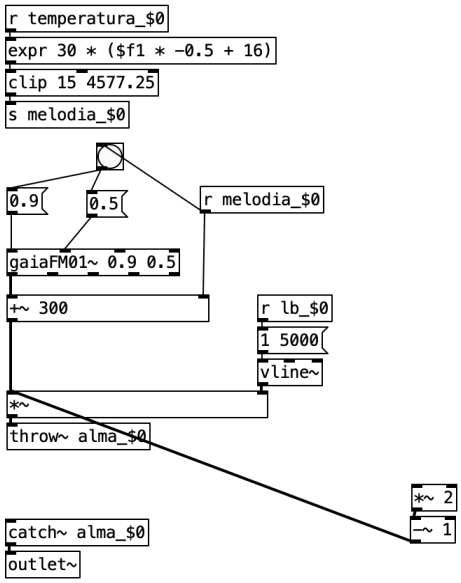

Figure 5. A Patch made using the Pure Data visual programming language. It uses a Digital Signal Processing to transform discrete data into continuous signals to be played by a device's speaker.

Similar to the animation, the intended purpose of a Patch in GaiaSenses is not to serve a sonification of a specific set of weather data, but to support the visuals in the production of an immersive aesthetic experience that work, by analogy, to the ways in which we experience the change in our surroundings. As such, along with the input data, the final soundscape also incorporates randomness and other generative interferences, producing unique compositions for different weather conditions.

Making sound weather data poses significant challenges, both technical and conceptual. Technically, it is hard to maintain coherence over different environments, for example, a browser DSP can sound different than a native DSP, enveloping different frequencies. Such integrations are work in progress and being developed within the open-source community.

Conceptually, to run an audio composition based on an input that changes only hourly poses interesting composition challenges, such as: how to map these changes into times that are more usual to our music hearing patterns? There is of course, no definitive answer to the question. But interestingly enough, the very compositional challenge mimics the climate change issue of crossing geological temporalities of change, like changes in global mean temperature, with our human scale of perception of time.

Conclusion

In this text, we presented the GaiaSenses project, a multimedia application that uses art and science to help raise awareness about climate change. Drawing from literature in art research, we propose that climate change is not solely a scientific and political concern; rather, it is also an aesthetic event. This emerging phenomenon necessitates the development of new conceptual, cognitive, and sensory frameworks for humans to comprehend the scale of this evolving environmental condition of our planet. We suggest that artworks like our GaiaSenses project, can contribute significantly to the creation of these new aesthetic capacities for non-climate-expert people. We then presented and discussed some approaches that our research group has used to try to create aesthetic experiences that register not only specific weather conditions, but aesthetic experiences that help users attend to the patterns of change in the environment that surround us. We also discussed some challenges of this approach and the current technical and conceptual limitation of having to deal with data temporalities that are not in sync with what is expected as the pace of change in audio-visual composition. A mismatch that suggests a conceptual analogy between the attempts to sync the temporality of human experience and the geological temporality of changes in the global climate.

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