The Application of Open-source Language in Interactive Installation on Enhancing Water Conservation Awareness

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Abstract. The support of Processing programming technology and Arduino open-source platform enables the art design of the installation mentioned in this paper to become more interactive and more appealing, thereby creating an immersive experience for the participants. In addition, its designer can explore the value of the two technical tools and unlock the potential through research and practices. Concerned over the waste of water resources, the interactive installation enlightens the participants to realize the consequences of water waste via controlling the water valve of the faucet and then receiving the feedback of dynamic effects on the screen. Furthermore, it is expected to attract the attention of the participants, to inspire them to take stock of their water usage habits, and to achieve the installation’s ultimate goal of enhancing the experiencers’ awareness of water conservation.

1. Analysis on the current situation of water scarcity
As the source of life, water plays an indispensable role in today’s production and life. Nevertheless, this source of life has been always not cherished and even wasted without thinking more during a long-term period, resulting in more severe water shortage. It is estimated that 45.6% of China’s 46 major cities are confronted with poor water quality; night out of the fourteen coastal cities suffer from serious water scarcity. More than 200 million people in the globe are currently threatened by water shortage. It is predicted that by 2025, the global freshwater shortage will increase to 2 trillion cubic meters. Given this situation, water scarcity has been listed as the world’s top risk we face[1].

1.1. Contributing factors of water scarcity
The total volume of the earth’s water is roughly 1.386 billion cubic kilometers, and 70.8% of the earth’s surface is water-covered[2]. However, 97.5% of these water resources is salt water, which cannot be directly consumed by humans. For the left part of 2.5% of fresh water, its 87% is composed of polar ice caps, alpine glaciers, and ice and snow in permafrost regions. As a result, they are extremely challenging for humans to exploit[3]. The water resources that humans can take advantage of include rivers, lakes, and groundwater, but which merely accounts for 0.325% of the earth’s total water[4]. This reality forces 70% of the world’s population to live under water shortage. Nowadays, 110 million people worldwide still do not have access to clean water; about 6,000 children die from water-related diseases every day, which is equivalent to the crash of 20 large passenger planes[5].

Given the development of the economy and the exponential growth of the population, the demand for water resources continues to stay on the rising track. However, the water resources management system is not well-designed enough, and we are confronted with serious water waste. Meanwhile, the people’s awareness of water conservation is still needed to enhance further.
1.2. Consequences of water waste

It is undoubted that issues on water resources are increasingly pressing. Specifically, since excessive extraction of groundwater caused ground collapse, “groundwater drop funnels” appeared in 24 of 27 major cities in China[6]. Even some water-scarce cities have troubled by water shortages in residential areas, thus conducting a regular and limited water supply and affecting locals’ normal life. In addition, droughts in arid areas are becoming more severe, crops lacking irrigation cannot grow, and famines may even occur in rural areas, which severely hinders the sustainable economic development of the region. Hence, it is apparent that water conservation requires immediate actions.

1.3. Significance of enhancing water conservation awareness

In accordance with the relevant data, if a faucet drips without being turned off closely, 3.6 kilograms of water will be wasted in one hour, leading to 2.6 tons of water waste in one month. In terms of the national urban tap-water pipe network, its damage rate reaches up to even 20%-30%, which does not include water running, spilling, dripping, and leakage in use. It turns out that water waste frequently happens though water resources are limited.

Since the 19th National Congress of the Communist Party of China, various institutions have been promulgated nationwide to further implement the water conversation policy and strengthen the control of total water consumption. However, the “water conservation” not only requires technological innovation and institutional control, but also requires the correction of people’s long-term misconceptions. This is the essential reason why this installation focuses on the theme of enhancing water conservation awareness. Through publicizing the related knowledge, it will become promising to see that people subconsciously have stronger consciousness of saving water, and then become inspired to take real actions in daily life.

2. The influence of open-source language on interactive installations

2.1. Introduction of open-source language technology

Processing acts as an emerging programming language technology. Considering its simple, open-source, and cross-platform features, this technology is deeply favored by designers. Designers use it as a creative programming tool for a wide range of digital creations involving diversified elements such as sound, image, prototype, and installation. Additionally, it symbolizes the fusion of art and science and the result of “sensory” calculation, which provides creators with a brand-new thinking and perspective, so that the work has a natural appeal. This can be counted as the trend of scientific and technological application development.

Arduino serves as an open-source electronic prototyping platform for people with no electronics and programming background, since it is simple, convenient, flexible and low-cost. Arduino is primarily composed of two parts as below. The first part is the hardware, or the Arduino circuit board, which is applied as a circuit connection; the second part is the Arduino IDE, which is the program development environment in the computer[7]. The program code written in the IDE will be transferred to the Arduino circuit board, and the circuit board will obtain signals, receive perceptions on the environment, and give corresponding feedback based on various sensors. Therefore, designers can employ it to control hardware such as lights, motors, and realize the two-way interaction and communication between people and installations to make the experience more immersive and real.

2.2. The influence of open-source language on interactive installations

Open-source technology enhances the interactivity and appeal of installations, so that the installations become precisely various, subjective initiative and personal intuitive. Moreover, they also become two-way interactive, open and inclusive, thus representing the integration of knowledge, affection and intention. These influences are attributed to the communication between Processing programming language and Arduino hardware.
Processing is a programming software that cannot directly control various interactive hardware, but with the support of the Arduino platform, it can connect to some sensors/controllers, read the values on the sensors, and then control various machines, electromechanical devices and other hardware entities. Also, it can generate the interaction between the visual interface and the hardware. Hence, the installations will not be confined to traditional static forms of expression such as texts and images, but will present richer interactive effects. Thanks to the help of processing programming, visual experience can be created and a dynamic interactive mode can be established. This allows the designer’s concept to be accurately expressed under the support of technology, and injects fresh appeal into installations. Traditional media forms such as texts and posters tend to be no innovative, and the audience can only receive information passively, which has limitations. Comparatively, the interactive installations based on open-source technology breaks through this limitation. Specifically, the multiple senses of the experiencer are evoked by the installation during the entire participation, and they are directly involved in two-way interactive communication. Besides, this sort of installations will not be restricted by multiple factors, it converts the changing situation into changing data, and then use the physical signals collected by Arduino to identify the behaviors of the experiencer. The installations can provide different feedback according to different behaviors, and takes the user’s behaviors as a part of themselves, tapping up the unlimited possibilities. Furthermore, they transmit information in a variety of forms, stimulates the experiencers’ multiple senses, in order to enable them to produce more real memories, and makes the installation design more intuitive and vivid, and inclusive for people at different education levels.

3. Application of open-source technology in designing the interactive installation

3.1. Design concept of the interactive installation, Water Is Not Inexhaustible

3.1.1. Design features. In response to serious water waste, the paper designed the interactive installation, Water Is Not Inexhaustible. The participant can turn the water valve switch and experience the different feedback brought by the animation on the screen, so that they can learn the grave consequences of this behavior, thus reflecting on their own water use habits and taking stock of their own behavior. With the support of related technologies, the interactive installation can display the design concept intuitively and interestingly, so as to ensure the immersive experience and let the audience bear in mind the concept of water saving.

3.1.2. Design intents. Water resources are becoming increasingly scarce, thus the “saving water” action requires no delay. In industrial production and domestic water use, faucets serve as the most widely used water appliance in buildings, but they are often the main “accomplices” in causing water loss[8]. This installation selects the faucet as the interactive carrier for the experiencer, bringing him or her into a familiar scene, and experiencing the changes on the screen under different actions. Besides, the digital animation of the installation is employed throughout, making the interaction more eye-catching and interesting. Therefore, it can make the experiencers feel empathetic and concerned with water resources, so as to enhance their awareness of water conservation.

3.2. Design presentation

3.2.1. The structure of the installation. The installation forms an overall layout through the display screen and external hardware, combined with programming software to achieve interactive purposes. Generally speaking, the installation is divided into two parts: the first part refers to a physical installation composed of Arduino chips, adjustable resistors, LED light strips, faucets and other materials; the second part is a digital display, which serves as a carrier for the animation feedback.
3.2.2. Technical analysis. This interactive installation, Water Is Not Inexhaustible, attempts to enhance its interactivity and appeal by combining processing programming and arduino hardware, so that participants can feel the preciousness of water. In addition, the installation utilizes rapid feedback to attract the participants’ attention and offer them inspiration and impression on water conservation, so that they can be conscious of the reality of “water is not inexhaustible” and the urgent necessity of saving water. By means of integrating rationality and sensibility, this installation ultimately achieves the goal of enhancing the experiencer’s awareness of water saving.

Before the construction of this installation, the research examines the details such as space size, material transportation, as well as the installation fixation and display. Grounded on the basic principles of Processing and Arduino, the operation procedure of this installation is formulated as below. First, put the adjustable resistor into the faucet, and set the action of “unscrewing the valve of the faucet” as the trigger point of the installation. Then, the valve of the faucet drives the resistance value of the adjustable resistor to change, and the installation is ultimately activated, and the LED lights light up.

```cpp
int potpin =0;
int ledpin=9;
int val = 0;
void setup() {
pinMode(ledpin,OUTPUT);
Serial.begin(9600);
}
void loop() {
val = analogRead(potpin);
Serial.print(val);
delay(1000);
if (val>0){
digitalWrite(ledpin,HIGH);
}
else if (val = 0){
digitalWrite(ledpin,LOW);
}
}
```

**Figure 1. Code setting on Arduino Uno chip.**

The installation takes Arduino as the lower computer to read and collect the resistance value from the adjustable resistor in the chip positioned in the faucet. Besides, it also replaces the description of the resistance value with the readings of Arduino (the reading range of Arduino is 0~1023Ω). According to the change of this value, this installation can identify the participants’ behavioral signals and input them into the Processing programming software (as shown in Figure 1).

```cpp
import processing.serial.*;
Serial port;
float val;
int val1 = 300;
int val2 = 600;
int val3 = 900;
PImage bkg;
PImage sealever;
PImage seabed;
PImage fish1;
PImage fish2;
PImage fish3;
PImage fish4;
PImage fish5;
PImage fish6;
void setup(){
size(1920,1080);
bkg = loadImage("bkg.jpg");
sealever = loadImage("sealever.png");
seabed = loadImage("seabed.png");
fish1 = loadImage("fish1.png");
fish2 = loadImage("fish2.png");
fish3 = loadImage("fish3.png");
fish4 = loadImage("fish4.png");
fish5 = loadImage("fish5.png");
frameRate(20);
val = port.read();
val = map(val,0,1023,0,height+100);
if ((val>=0)&&(val<270)){
val1 = 300;
val2 = 600;
val3 = 900;
}
else if ((val>=270)&&(val<=570)){
val1 = -100;
val2 = 600;
val3 = 900;
}
else if((val>570)&&(val<=870)){
val1 = -100;
val2 = -100;
val3 = 900;
}
else if (val>870)
```

4
fish6 = loadImage("fish6.png");
port = new Serial(this,"COM4",9600);;
void draw(){
val1 = -100;
val2 = -100;
val3 = -100;
}

Figure 2. Code on dynamic effects of Processing programming control screen.

The installation applies Processing programming technology to control the screen (as shown in Figure 2), and provides certain feedback and responses to the behavior of the participants, so as to ensure the interaction between human and this installation and the appeal of itself.

3.2.3. Programming realization of the installation. The research includes the extraction and summary of redundant information, and ultimately selects such elements as the lake bottom, fish schools, and wreckage for visual refinement and drawing in software like Photoshop and Procreate. Given the work above, these elements can display on the screen in a digital way in the end.

At the beginning, the screen of the installation presents a colorful animation of the blue lake bottom and the harmonious symbiosis of fish schools. The participants can activate the entire installation through “twisting the faucet”. Additionally, the LED light strip simulates the transmission of water, then marking the official outset of the interaction between the participants and the screen. Particularly, the opening degree of the faucet valve is inversely proportional to the depth of the water and the installation can provide feedback in terms of the opening degree. The dynamic effect of the slowly dropping water surface is synchronized with the users’ opening the faucet until the water surface decreases to the corresponding water depth. Meanwhile, the creatures at the bottom of the lake will gradually disappear as well. If the experiencer opens the water valve of the faucet to the maximum, it means that he or she is wasting water uncontrollably. Such behavior will cause the water surface on the screen to continue to drop down. Eventually, the screen will show the black and white picture of fish bones buried in the sand, and the slogan of this installation will slowly appear on the screen.

If the experiencer switches off the faucet, the water on the screen will gradually rise back. The creatures in the lake will gradually increase as the water surface rises. The screen animation will show the original appearance of the harmonious coexistence of the blue lake bottom and the fish schools.

Figure 3. Design procedure and experience process of the installation

The design of this installation explores the possibilities of integrating Processing and Arduino. It is not merely a simple artwork, but an ingenious combination of human, art and technology. The
The experiencer can interact with the installation’s creator and realize the treasure of water. The participants can examine themselves, and enhance “water-saving awareness” through the interaction.

4. Conclusion
With the support of Arduino, the open-source technology, this interactive installation has achieved remarkable results on “enhancing water conservation awareness”, and digital art has been prevailingly seen in our life. Furthermore, interaction has distinguished this era from others, and people pay more attention to the experience and feeling of art installations. Comparatively, installations with static and one-way information transmission have no longer catered to the needs of the public and are outdated for publicizing knowledge. Therefore, interactive installations will build the trend for its storyline design, multi-sensory experiences, and interaction between human and installations. There are countless mysteries of open-source technology, so as to create unique and influential interactive installations.

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