WeatherTank: A Tangible Interface using Weather Metaphors

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ABSTRACT
We present WeatherTank, a tangible interface that looks like a vivarium or a diorama, and uses everyday weather metaphors to present information from a variety of domains, e.g., "a storm is brewing" for increasingly stormy weather, indicating upcoming hectic activities in the stock exchange market. WeatherTank represents such well-known weather metaphors with real wind, clouds, waves, and rain, allowing users to not only see, but also *feel* information, taking advantage of our skills developed through our lifetimes of physical world interaction.

Keywords
Weather metaphors, tangible interface, universal interface.

INTRODUCTION
Metaphors—concrete images that illuminate abstract ideas [4]—are common in user interface design [1]. We propose to use the rich and well-understood natural phenomena of weather as metaphors to represent abstract information from other domains. Many people, irrespective of educational level, literacy, and profession, understand weather metaphors intuitively.

In this paper, we present WeatherTank, a tangible visualization system that uses weather metaphors to give an overview over information, employing our visual, tactile, and—indirectly—aural and olfactory senses. WeatherTank conveys a weather metaphor in a different way than a verbal description does, because it predominantly uses cognitive resources of our spatial/visual thinking (right hemisphere), conflicting less with our busy verbal/vocal brain processes (left hemisphere). Furthermore, unlike pictures and movies of weather, WeatherTank also employs our tactile and olfactory senses, taking advantage of the richness of multimodal human senses and skills developed through our lifetimes of interaction with the physical world.

WEATHER METAPHORS
We all experience weather and are affected by it. It is not surprising that from the earliest times on, mankind was studying the winds, the waves, the clouds, and other objects from which the signs of coming changes in the air and the sea might be foretold. As a result, a rough set of rules about the weather has been passed down the generations. Some of these observations have settled down into the form of proverbs; others have taken the shape of rhymes. They might vary according to local idioms, but own a common origin and purport [3]. "A storm is brewing" talks about imminent trouble. "This is just the tip of the iceberg," means that a large part of a problem is still hidden. We suggest using such metaphors to represent complex data from other domains. Some examples: A morning of an unsteady stock market could be visualized with stormy weather. Later, when the market starts to "settle down," the clouds and winds would disappear, showing a more moderate and warm climate. In the domain of network conditions, congestion can be represented as clouds, heavy traffic as high waves, intrusion attempt as lightning.

THE WEATHERTANK SYSTEM

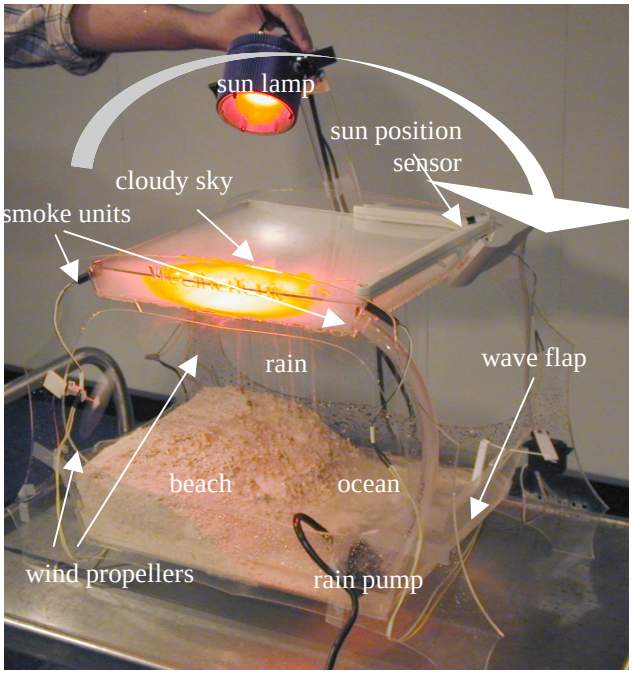

Figure 1: WeatherTank

The system is implemented in an acrylic tank like structure, 62cm wide, 41cm high, and 30cm deep (Figure 1). It consists of two sections: The lower section corresponds to land and ocean, and contains water and the model of a

coastline with sandy beach. The upper section, an enclosed transparent box, corresponds to the sky from where rain falls and where there can be clouds. The active weather components are: sun, rain, clouds, waves, wind.

Interactions

Any combination of these components can be used to display a weather situation. Up to 12 different weather situations are possible per day, which allows for complex and dynamic daily weather patterns. The user can modify the time of day by positioning the sun at the appropriate position in the sky, playing back the weather situation of that time. This sun, a color-changing lamp, is mounted on a rod that rotates along an arc over the tank. The color changes dynamically to express the time of day. When the sun is rising (on one side of the tank), it is red. When it's moved towards its peak position, it gradually becomes white, and if it is moved even further, it turns again orange and red until it "sets" on the other side of the tank. Each position of the sun (time of day) can be associated with a different weather situation.

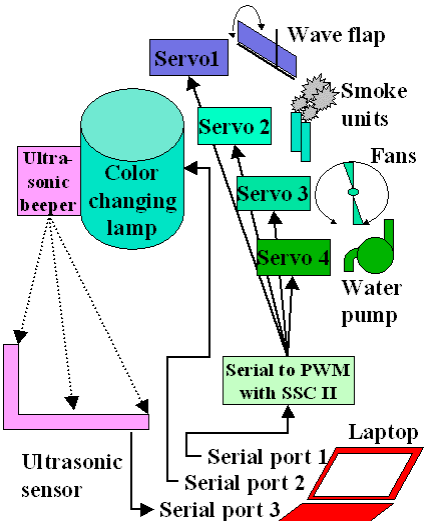

Figure 2: Functional schematic

Technical implementation

WeatherTank is implemented as follows (Figure 2): The absolute coordinates of the sun are determined with a sensor (ultrasonic trilateration) and evaluated by a PC, which changes the sun's color, hue, and brightness accordingly. Clouds are produced using four chemical smoke units. The smoke is lead into the upper transparent box, so that a thick layer of clouds can appear "in the sky." Clouds can filter and break the light from the sun, changing its intensity and diffusion. A water pump transfers water from the lower box (ocean) to the upper box (sky). From there, it rains down through an array of holes. Waves in the ocean are created using an underwater flap, driven by a servo. The flap's amplitude and frequency can be modified to create a rich array of waves, from light ripples up to heavy breakers. Wind is created using two propellers, mounted on the pillars that connect the lower and upper box. Wind is not only felt directly by the user, but also influences the formation and persistence of clouds, the direction of a downpour, and the ocean's surface in an aesthetic and realistic way. As a byproduct, WeatherTank also generates a distinctive array of smells, depending on what amounts of clouds, rain, and wind are present.

RELATED WORK

Abundant work has been done in the area of metaphors in the user interface (e.g., [1]), as well as tangible interfaces. E.g., Dahley et al. [1] suggested ambient fixtures called *Pinwheels* and *Water Lamps*, which present information through subtle changes in sound, light and movement. However, WeatherTank focuses on well-known weather metaphors to convey meaning; it can reproduce fairly complex and realistic weather situations in a compact, desktop size box; the user can feel, touch, and smell the weather elements very realistically.

CONCLUSIONS

In this paper, we present WeatherTank, a tabletop size installation that produces real wind, clouds, waves, and rain to represent and summarize complex data such as stock reports. Our intention is to give the user a "real feel" for data, using well-known weather metaphors. We expect that WeatherTank presents data in a more physical way than GUIs do, since the user can feel (and smell) the stormy wind, the wet rain, the pounding waves, and sun obstructing clouds with her own hands. The system, implemented as a proof of concept, was demonstrated in an interaction design class at MIT, and about 20 students with computer science, architecture, and design background played with it to test the implemented weather situations such as stormy morning and mild sunset. Being inspired by this prototype, they gave us valuable feedback about the possible use of this interface, for example, displaying their current emotional states, or visualizing abstract information in architectural installations.

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