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Slicing the Aurora: An Immersive Proxemics-Aware Visualization

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Abstract
The Aurora Borealis or Northern Lights is a phenomenon that has fascinated people throughout history. The AuroraMAX outreach initiative provides a collection of time-lapse videos of the night sky captured by a camera at Yellowknife in Canada. We present an interactive visualization of this AuroraMAX image data on a large touch display. Our visualization slices each time-lapse video to represent an entire night as a single image or keogram, provides different views on the keograms, and allows people to explore and compare nights to discover interesting patterns. To entice people to interact, we use proxemic interaction and animate the visualization in response to people's movements in front of the display. We deployed the visualization in a public space at an art-science festival. Initial findings suggest that the proxemic interaction aspect helps to draw people in and that the visualization generates interest from passersby, providing opportunities for science outreach.

Author Keywords
Information visualization; proxemic interaction; aurora borealis; interactive surfaces; large displays.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

The Aurora Borealis or Northern Lights is a phenomenon that has bewildered people throughout history and continues to fascinate artists, scientists, and photographers. Physicists at the University of Calgary deploy automated cameras and other measuring instruments in northern Canada to study the Aurora Borealis. The cameras used for taking these images are usually equipped with a wide-angle lens to capture the entire night sky. This data and images are made available on the Internet for other scientists to explore [19]. Additionally, the AuroraMAX outreach initiative [20] makes time-lapse videos of aurora activity available to the general public. These videos are created from images of the night sky captured by a high-resolution SLR camera in Yellowknife. Even though these videos are an excellent source for teaching and science outreach, there is no easy way for the general public to explore and engage with this data in more detail. Exploring and comparing different nights requires looking at the time-lapse videos of each of those nights one by one. Sifting through large quantities of video data to find a specific event or interesting occurrence is known to be a tedious and time-consuming task [18].

To provide the general public with an engaging way to explore this high-resolution image data, we designed an interactive visualization for a large touch display. We designed the visualization for large displays because of its benefits for deployment in public spaces such as libraries or museums [11], and to support multiple people interacting with it at the same time. Large displays are proliferating in (semi-)public spaces [10,12,17], and have been explored for "*educational, entertaining, participative, and evocative experiences*" [10]. This makes these displays an ideal platform for creating engaging information visualization experiences for the general public.

Once one or more people are interacting with a large display, they tend to attract more bystanders, a phenomenon known as the *honeypot effect* [5,16]. However, it can be difficult to get people to start interacting with a display [9,13,15], or even to notice that the display is interactive (*interaction blindness*) [17]. To draw attention and entice people to interact, we integrated aspects of proxemic interaction [4] into our visualization. The elements of the visualization move and animate in response to people's movements in front of the display, which can help to make passersby notice that the display is interactive [16].

We deployed the visualization in the University of Calgary's Taylor Family Digital Library, during the local Beakerhead art-science festival. We observed that the proxemic interaction aspect did help people to notice the display while walking by and invited them to interact. The visualization generated lots of interest from passersby, which often interacted in groups.

In what follows, we explain the design of our visualization including the use of proxemic interaction, discuss initial findings from our deployment in a public space, and provide directions for future work.



Figure 1. Keograms slice through each frame of the time-lapse videos to condense the video into a single image.

Keograms: Slicing through the Videos

To allow people to more easily explore the archive of time-lapse videos from the AuroraMAX initiative [20], we designed a visualization that slices through the time-lapse videos. This technique has been used previously for exploring video streams [18], as well as for visualizing temporal data using space-cutting [3].

The AuroraMAX videos tend to be about 3 to 4 minutes in length, depending on the duration of the night. We condense the video of each night into a single image or *keogram* (Figure 1). The word keogram is derived from 'keoeeit' [14], the Inuit word for the Aurora Borealis. keograms can be seen as a horizontal timeline that starts with the evening on the left and ends with the next morning on the right, as shown in Figure 1. Like the time-lapse videos, the keograms differ in length depending on the duration of the night.

Keograms support an at-a-glance overview of the contents of the time-lapse video. They transform a large series of images (i.e., the different frames of the time-lapse video) into a single image. Figure 2 shows several examples of keograms, and how they can be used to identify both occurrences of the aurora and other features such as clouds during the course of the night. Eather et al. [7] first described and used keograms in the seventies for studying the aurora. While they used scanning photometer data to describe the latitude-time morphology of auroras, the images we used in this application were captured using an off-the-shelf DSLR camera that captures most visible light.

Visualization Design

The visualization provides an overview of about five months of image data. It also supports smooth

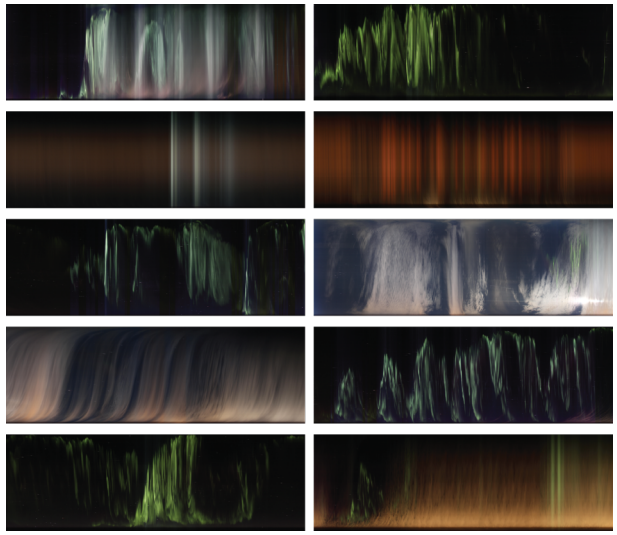


Figure 2. A set of keograms from our visualization. Reading the images from left to right provides a timeline of aurora activity in the video and other interesting events such as clouds or the rising sun.

transitions between the *overview* of all nights and a *video view* to explore the time-lapse video of a particular night. Both the overview and the video view are based on keograms.

Overview

In the overview, keograms for all nights are rotated at 90 degrees to create vertical bars whose height encodes the duration of the night, as shown in Figure 3 (*top*). By default, the horizontal axis encodes time, such that the rightmost keogram represents the latest night. In addition, small icons below the keograms show the moon phases.

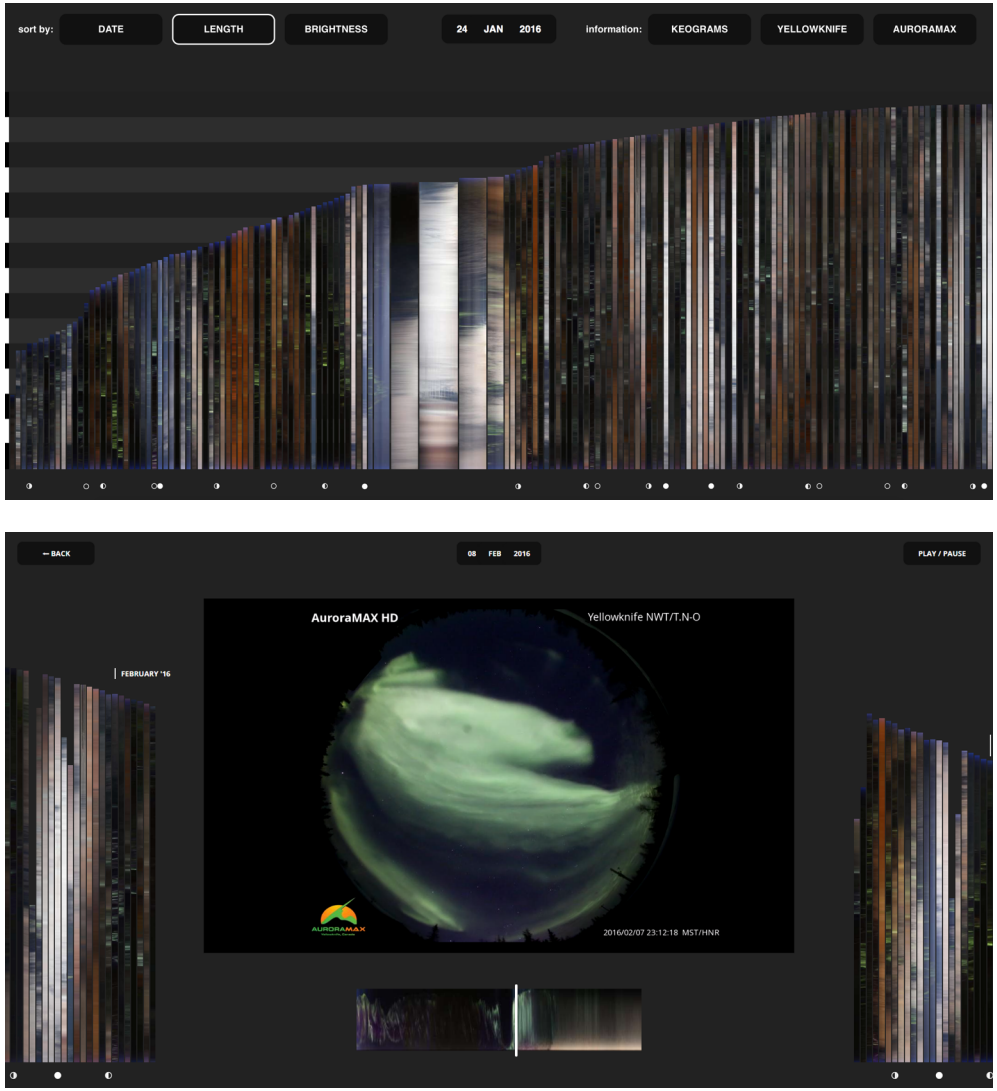


Figure 3. *Top:* The overview of all keograms, with the night of January 24th as the focal region. In this view, the keograms are sorted by duration of the night, and icons below the columns indicate the moon phases. *Bottom:* The video view, where the keogram on the bottom can be used to scrub through the time-lapse video of that night to discover interesting events. AuroraMAX images © Canadian Space Agency.

A multi-focal detail-in-context view [2,6,8] influences the width of these columns. Figure 3 (*top*) shows one active lens in the middle. The focal detail can be positioned on the display using touch. The focus follows the position of a person's finger while sliding through the columns. Multiple foci can exist when multiple people are sliding through the columns at the same time.

The keograms can be sorted using the buttons in the top left corner of the screen. The columns can be sorted based on various attributes, such as the date or length of the night, and the brightness of the image.

Tapping on a certain keogram selects it and triggers the transition from the overview of all keograms to a view showing the full video of the selected night, as shown in Figure 3 (*bottom*).

Video View

When a keogram is selected, the space opens up to show a full video of that particular night (see Figure 3 *bottom*). The video view shows the time-lapse video of the AuroraMAX project for the selected night in the middle of the screen. A larger version of the corresponding keogram is shown below the video and functions both as an indicator and a control for the playback position of the video. This allows people to use the keogram to identify and jump to interesting parts of the video.

Proxemic Interaction

The foci in the overview can be placed using either touch or proxemic interaction [4], supporting multiple people simultaneously. We use proxemic interaction to provide a more *immersive experience*. People's body

movements are translated to motion on the screen to allow them to physically interact with the data. Each person's body in front of the display acts as a cursor that can be used to browse through the data. People walking by the display cause a *ripple effect* on the keograms when they move across the display. The goal of this effect is to attract the interest of people walking by and to help them notice that the display is interactive as it responds to their presence and movement. The proxemic interaction features are only active in the overview, and they turn off when people are close to the display to avoid bystanders disturbing people who are interacting using touch.

Note that we do not use silhouettes or skeletons to represent people on the display. While these provide stronger cues for people to interact with a display and recognize that it is reacting to their movements [1,9,16], they take up space, disturb the visualization content, and affect the overall experience. Nevertheless, exploring how these representations can be better integrated into visualizations is an interesting direction for future work.



Figure 4. People using the application in the video view during its deployment in the library. Five people are interacting, while a passerby glances at the display.

Implementation

We downloaded the AuroraMAX image data from the data page of the Space Physics Groups of the University of Calgary [19]. For every night, there are thousands of images depending on the length of the given night (approximately 1 GB / night). We use a Python script to read a vertical line of pixels in the middle of each image and to combine them into one output image, which are then loaded into the application.

The application is written using web technologies such as HTML, CSS and JavaScript. To support proxemic interaction, we use a Kinect v2 sensor and a small C# program that interacts with the Microsoft Kinect SDK. This program provides tracking data in JSON and communicates with the rest of the application via web sockets. This setup provides flexibility to deploy the application offline on a large display with a Kinect sensor. It also makes it possible to run the application on a website that anybody can use on their devices, regardless of whether they are touch-enabled.

Deployment and Initial Findings

We exhibited the application on a large touch display with Kinect sensor in the entrance hall of the Taylor Family Digital Library at the University of Calgary for a day, as shown in Figure 4. This provides us with initial insights into how people react to the visualization, and how they interacted with it. The overall appeal of the

installation was quite high. We had around 40 groups, consisting of one to five people, interacting with the display. We also observed that the proxemic interaction features helped to get people to notice the display while walking by and invite them to interact with it.

Conclusion

We designed a visualization for Aurora Borealis image data on a large touch display to provide an immersive experience for the general public. Our visualization uses proxemic interaction to entice people to interact with and engage with the display. Findings from an initial deployment suggest that this holds promise for drawing people in, and can result in engaging experiences, providing opportunities for science outreach.

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