The Eye of the Sun — A touch- and motion-sensitive, interactive, audio-visual sculpture combining curiosity and solar physics

TIM SCHNEIDER, Université Paris-Saclay, CNRS, Laboratoire Interdisciplinaire des Sciences du Numérique (LISN); La métonymie, Le sas, France
GÉRARD KUBRYK, Université Paris-Saclay, CEA, CNRS, Inserm, Biomaps; Forum des images; La métonymie, Le sas, France
VINCENT HULOT, La métonymie, Le sas, France
MATTHIEU COURGEON, CERVVAL, France
DAVID POIRIER-QUINOT, Institut d'Alembert, Sorbonne Université, CNRS, France
FRÉDÉRIC AUCHÈRE, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, France
FRÉDÉRIC BAUDIN, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, France
ÉRIC BUCHLIN, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, France
XAVIER MAÎTRE, Université Paris-Saclay, CEA, CNRS, Inserm, Biomaps; La métonymie, Le sas, France

In this paper, we present *the Eye of the Sun*, a solar composition for visitors, sensors, speakers, computers, lenses, mirrors and video projectors, in aluminium and acrylic. *The Eye of the Sun* is a motion- and touch-sensitive digital sculpture representing a gigantic human-like eye with a realistic aesthetic. The size of a human being, it is spherical, white and vascularized. It is connected to the surrounding world by an electrical optic nerve, has its own behaviour and is animated by rapid eye movements to scan the space around it. When spectators interact with the Eye in the right way, it unveils to the public the Sun as seen in the ultraviolet spectrum. *The Eye of the Sun* is a play on curiosity that seeks to redefine the spectator-artwork relationship.

CCS Concepts: • **Applied computing → Media arts**.

Additional Key Words and Phrases: Interactive Art, Digital Art, Audio-visual, Touch-sensitive, Solar Physics, Astrophysics

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Authors' Contact Information: Tim Schneider, tim.schneider@lisn.fr, Université Paris-Saclay, CNRS, Laboratoire Interdisciplinaire des Sciences du Numérique (LISN); La métonymie, Le sas, Orsay, France; Gérard Kubryk, Université Paris-Saclay, CEA, CNRS, Inserm, Biomaps; Forum des images; La métonymie, Le sas, Orsay; Paris; Orsay, France; Vincent Hulot, La métonymie, Le sas, Orsay, France; Matthieu Courgeon, CERVVAL, Brest, France; David Poirier-Quinot, Institut d'Alembert, Sorbonne Université, CNRS, Paris, France; Frédéric Auchère, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, Orsay, France; Frédéric Baudin, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, Orsay, France; Éric Buchlin, Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS, Orsay, France; Xavier Maître, Université Paris-Saclay, CEA, CNRS, Inserm, Biomaps; La métonymie, Le sas, Orsay, France.

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1 Introduction

Our need for stimulation and information is insatiable. Curiosity is one of the most powerful and laudable engines of the human being. Curiosity is also a disparaged and pernicious feature. On the one hand, it may be unhealthy but, on the other hand, it does urge the discovery of the world and the encounter of others. Curiosity drives exploration, inquiry and learning. Curiosity is an inner desire, an emotion that modifies our psychic and physical state. In other words, it is a state that is reproduced in very different contexts and therein defines us. It is the emotional rapture of curiosity and the ambiguity of its consideration that inspired *The Eye of the Sun*, a solar composition for visitors, sensors, speakers, computers, lenses, mirrors and video projectors, in aluminium and acrylic.

Space-times of feeling and understanding, knowing and sharing, motion and emotion, art and science tend here towards reciprocity. In a multidisciplinary experimental laboratory, they keep an eye on each one of us. Wide open to any primary interaction, such as touching or nearby movement, *The Eye of the Sun* invites everyone not to avert their eyes but to cross looks in dynamic exchange and sharing (Fig. 1).

2 Concept and technical details

2.1 Concept

The Eye of the Sun is a motion- and touch-sensitive digital sculpture representing a gigantic human-like eye with a realistic aesthetic. It consists of two hemispheres with a diameter of 1.7 m which act as hemispherical screens for two on-board video projectors. The installation is a play on curiosity. It seeks to redefine the spectator-artwork relationship. Upon arrival, visitors find themselves face-to-face with the Eye which looks at them (Fig. 1, left), periodically blinks, squints (Fig. 1, right), changes its iris colour, and follows visitors around as they move and try to walk around it. The result is an inversion of the established roles: it is now the artwork that is curiously watching the human visitor. When curiosity is returned and the visitor performs the right gesture (see Table 1), the Eye opens up and reveals its interior, an interactive simulation of the surface of the Sun (Fig. 2) showcasing images of the solar corona captured at different extreme ultraviolet wavelengths ($\sim 10 - 170$ nm) by NASA's Solar Dynamics Observatory satellite [5]. The Sun is no longer this serene eternal yellow orb suspended in the sky but a living celestial body with its own internal dynamics that can be perceived once we go beyond the visible light spectrum. Taken for granted and for good, the Sun is here laid open with nuclear reactions deep inside, γ photon emission and diffusion to the periphery, their propagation and partial absorption down to Earth. The Sun paves the way for research that pushes the boundaries of knowledge and understanding further.

2.2 Technical setup

The two hemispheres on which the images of the Eye or the Sun appear are connected by a 15-cm-thick central technical disk that houses the two video projectors alongside the required optical equipment (lenses and mirrors), a network router, a sound card, and the several power supplies and cables (Fig. 3). Moreover, 16 infrared cameras, 8 loudspeakers and several ventilation fans are positioned around this technical equator. Along the light path, each video projection system is composed of a long focus video projector fixed horizontally to an equatorial metallic plate located inside the technical disk, two optical lenses that aim at focusing the image produced by the video projector on a small area (1-2 cm in diameter) where an oblique mirror directs the projection either upward or downward, and a very short focus (quasi-hemispherical) optical lens to project the image on an even smaller surface (1-2 mm in diameter) where a fisheye lens is set to cast the image over the whole hemisphere.

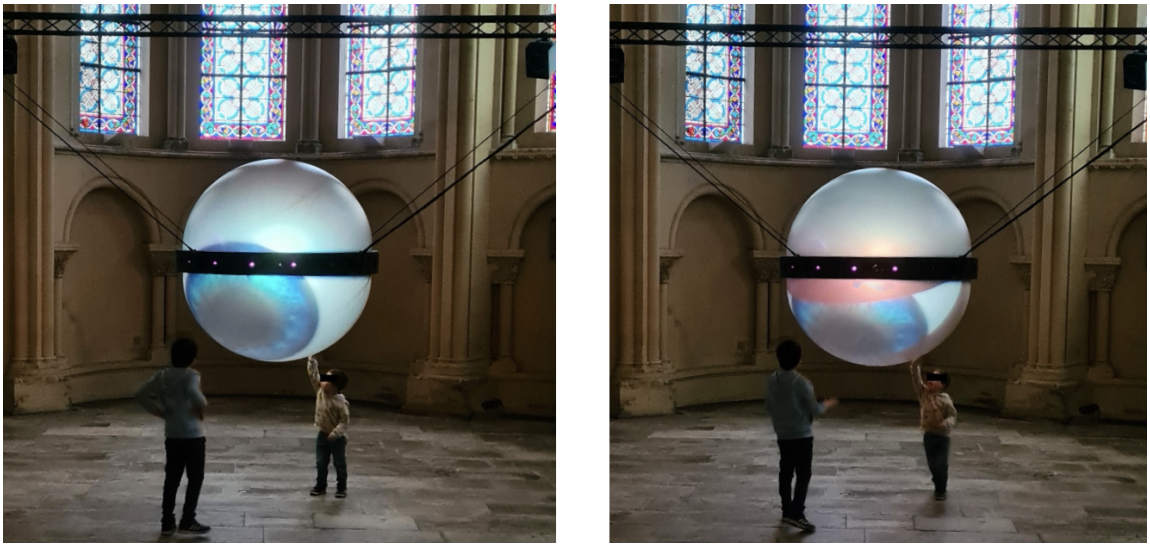

Fig. 1. Young visitors interacting with the Eye (left). The Eye squints after being touched (right).

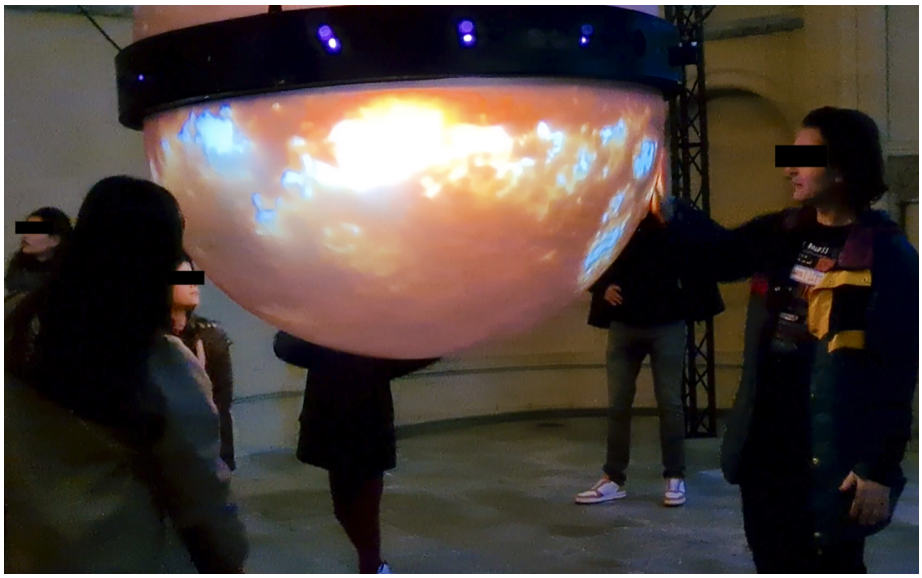

Fig. 2. Visitors exploring the surface of the Sun and causing coronal perturbations with their touches.

The 16 infrared cameras are used to detect motion around the Eye. The loudspeakers provide spatialized sound effects when the Eye blinks, squints, moves or when certain interactions are performed (Table 1). Finally, two more wide-angle infrared cameras are installed centrally on both sides of the equator disk allowing for hand detection through the semi-transparent hemispheres. The motion- and touch-detection, interaction responses, graphics and audio are

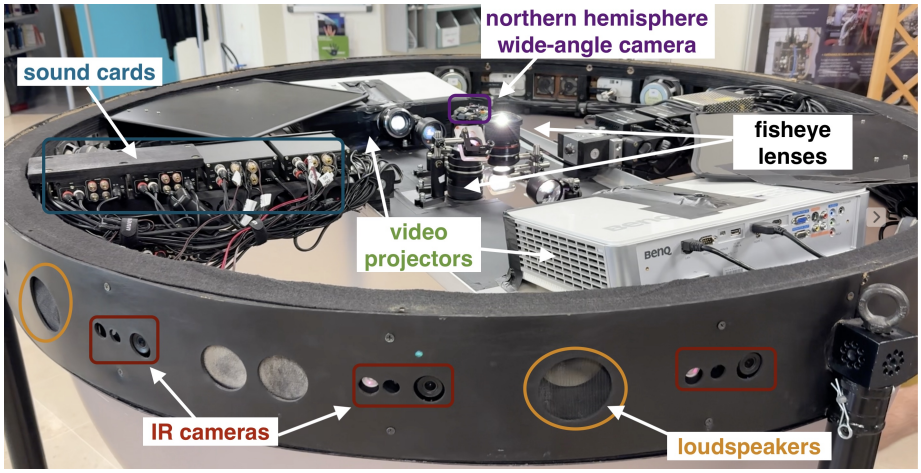

Fig. 3. The Eye with its northern hemisphere taken off to reveal the technology hidden inside it.

controlled by custom-developed codes on a Dell Precision 7920 computer located a few meters away from the Eyeball and connected to it via two RJ45 cables for sound and video streams.

2.3 Software development and interactivity

The Eye and the sun are rendered using a proprietary OpenGL [2] game engine implemented in C# and Microsoft's .NET framework [4] (Fig. 4, bottom row). A custom motion-detection algorithm developed in Python using the OpenCV library [1] allows the Eye to *see* and follow visitors moving around it. The input to the algorithm is a panoramic view of the Eye's surroundings (Fig. 4, middle row), stitched together from the images of the 16 infrared cameras distributed around the technical equator. To localize clusters of motion, the differences between consecutive images are computed, filtered and joined by size and proximity. The new target for the Eye's gaze is calculated as a function of the size of the motion clusters and their distance from the current gaze direction.

A peculiarity of the Eye is its multi-touch sensitivity. This is achieved through two wide-angle infrared cameras installed on either side of the equator disk which allow it to survey the northern and southern hemispheres from the inside (Fig. 4, top row). An object detection model based on the nano version of the YOLOv8 architecture [7] was trained on 800 manually labelled images to recognize hands touching the two hemispheres of the Eye (Fig. 4, top right). This haptic interface opens up different interaction possibilities with the Eye (which will twitch and squint when touched — like a real eye) and especially with the Sun where users can trigger ripples in the solar surface (Fig. 2), cause coronal mass ejections or swipe between coronal layers captured at different wavelengths (Fig. 4, bottom row). Table 1 lists the implemented interaction modalities alongside the corresponding events triggered in Eye and sun mode.

3 Exhibition during *Nuit Blanche* 2024 and immersion study

The Eye of the Sun was installed in the Museum of Arts and Crafts, Paris, and more precisely in the apse of the St-Matin-des-Champs church belonging to the exhibition spaces of the museum. The spherical sculpture was suspended from a 4.5 m-tall aluminium structure that was erected specifically for this occasion. Eight more loudspeakers as well as two subwoofers were installed on and around the aluminium structure to provide the ambient soundscape and a standard

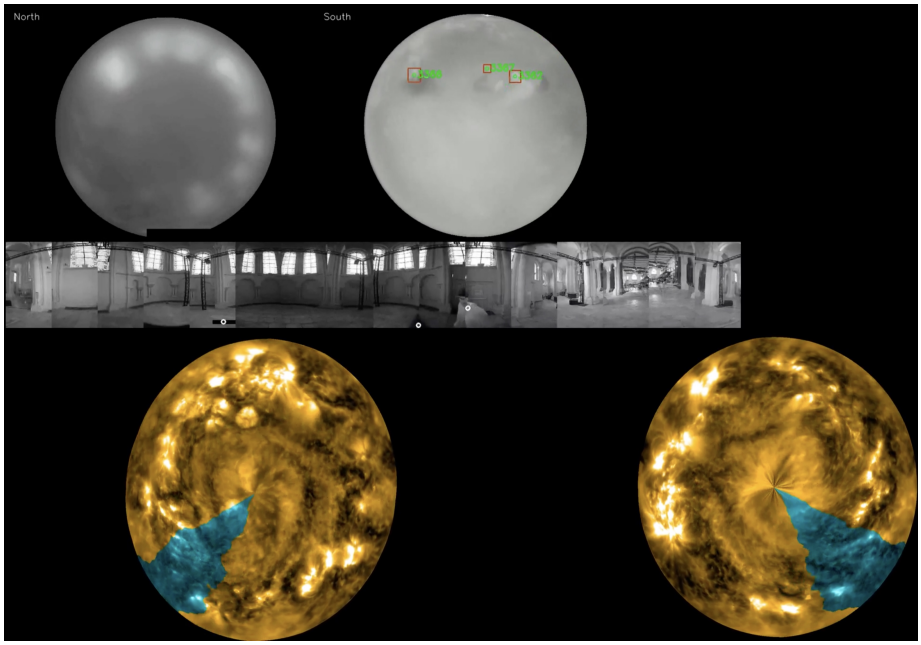

Fig. 4. A screenshot illustrating the different camera inputs and how the Sun is rendered. Top row: Views of the northern and southern hemispheres captured by the two wide-angle cameras hidden inside the Eye. In the south, three touch events are detected (red rectangles) and tracked with unique identifiers (green numbers). Middle row: A panorama of the Eye's surroundings stitched together from the 16 infrared cameras positioned around the equator. Clusters of motion are detected and marked by a white circle. Bottom row: The images rendered for the north and south hemisphere video projectors. The touches of a visitor are about to trigger a transition between two coronal layers (yellow and blue sections). Note the distorted circle shapes which compensate for aberrations along the optical path and assure a neat final projection onto the acrylic glass hemispheres.

24-inch computer screen was attached to one of the aluminium pillars to represent a "thermometer", indicating the temperature and wavelength of the current coronal layer when in Sun mode. The installation was included in the usual museum admission and was accessible to the general public during the event *Nuit Blanche* 2024, where it was seen by over 3000 visitors, and for the two weeks following the event. *The Eye of the Sun* was included in a comparative field study together with three other experiences of varying degrees of immersivity in (1) virtual reality (VR), (2) cylindrical 360° video projection, and (3) floor and wall video projection. Subjective user experiences were assessed for each installation using a questionnaire that primarily addressed the spatial presence in immersive environments, SP-IE [3]. The study results suggest that the intuitive interaction design of the Eye (motion and touch detection) as well as its realistic aesthetics lead to a high perceived affordance and realism of the installation, exceeding even the scores reported for the VR experience considered in the study [6].

4 Conclusions

Presence is usually expected to increase with the degree of technical immersivity of a system. Even though the immersivity of *The Eye of the Sun* is very low with respect to enforced virtual reality systems with head-mounted devices or 360° videoprojection, the behavioural function and the natural interaction with the Eye and the Sun capture visitors' attention, promote their engagement and encourage a constructive personal or collective exploration of the

	User interaction	Triggered event
Eye mode	movement around the Eye	Eye changes its gaze direction, focussing on nearest, largest motion cluster; large movements are accompanied by a "swoosh" sound
	continued walking around the Eye, leading it to do a half-turn	Eye opens up to reveal the sun + impact sound
	touching the Eye	Eye squints, gaze directed at hand + shrill ringing sound
	touching the Eye when Sun can be seen through its pupil (happens every 60-120 seconds for a few seconds)	Eye opens up to reveal the sun + impact sound
Sun mode	short static touch (<2 s)	triggers concentric ripples in the solar corona propagating outwards from the touch position + popping, impact sound
	prolonged static touch (>2 s)	plasma protuberances (coronal mass ejections) start growing radially outwards from the touch position
	touch performing an azimuthal swipe motion	another layer of the solar corona (corresponding to a different UV wavelength) is uncovered; once the swiping motion crosses a threshold angle, the transition to the next layer completes automatically and a swoosh sound is played

Table 1. Interaction modalities and triggered events implemented in the Eye and Sun modes.

work [6]. *The Eye of the Sun* is where art and science meet. It challenges visitors' curiosity and plays with their emotions and reason. It also challenges the demands of immersion, as visitors are not immersed in the artwork. They see it from a distance. They turn around it. Sometimes they touch it. Such interactions create a strong bond between the visitors and *The Eye of the Sun*, so that they can engage in a real dialogue with the artwork and feel drawn into its reality.

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