WeatherTank: Interface for Non-literate Communities and Ambient Visualization Tool

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ABSTRACT
Information and communication technologies have provided significant opportunities in the economic, cultural, and political spheres. However, only a small fraction of the human race is enjoying those benefits [1]. One of the main barriers to using these technologies is illiteracy. In this paper, we discuss how tangible and ambient media developed by the Tangible Media group at the MIT Media Lab can be used to circumvent the literacy requirements for participating in the digital revolution. To illustrate our points, we present WeatherTank, a water tank based installation that presents location specific weather forecasts with desktop sized wind, clouds, waves, and rain. WeatherTank can be used also less literally to visualize information such as a person's current mood, or more abstract information such as network traffic.

Keywords
Non-literate communities, universal access and tangible interfaces, weather visualization.

INTRODUCTION

There are two kinds of barriers to accessing the information technologies: barriers to connectivity and barriers to use. The barriers to connectivity are due to high costs of technology, lack of infrastructure, and ineffective policies. The first two issues are being addressed by initiatives such as the Digital Nations project [2] and LINCOS (Little Intelligent Communities) [3] at the MIT Media Lab, by developing community computing resources and low cost access devices. E.g., five rural communities in Dominican Republic have been provided with LINCOS containers that serve as community computing resources.

Some remote rural communities are fortunate to have access to such computing resources. However, they are not able to effectively use those technologies due to lack of appropriate interfaces and their own illiteracy problems. In this paper, we discuss how tangible and ambient media could be used to overcome illiteracy barriers. To illustrate this, we have developed WeatherTank, a water tank based location specific weather visualization system.

BACKGROUND

Anthropologists have found that many early civilizations used physical artifacts to store and process information. A few examples are finger based counting, Lusaka (memory board) (e.g., [8]), and the Abacus (e.g., [9]).

More interestingly, many non-literate communities are able to operate and maintain complex machinery such as automobiles and farm equipment just by 'touch' and 'feel' without reading any user manuals. However, they are not able to benefit from wealth of information available on the web and utilize the communication facilities that are available on the Internet. Some of this information can be vital, such as reports about epidemics, weather situation, etc.

For most communities, information about the local weather is very important. For example, accurate weather information would be crucial for the fishermen in scheduling their fishing expedition [4].

Tangible User Interfaces for Non-literate communities

Tangible interfaces do not rely primarily on characters as mode of communication, but on other means such as touch. Furthermore, information is not only presented with a graphical user interface (GUI), but also with alternative solutions. Therefore, such interfaces could be effective in alleviating the information poverty these communities suffer from.

As an example for such an installation based on tangible user interface paradigms [5], we would like to introduce WeatherTank (figure 1). It consists of a desktop size installation that, in conjunction with a computer and Internet connectivity, can be used to present weather forecast information, or any kind of more abstract information mapped to weather phenomena like storm or bright sunshine.

RELATED WORK

Although miniaturized landscapes are common for model train installations, they are not built to visualize weather at all, but just to illustrate a static landscape surrounding the moving miniature trains.

Dodge et al. have proposed *Sandscapes*, an installation that consist of a natural landscape. "The surface of sand permits a four-dimensional display of information over space and time. The resulting Sandscapes is a dynamic sculpture that encodes abstract expression through its shape, form, and texture." [6] It was supposed to be an artistic mapping of bits to structures on the sand dunes, and the authors did never intend to create realistic weather patterns. The project was never realized.

Figure 1: Current implementation of WeatherTank

Dahley et al. [7] have suggested ambient fixtures called *Pinwheels* and *Water Lamps*, which present information through subtle changes in sound, light and movement. These installations could be considered as direct ancestors of our WeatherTank. However, WeatherTank has much richer expressive capabilities because it can reproduce complex and realistic weather situations.

THE WEATHERTANK SYSTEM

The system is a tank like structure built out of laser cut Acrylic. It consists of two portions: the upper portion corresponds to sky, and the lower corresponds to earth and ocean. The lower portion contains water with the model of the coastline, representing sandy beach.

The currently active weather components in the system are sun, rain, clouds, waves, and wind.

Interactions

Interactions of the system are:

Input

The system has an intuitive and tangible interface: a lamp that represents the sun. This sun is mounted on a rod that can be used to move the sun along an arc over the tank. A complete of sweep arc by the sun corresponds to 12 hours of day. The arc is also divided into smaller segments that correspond to 2-hour intervals. Therefore, the current system implementation can be used to show weather forecasts just for a day.

Output

The color of sun changes to indicate the change in time. When the sun is rising, it is bright red. The presence of clouds, rain, waves and winds correspond to appropriate real weather conditions.

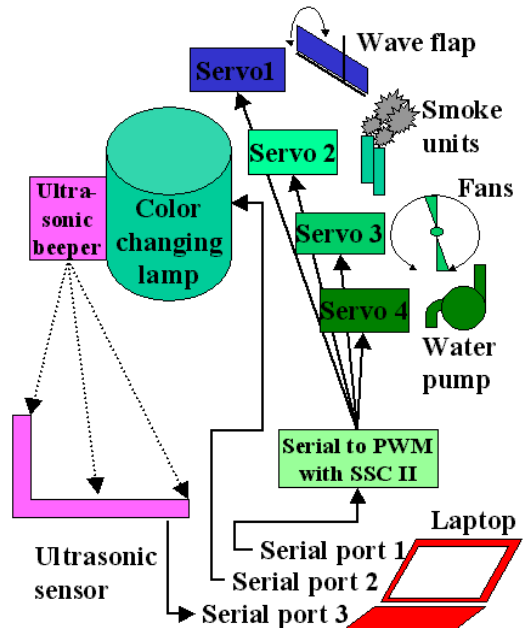

Figure 2: Functional schematic of WeatherTank

Technical Overview

The following are the current components (figure 2) and their technical implementations (figure 3):

A ColorKinetics C-75 series light that can be networked and controlled by a PC through a serial port acts as the sun. This lamp can be controlled from the computer to change color, hue, and brightness.

When this sun moves across the tank to represent progression (or retrogression) of time, a 3D-position sensor by Pegatech senses the position of sun and sends the absolute coordinates back to the PC. Depending on the position of sun, different weather conditions are created in the system.

Clouds are produced using four smoke producing units that are switched on and off by a servomechanism.

Rain is created using water pump that sucks the water out of the lower chamber and pumps it up into the upper chamber. The bottom portion of the upper chamber contains and array of holes to let the water drip down like rain. The rain is controlled programmatically using another servo mechanism.

Waves are created using a flap that moves horizontally inside the water. The amplitude and frequency of the waves are controlled using a servomechanism, creating a rich array of possible waves, starting from light ripples up to heavy breakers.

Finally, wind is created using two motors with mounted propellers.

All the required software is written in Java and C++ using ColorKinetics DMX API, Javasoft's serial communication API, Pegatech's sensor API.

Figure 3: Details of prototype (from top left to lower right): rain and cloud box; lamp as sun; fan with gearbox; rain pump, wave flap, and wave generator servo.

Development of the prototype

The tank was first sketched manually (figures 4 and 5). First, several tests were conducted with different sizes and shapes of the upper portion of the tank, to get the most realistic rainfall and clouds. E.g., if the holes of the upper box were too small, the water would not fall nicely because of its surface tension. Several water pumps and tubes of different diameters were tested to direct the water and the clouds into the upper box. During these tests, we have realized that some weather patterns do not scale down easily, like clouds. First tests were made with dry ice and humidifiers. The former, due to its low temperature, is heavier than air, which makes it drop too quickly. The latter would have the advantage of being "real" clouds, but this mist disappears too fast and is difficult to generate.

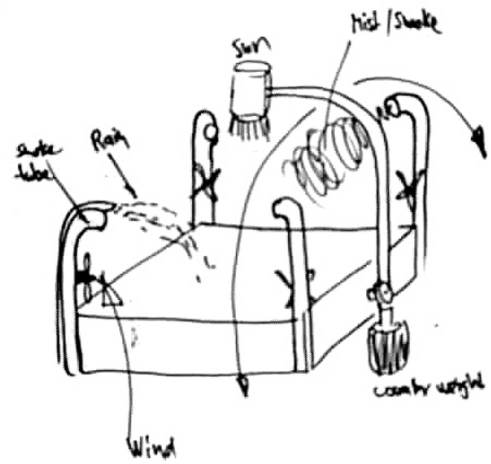

Figure 4: Early sketch

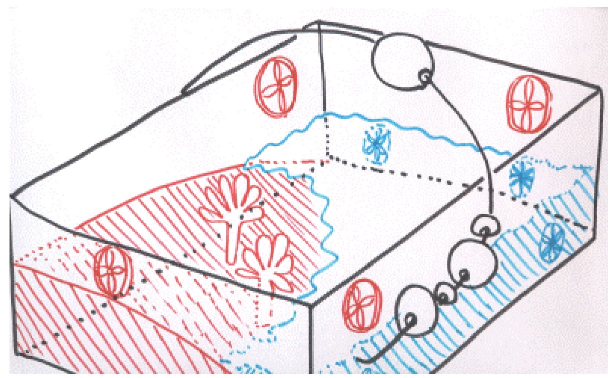

Figure 5: Another sketch

We decided to use four smoke units that are usually found in model trains. However, even these smoke units are too weak to generate clouds in an open environment, so we enclosed the "sky" completely in a transparent box. The lower portion of the upper box is punctuated with holes. A small aquarium water pump sucks the water from the lower tank and releases it into the upper one. It fills the upper box partially and drips down onto the beach and the ocean.

The beach consists of a block of Styrofoam that is carved into a wedge shape. Clean sand and little stones are spray glued to its surface. Finally, the whole beach is glued to the lower box (otherwise, it would float).

The wind is generated with small 3V pager motors with an included gearbox. These motors and propellers are used for slow flyer R/C models.

The waves are generated with a wide flap on two hinges that are glued to the lower box on the ocean side of the tank. A servo with a long servo arm moves the flap back and forth, where as the frequency and amplitude of the flap movement can be controlled completely by the PC.

The AC power adapters for the smoke units and the fan motors, as well as the DC water pump are plugged into three separate power strips, each of them are switched manually on and off with standard R/C servos. The servos are connected to an SSC II board that controls them and connects to the serial port of a laptop. Also connected to another serial port is the adapter cable that connects the lamp (RS-458 to RS-232), as well as the receiving part of the position sensor that computes the absolute position of the sensor mounted on the lamp, using ultrasonic chirps that are synchronized with infrared.

After having decided on the structure of the tank, the parts were drawn in CorelDraw and printed out with a laser cutter on cardboard in several different scales. After the final size was decided and further modifications made, it was printed again on 1/8th inch Acrylic. The elements were glued together with epoxy resin and waterproofed with silicone rubber (figure 6).

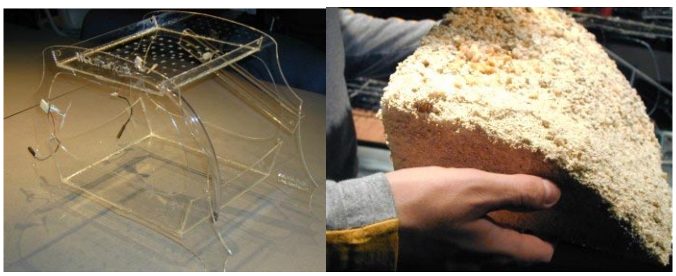

Figure 6: Empty Acrylic tank (left) and "land mass" (right)

CONCLUSIONS

In this paper, we present the WeatherTank, a desktop size installation that produces real wind, clouds, waves, and rain to visualize weather forecasts.

Our hypothesis is that it gives the user a "real feel" for the weather that will be tomorrow. WeatherTank is appropriate for non-literate communities because it doesn't use text as output. Furthermore, we would expect that it demonstrates the weather in a more physical way than any GUI could do, since the user can feel the stormy wind, the wet rain, the pounding waves, and sun obstructing clouds with her own hands.

WeatherTank comes with a number of computer controlled output mechanisms as well as an intuitive input mechanism. To express the time of day, the user can move the sun manually over the tank according to the time of day.

FUTURE WORK

The current implementation of the system uses preset weather scenarios for one day, e.g., sunrise at 8am, clouds starting at noon, wind, and slight waves at 2pm and additional rain at 6pm. In the future, weather forecast data should be retrieved from the Web and parsed automatically into an ASCII file that can be "read" by the WeatherTank. Furthermore, we need to add the ability to present weather forecasts for more than one day.

Along the same lines would be the modification to show weather not only of a different time, but also a different location. E.g., modifying the WeatherTank so that it can reproduce the current weather in Switzerland, or of a specific region of Australia. An intuitive solution has to be found to specify the location, though.

In the current implementation of the WeatherTank, some weather elements are binary. It would extend the tanks expressive capabilities if wind, rain, and clouds could be controlled more precisely and continuously, e.g., by specifying the wind speed and the amount of overcast.

Additional weather elements could be added, e.g., four motors/propellers mounted on the four colons that can be switched on and off separately to simulate wind of different characteristics and from different directions. Furthermore, weather elements like snow and low lying fog would add to the realism of the scenarios. In order to make the weather more "sensual," the air and especially water temperature should be adjustable. All these extensions are relatively simple to add to the current prototype, and the software is upgraded easily. An attractive, but probably more difficult element to add would be lightning.

One of the problems that we had to overcome with the current prototype is the very high "erosion" of this small-scale landscape. The landmass (sand, stones) has to be very inert so that it doesn't get washed down into the ocean immediately. Currently, sand and stones are glued to the Styrofoam. Another option would be to add real vegetation—which is how nature usually solves the problem of erosion. Furthermore, real plants with leaves could visualize the wind nicely. Along the same lines are suggestions to deploy real animals in the habitat: fish, insects, or reptiles.

However, even more important than adding more weather elements, flora, and fauna to make the weather look more realistic would be extending the possible input data sources: Since human beings have a strong feel for weather, elements of weather are used as metaphors in many different contexts. Since the WeatherTank is a powerful and flexible enough to represent many different weather conditions, we think it can be extended to visualize and represent information in widely different domains such as human emotions, network traffic, stock market condition etc. For instance, a happy mood can be represented as sunny day with light waves, anger as thunder, confusion as cloudy, sunless weather etc. In the domain of network conditions, congestion can be represented as clouds, heavy traffic as high waves, intrusion attempt as lightning.

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