Wave Alchemy: Perception and Reminiscence of Expressive Moments through Waves

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Abstract

Life is full of moments that come with obvious or subtle expressions of energy. It is common for us as human beings to attach different emotions to such expressions. However, when we want to capture it and interact with them, we are often constrained to flat, 2D encapsulations of video, audio, or photographic recordings. Moreover, the way we would look back at a memory in this digital age is now often through a screen with hundreds of files digitally stored away, further removing the experience of the event's emotion. Authors question what if there was a way to experience this emotional energy again, and dynamically interact with it in infinitely complex ways. Here we present a concept and prototype that explores a novel physical-visual language of dynamic, emotionally expressive waveforms, designed to transform the way we perceive different forms of energy as we go about our daily lives. With the power of computation hidden within the physical materials used in the interface, we create an interactive form that takes one form of energy and transmute it into a waveform as its output, or Wave Alchemy.

Author Keywords

Wave interfaces, haptics, actuated displays

ACM Classification Keywords

H.5.2. User Interfaces.

Introduction

"The simple things are also the most extraordinary things, and only the wise can see them."
— Paulo Coelho, The Alchemist

Nature is full of examples of simple events that nevertheless enchant us, such as the dance of flames that we can sit in front of contently for hours. The waves of the ocean, or the ripples created by a canoe gliding through a lake, are other examples. In this paper we present a novel concept along with a work-in-progress prototype that explores a bidirectional interaction through emotionally expressive and context-aware waveforms.

In this paper authors propose a bidirectional physical I/O system with physical wave being the interface.

Wave

We have explored wave as a medium of interaction for two reasons, its expressiveness and versatility of emotions. Humans are usually good at perceiving the cause of a wave, and then attaching an emotion to it. A wave in water can result from a gentle breeze, or a gusty wind, or a heavy rain, or a stone thrown by a lonely soul, or the complex mechanics of invisible under-current and strong gravitational forces. The capability to represent such a wide range of complex emotions justifies the introduction of yet another user interface paradigm.

Alchemy

The term 'Alchemy' most commonly evokes the thought of transforming one material into another. Through computations hidden within the physical interface, we create an interactive form that can take one form of energy and transmute it into a waveform as its output, which we have named Wave Alchemy.

Wave Alchemy and the evolution of Tangibles

Tangible interfaces have undergone remarkable changes in the past two decades. Generally starting from static passive interfaces, we have seen tabletop modeling in the form of metaDESK and Urp, and computationally updating models in the form of Sandscape and Illuminating Clay [2]. The movement towards kinetic and active investigations brought about transformable materials such as Relief and Recompose, moving objects within PICO, and embodied kinetics like Topobo and Intouch [2]. We drew inspiration from the idea of contextual awareness, and combined it with transformable properties that would be visually evocative and tangible as well. Wave Alchemy is similar to an embodied kinetic in the sense that it can take input and store it, to be brought out later (or synchronously as a waveform output, as in the case of InTouch). An intriguing related work is that of Pete Bennett [7], whose Chronotape is a tangible timeline that users can interact with to access previous history. Our system differs from previous work through the sense that it takes both human gesture/direct manipulation and environmental energy/entropy as inputs. It serves as a means to materialize and interact with the energy of events and emotions occurring around us.

Design inspiration

Our primary design inspiration for Wave Alchemy came from an art installation called 'Waves' by Daniel Palacios [4]. 'Waves' is a rope-based mechanical wave machine, which detects the presence and motion of viewers around it. Depending on these contextual parameters, the frequency of the rope and the sound it generated are altered. If the audience was mostly immobile or still, the waves and sound environment was more harmonious. In other situations, it was more irregular and chaotic. Natalie Jeremijenko's Dangling String is also similar in the design of the cables' responses to the Internet traffic around it [8]. We found a number of other implementations with varying degree of complexity, from the classic Shive Wave Machine [6] to gigantic architectural robotic surfaces like HypoSurface [1]. We chose to follow the simplest technique [5] to avoid the users from getting overwhelmed by the complexity of the interface itself [3].

Design

Our design decisions were mainly motivated by the range of wave movements possible from both the auditory realm and from wave physics. For example, sounds can come in the form of clicks (pulses) and tones (standing waves), of many varying tempos (beat speeds). In thinking of various ways to manipulate wave signals, we imagined changes in the dampening or resonance of the waveform.

Implementation

The Wave Alchemy system (Figure 1) comprises of an array of 34 equidistant sticks as cross-arms, a duct-tape as the medium, a metal structure to hold the wave in tension and one stepper motor controlled by Arduino and Processing code. Each stick has two equal-weight blobs of magic-clay at two corners. At current stage of implementation, the Processing code listens to the sounds in the environment, and converts it into motor step commands through Arduino. The motor causes its nearest stick to oscillate at a certain frequency and amplitude. That energy is then transferred from one stick to the next one, causing wave propagation. The other end of the system is tied to a rigid stand.

Amplification

The sensitivity of Wave alchemy is reconfigurable. It can amplify, attenuate or maintain the amplitude of the signal it is listening to. When placed next to a faucet, its amplitude rises to the maximum level, and then gradually reduces to the minimum, following the water-flow (Figure 2).
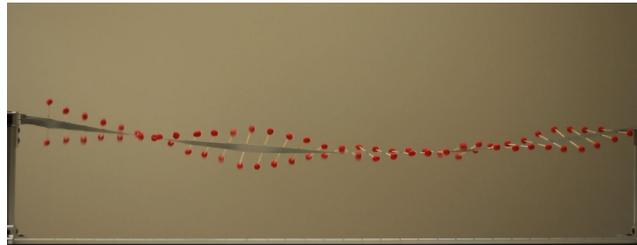

Figure 1. Wave Alchemy system.
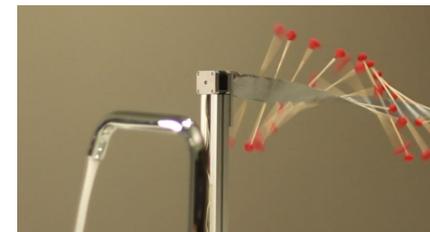
Figure 2. Wave Alchemy generated by a faucet.

Harmony Detection

When a crowd cheers for their favorite team, they usually say a number of words repeatedly and synchronously. Wave machine then assumes the shape of a standing wave (Figure 3).

Transient events as pulses

Wave alchemy when coupled with sensors can also be used for notification of transient events, like clapping, incoming email, temperature, number of people etc. (Figure 4).

Figure 3. Standing wave from remote synchronous cheer of a crowd.
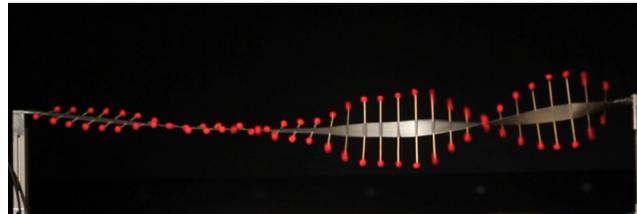
Figure 4. Transient pulse propagation from clapping.

Tempo

Each genre of music maps to a signature pattern in Wave Alchemy system (Figure 5).

Extended Projection

Even the shadow of the Wave Alchemy can be used as a form of interface. Depending on the position of the light source, the amplification can be controlled (Figure 6).

Use Case Scenario

Reminiscence through Dynamic Physical Querying

With the ability to capture and store events and memories of all different energies and emotions, Wave Alchemy can transform the way we interact with the contextual information of any place in the past. A Wave Alchemy system can be used for reminiscing, or searching. Imagine our system to be situated in a city neighborhood on a quiet sunny morning in May. As the sun ascends into the sky, birds begin to chirp more loudly and our waveform ripples gently in response.
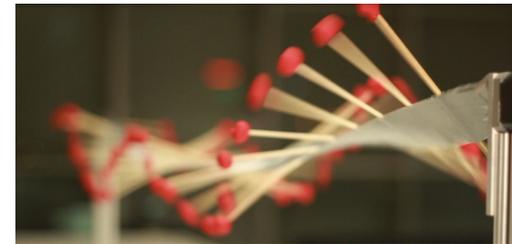
**Figure 5.** Wave Alchemy from music.

Figure 6. Shadow of Wave Alchemy.

Through an open window, the sounds of a shower starting and coffee being poured emanate, and the wave responds with greater vigor. Over the course of the morning and into the day, the energy of the city permeates into the air around the waveform and it dances in response, and collects all of this energy into a form of memory.

Later, a user who wants to know more about what happened in the vicinity can come to the waveform, and query through direct physical, dynamic interaction with the components (Figure 7). The search results depend on the ability of the user to correctly input expressive motion that matches the energy of what he wishes to find from the past. We imagine future development of our interface to include innovative ways the user can then experience the results found with expressive input, perhaps a medium beyond mere

visuals or audio recordings. Thus, Wave Alchemy not only takes as input the environmental, contextual energy of life occurring around it, but also requires the user to move and incorporate emotion into their query. Previous explorations of emotional information retrieval include one by Schmidt and Stock [9], who created a database of emotional images through user input and discussed the potential of using this information to query emotionally.

However, querying with Wave Alchemy is still a contrast to current common ways of searching with online engines, or manually through digital compilations of media. Whereas current methods are often point-click-type, here the user must think in terms of what dynamic, expressive physical movements match what he is searching for.
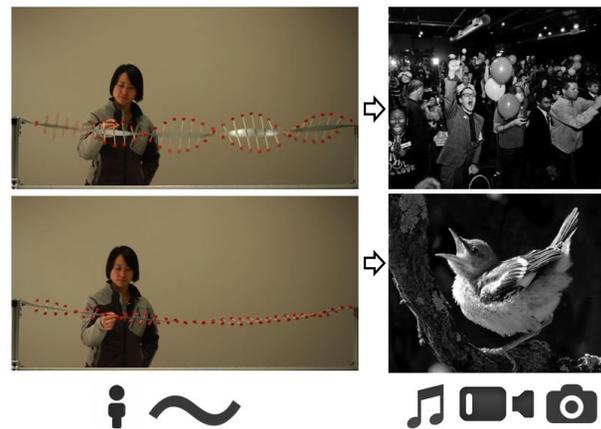
Figure 7. Dynamic physical querying by modulation of amplitude

Evaluation

As for a preliminary evaluation, we deployed the Wave Alchemy system at an in-house party with about 100 attendees. We set it up so that it reacts to the noise level of the party room in real-time, and installed it as an ambient display device that expresses the real-time excitement of the atmosphere in a physical wave format. According to the feedback and comments by the attendees, we were able to verify that the physical wave representation generated by Wave Alchemy is effective and meaningful for indicating the current status of the atmosphere to the users. We also got positive feedback for its attractiveness as an interactive installation.

Future Work

The next step for advancing the current prototype would be to add an input framework to the system. As described previously, the ultimate goal of this system would be to not only represent contexts in wave format, but also allow users to query past events and occurrences through the manual input of waves. We are considering implementing this using a vision-based motion detection technique. We will also conduct a detailed user study to evaluate the intuitiveness of this input framework, along with the existing physical wave output.

Conclusion

In this extended abstract, we proposed and implemented a prototype, Wave Alchemy system, which translates expressive moments into physical waves.

As a burgeoning area of interest in the HCI field is the development of computational systems that better recognize and represent emotion, we believe the Wave Alchemy system can facilitate this. Many current I/O systems constrain interactions to visualizing screens, point-click-type commands, and almost purely informational means of communication. Considering that estimates of the prevalence of non-verbal communication between humans run as high as 50-65%, it seems likely that for I/O systems to truly tap into the range of human expression in the future, they must include abstraction and movement such as exemplified by the Wave Alchemy system.

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