Taifūrin: Wind-Chime Installation As A Novel Typhoon Early Warning System

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Abstract
Taifūrin is a novel typhoon early warning system that informs people when a typhoon is approaching. We combined a traditional Japanese wind-chime (known as *fūrin*) with near real-time remotely-sensed typhoon data and electronic components connected to a single-circuit board computer to create a unique IoT (Internet of Things) device in the form of a simple art installation. In doing so, we aimed to combine modern interactivity with a traditional sense of Japanese aesthetics, known as wabi-sabi.

Author Keywords
interactive art, Internet of Things (IoT), Japanese, wabi-sabi, sound art, disaster information, location-based services

ACM Classification Keywords
D.2.2 [Design Tools and Techniques]: User interfaces — Evolutionary prototyping; H.1.2 [User/Machine Systems]: Human factors — Human information processing; H.5.5 [Sound and Music Computing]: Systems; J.5 [Arts and humanities]: Fine arts

Background
The area surrounding Japan is subject to more than 20 typhoons annually, with approximately three on average making landfall each year [11]. These typhoons can have

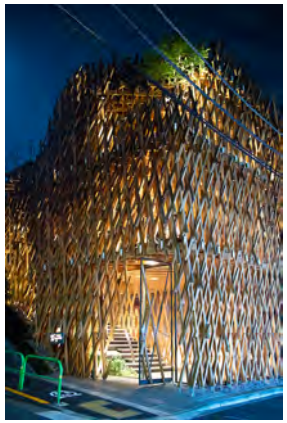

Figure 1: Kengo Kuma's "Sunny Hills" building in Tokyo. By combining natural materials and modern building materials, Kuma considered this combination to be "a new kind of wabi-sabi" [3]. Photo by Paul Haimes.

a devastating effect. For example, in 2015 Typhoon Soudelor impacted several territories including parts of Taiwan, China and Japan, leaving a path of destruction that resulted in the death of several people, dozens injured, damage to property and hundreds of buildings destroyed [10]. Typhoon warnings are available through a variety of digital sources (e.g., [2]). However, with Japan's population rapidly ageing [1], many people may not want, or be able, to rely on software-based approaches delivered through smart phones or websites.

We have therefore created a novel installation using a traditional Japanese wind-chime — known as fūrin — that provides multimodal output to alert people to an approaching typhoon. In doing so, we have created a work that reflects traditional Japanese Zen aesthetics, known as wabi-sabi, by blending modern technology with raw, natural materials.

By relying on an object that should be familiar to most Japanese people, we hope to provide a positive user experience despite the fact that the device is functioning as an early warning system. The name of our system comes from combining the Japanese word for typhoon (*taifū*) with the word for wind-chime (*fūrin*).

The aesthetics of wabi-sabi

Wabi-sabi — a concept from Japanese Zen Buddhism — is often described as "wisdom in natural simplicity" [6]. Wabi-sabi emphasises the ephemeral, and frequently features the use of raw materials and organic, natural artefacts, including decay [9]. Traditional artistic practices in Japan, such as tea ceremony rituals (*chanoyu* in Japanese), zen gardens (*karesansui*) and *ikebana* (a traditional Japanese style of floristry) are three examples that encompass this ideal [9, 6]. Although wabi-sabi shares a sense of simplicity and an appreciation of humble forms with the modernist movement of the 20th century, it also embraces uniqueness rather than mass-production [9].

Although the concept of wabi-sabi is around 500 years old, modern Japanese designers and artists across a variety of disciplines — such as architecture (such as Kengo Kuma and Tadao Ando [3]) and fashion design (such as Issey Miyake and Rei Kawakubo [5]) — continue to be influenced by the tradition, incorporating raw materials into their works and creating shapes inspired by those found in nature (e.g., Figure 1).

When discussing Tangible User Interfaces (TUI) and the use of organic materials in physical interfaces, Holman and Vertegaal asked: "What might computers look like if they were designed with a little more wabi-sabi? More curved, like a piece of earthenware, more flexible, like a sheet of Japanese Washi rice paper and more delicate, like handmade knitware?" [7]. The authors provided one possible answer by describing Hiroshi Ishii's *PingPongPlus* project at MIT's Media Lab, where virtual water would splash and projections of fish would scatter according to where the table tennis ball would land on a conventional table-tennis table during a game. However, unlike the wabi-sabi aesthetics encountered in other disciplines (e.g., [3, 5]), the example given by Holman and Vertegaal [7] did not contain raw or natural materials (although it clearly took inspiration from nature).

With our Taifūrin system, we have taken a cue from Kengo Kuma's approach of merging new and old to create "a new kind of wabi-sabi" [3], by blending natural materials with technology in a modern setting. By relying on natural, raw materials, rather than plastics or other processed materials, we consider our prototype to be more environmentally-friendly. Here, we have consciously considered the aesthetics of wabi-wabi when designing our prototype. Our design

is simple and humble, and used natural materials wherever possible, such as wood and yarn.

Typhoon data

Near real-time typhoon data is available through several sources. We are using a data feed provided to us by Japan's National Institute of Informatics[1]. The data — sourced from geostationary meteorological satellites — has been provided to us in GeoJSON (A JavaScript Object Notation file which contains geographical information, including longitude and latitude) format. The data includes geographical coordinates, the class (category) of the typhoon, the time it was detected, and the wind speed and wind pressure. An example of a reading in the format is shown below.

Figure 2: Testing the server-side part of our application. This shows the distance between the user and the typhoon. The typhoon's location is also shown on the map in the background.

```
{
        'geometry' : {
           'coordinates' : [
              162.2,
              13.3
           ],
           'type' : 'Point'
        },
        'type' : 'Feature',
        'properties' : {
           'display_time' : '2015-07-29
           18:00 UTC',
           'wind' : '0',
           'pressure' : '1006',
           'time' : 1438192800,
           'class" : '2'
        }
```

Design of our system

Firstly, a *PHP* (PHP Hypertext Preprocessor) script hosted on our server was created to calculate the distance from the latest typhoon reading to the user's location, based on their IP (internet protocol) address and the data contained in the JSON data provided to us from the National Institute of Informatics. These values were then used to create a simple JSON file containing the typhoon's name, latest location (including distance from the user) and category. A simple map on a web page was created using PHP, *HTML* (HyperText Markup Language) and *CSS* (Cascading Style Sheets) as a means of confirming the data during testing (Figure 2).

A *Python* script was then created on a Raspberry Pi [12] B+ single board computer (running the Raspbian *Linux* operating system) to retrieve the distance and category of the typhoon from the aforementioned JSON file. Based on these readings, the distance would be used to trigger the movements of a servo motor, while the category would determine the colour of a multi-colour LED (Light-emitting diode) light.

A Linux *cron*[2] job was set up to run the Python script every 15 minutes, which retrieves the latest location of the Typhoon plus its category from the JSON file on our server each time that it runs. The system's bell then rings if a typhoon is within 500km and also flashes the LED, with the colour of the LED based on the typhoon's category:

- Blue = category 2
- Green = category 3
- Yellow = category 4
- Red = category 5.

[1] http://www.nii.ac.jp

[2] A software program for Unix-based operating systems that automatically schedules commands and runs scripts.

System overview

1. Retrieve typhoon data from NII's GeoJSON file
2. Calculate (on our server) the distance from the typhoon to the user's Taifūrin system
3. Python script on Taifūrin system retrieves the distance and typhoon category from our server.
4. If the typhoon is 500km or less from the user, a motor rings the Taifūrin system's wind-chime. An LED flashes a colour according to the category of the typhoon.

Figure 3: The exterior of our Taifūrin system. The box contains a Raspberry Pi [12], its power source, a servo motor and an LED (See Figure 4). Below the box hangs a traditional Japanese wind-chime (fūrin), which is attached to the servo motor and the LED, which is placed inside the bell. By relying on natural materials and creating a simple interface, we consider this design artefact to incorporate wabi-sabi aesthetics.

The duration of ringing is also determined by how close the typhoon is. By providing both visual and aural feedback, our system incorporates inclusive design [4], making it accessible for a majority of users. Although our system simply informs people of the presence of an approaching typhoon, it is hoped that the alert it provides prompts users to then search for more detailed information, either through the application hosted on our server (Figure 2), or through the media of their choice (regardless of whether it is digital media, or more traditional media such as television or radio). By leveraging existing typhoon data, making it meaningful to users (by alerting them to the fact it is in or near their vicinity) and delivering it through a unique physical device, we consider our system to be an IoT [13] device. Installation of the device is simple: users simply need to connect a power supply. The device then boots up and (assuming a wireless internet connection is available) begins monitoring our server for available typhoon data. Figure 3 shows the system in operation, complete with its aesthetics inspired by wabi-sabi.

Wabi-sabi qualities of our system
Due to the following characteristics of our system, we believe that it could be considered a wabi-sabi device:

- Like the architecture of Kuma and Ando [3], and the work of fashion designers such as Issey Miyake and Rei Kawakubo [5], our system blends the new with the old, and uses raw, natural materials.
- Our system uses natural objects including yarn (the box is suspended from a hook by yarn), unfinished

Figure 4: The simple components inside our system (Figure 3): A Raspberry Pi single board computer with a multi-coloured LED and servo motor attached.

wood and paper.

- Our system accommodates decay [9]: the natural materials used may deteriorate, but that will not affect the system's function (but will likely add character to its aesthetics).
- A wind-chime is a traditional man-made object but one that interacts with nature (although we have used technology to modify the way it interacts with it).
- Our system's design is simple and humble, fundamental characteristics of wabi-sabi [9, 6].

Early informal user feedback

We asked seven participants in Japan whether our first prototype reflected wabi-sabi ideals regarding aesthetics. All participants agreed that our Taifūrin system had aesthetics that incorporated wabi-sabi to some degree. Five of these participants also considered it to be an interesting device that could serve a useful purpose. We intend to undertake more formalised user testing once we have a second working prototype completed (the model shown in Figure 3 is our initial prototype).

Further work

We aim to make some small changes to our system. We will replace our servo motor with a stronger motor, which we will use to power a small fan that blows air to make the wind-chime ring, rather than the current system where the chime is rung directly with a motor. This will also reduce the amount of motor noise when the bell is ringing. We may also consider other methods for obtaining the user's location other than using their IP address.

We will also investigate other opportunities for presenting other useful internet-based information in an interesting way through a physical interface that incorporates wabi-sabi aesthetics, blending current technology with natural materials. More broadly, we will also work towards further establishing guidelines for incorporating wabi-sabi ideals into digital technology.

Discussion and conclusion

Although our solution relied on a novel art installation application of IoT technology, our intention is to encourage others to consider ways in which beneficial (yet technical) information can be delivered to a non-technical audience in a way that does not rely on complicated software or unfamiliar modes of operation. In creating this system, we have also demonstrated that geospatial information and location-based services can be presented to users in ways that move beyond conventional mapping software.

We hope that the system we have described here provides one answer to the question asked by Holman and Vertegaal: "What might computers look like if they were designed with a little more wabi-sabi?" [7]. Furthermore, we hope that the example provided here, which was inspired by the merging of new and old frequently encountered in Japan, encourages interaction designers and artists to consider wabi-sabi aspects of their own works.

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