On the Design of Open Source Programming Language in Noise Pollution Interaction Installations

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Abstract. With the progress of time and the development of science and technology, interactive installation art, as an important and novel part of the new media art, is becoming more prominent on the stage of major international exhibitions. Artists create a new experience in a variety of perceptions using the unique language of interactive installation art to stimulate people's inspirations through their interaction with the works, and to trigger in-depth thinking. This new art form shortens the distance between art and the public and gives people novel experiences in the interaction. Taking the work “Uncomfortable” as a case study, this paper shows the harm of noise pollution to human bodies with the help of Processing and Arduino, studies the practical value of program design in interactive installation art, discusses the influence of open source programming language on the future development of interactive installation art, and provides new ideas for further integration of future art and technology.

1. An overview of the art of interactive installations
Interactive installation art is a new art form by which artists integrate and transform the social culture of people's daily lives in a specially set context, adopting programming technology to show the diverse interdependences and mutual influences between people and sci-tech, men and the society, and men and nature[1].

Compared with the traditional installation art, which mainly relies on the creator's own expertise and professional capability, interactive installation art needs to be created covering several disciplines by several teams[2]. This will also promote the development of interactive devices, increase their manifestations, and provide innovative technical support for the art of installations. With the addition of computer programming language, interactive devices are no longer self-entertainment for the artists, and the public can also immerse themselves in the in-depth experience of works of art, thus greatly improving their interactivity and integrating art into the lives of the masses.

In the future development process of interactive installation art, with its unique forms and functions, multimedia science and technology will also be increasingly radiant in providing new possibilities for the public to appreciate the art and in being the essential creative means for the artists to express their own ideas.

2. Technical support for the art of interactive devices in open source programming languages

2.1 Processing
Processing is an open source programming platform, a revolutionary and forward-looking emerging computer language. It is an expansion of the Java language, supports many existing Java language
structures, simplifies the grammar of Java and "visualizes" the results of its operations, enabling the designers to learn and process beautiful interactive installation art in a short period of time. *Processing* upholds the principle of open source. Like the recently popular Linux operating system, Mozilla browser, etc., users are free to choose the most appropriate usage pattern according to their needs, which greatly increases the interaction and learning efficiency of the entire community. Its application is also rich and widespread correspondingly.

2.2 Arduino chip

*Arduino* is a smart, fast and easy-to-use open source platform that to a great extent meets the scientific and technical needs of designers. It consists of two main parts: the Arduino board, which connects circuits for the operation of various appliances and sensors, and the Arduino IDE. The developers simply need to write the required program code in the IDE and transmits the code to the board via a USB interface, and the IDE will inform the Arduino board developers of what they need to do. For learners with no previous programming knowledge, the Arduino community also has a number of program codes that can be used directly. In addition, many manufacturers have developed visual programming software based on Arduino technology chips and the developers have a more perceivable programming experience to develop a more complete interactive installation design.

3. The application value of open source programming languages in the art of interactive installation

As an important part of the art of new media, interactive installation art is playing an increasingly important role in the field of design. The effective application of programming languages to the interactive installation art provides technical support for the more direct display of art works, further expands its application value and promotes its development in the age of science and technology[3].

3.1 Enriching the interactive experience of interactive installations

Interactive installation art uses its unique scientific and technical support to create works for people to hear, see, touch and feel for themselves, and to understand the practicality of their use during the interaction and immersion. At the same time, with the help of open source programming technology, people can fully experience the creativeness and beauty brought about by some works whose creative ideas are previously incomprehensible to the audience. The art of interactive installations goes beyond one single means of expression and brings vivid works with visual images to the audience. In addition, through acoustic support and promotion, people can fully feel the special charm of the installation of art works on the basis of visions, with their thoughts provoked and inspiration triggered.

3.2 Enabling interaction between installations and the public

Through physical situational displays, interactive installation art builds a platform for emotional communication between the designer and the audience. Designers can more directly show the audience their creative ideas and express their feelings. The addition of programming technology drives the art of installation to intelligently adapt to the reactions of different experiencers. The ultimate goal of interactive installation art is to express more effectively the design concept and infinite charm brought about by art design through human-computer interactions and the interactive installation art that adopts programming technology is able to guide people to think and feel the unique value brought by art design in the process of human-computer interaction[4].

3.3 Increasing public engagement

Like the body games, interactive installation art surpasses the traditional art form of a single mode of appreciation, and the audience can actually feel that they participate in, whilst appreciating, the works of art. By virtue of their analysis of different data, the open source programming languages stimulate the audience's interest and initiative in feeling about the art, explore infinite possibilities for the
audience to engage in this interactive installation work, enhance the integration between art and the public and the audience's level of experience.

4. Background research on noise pollution

4.1 Overview of noise pollution
With the development of science and technology and social urbanization, noise pollution has been regarded as one of the four major environmental problems in the world, and has become an "urban disease" affecting many cities[5]. The harm caused by noise pollution should not be underestimated. People's health are unconsciously harmed for lack of awareness of noise pollution and the development of their lives have been hindered since.

Typically, the human ear is more comfortable with sounds of 60-70 decibels and the 80-90 decibels destroy the nerve cells of the human body. When the volume exceeds 100 decibels, it is strong enough to cause hearing loss. The degree of noise pollution is closely related to itself, and the louder the noise, the greater the degree of pollution. Because noise is a sensory hazard, there is no pollutants in noise pollution. The impact of noise pollution on the environment is not persistent, nor accumulated, and its transmission distance is also very limited, the noise source is rather dispersed, therefore, special treatments are needed for control.

Noise pollution can be divided into four sources, the first is industry noise, which usually refers to the noise coming from the production of various equipment in the factories, inflicting the workers in and the residents near the factories. Second, traffic noise. Noises from motor vehicles, aircrafts, etc. can all be categorized as sources of traffic noise. With the development of social economy, traffic noise has become one of the main noise sources in cities[6]. Then there is the building noise, which occurs in areas with high population density and has a serious impact on the living of residents. Finally, society noise, which comes from people's daily lives: the use of home appliances, audio equipments, etc. These noises and people's lives are quite closely related, therefore they easily lead to poor sleep quality and irritability.

4.2 Harm to human body caused by noise pollution
Damage to hearing is the most direct manifestation of noise pollution. When people remain in an environment of strong noises for a period of time, they will feel uncomfortable in the ears and may even have dizziness and headaches. Living in strong noises is likely to trigger noise-induced deafness. If people are suddenly exposed to extremely loud noise, the auditory organs can experience acute trauma that can lead to complete hearing loss. Noise pollution also has a serious impact on people's sleep quality and many sleep problems may occur, like dreaming much and, wake-up easy, etc. Accordingly, more problems may arise in the routine daily lives, for example, feeling upset, distracted, or fatigue-prone. In addition, serious noise pollution can lead to intellectual decline in children, adversely affecting people's eyes and heart, and may even lead to a risk of cancer[7].

5. Design implementation of noise pollution interaction installations

5.1 Preliminary creating ideas
Today's urban noise problem is becoming more and more serious, but people's awareness of noise pollution is far from enough. Through the in-depth understanding and data analysis of the current situation of noise pollution and human harm, this paper conceives and produces an interactive installation art work “Uncomfortable”, which can introduce and popularize the current situations and sources of noise pollution to the public, reflect its harm to human bodies, and arouse people's attention and resonance. In the creation process of “Uncomfortable”, the theme of four different kinds of noise pollution is used: industry, traffic, construction and society, which people come into contact frequently in daily lives. Combined with the radio module, we connect the projection equipment to play the animation, showing the different reactions when people are exposed to noises of different decibels.
The work uses programming code technology to combine animation, sound effects and different operation behaviors of the audience. When people go into the device and operate, they shall press the corresponding sound button and the radio module will collect voices of people coming by, and the screen will then display corresponding animation, so that people can have an immersive experience – feeling on the spot, they can understand better the serious harm caused by noise pollution. In turn, people are stimulated to pay more attention to the prevention of noise pollution and the public's life health index may be improved.

The device is equipped with four sound source buttons, which represent the commonly seen four sources of pollution: industry, traffic, construction and society. A human voice collection device with a radio module is set beside the device to collect the real-time voice of the past audience. When the experimenter presses the corresponding sound source button, the characters in the animation will respond according to the decibel sizes of both the sound source pressed and the real-time human voices. In addition, the device also supports the simultaneous triggering of multiple noise sources, achieving the effect of superposition. When there is no experimenter, the radio module will work as usual. When there is too much a racket in the environment, the animation characters will also make corresponding responses. Finally, when the sound reaches the highest decibel, the animation characters will show an image of deafness, so that people can see with clarity the hazards of noise pollution to human body, realize the seriousness of noise pollution of today, and improve people's awareness of attention needed for noise pollution.

```cpp
void loop() {
    sound = analogRead(0);
    if(button1==HIGH){
        Serial.write("a");
        digitalWrite(sound1,HIGH);
    }
    if(button2==HIGH){
        digitalWrite(sound1,HIGH);
        Serial.write("b");
        digitalWrite(sound2,HIGH);
    }
    if(button3==HIGH){
        digitalWrite(sound1,HIGH);
        digitalWrite(sound3,HIGH);
        Serial.write("c");
    }
    if(button4==HIGH){
        digitalWrite(sound1,HIGH);
        digitalWrite(sound4,HIGH);
        Serial.write("d");
    }
    if(sound>=512){
        Serial.write("e");
    }
    if((button1==HIGH)&&(button2==HIGH)){
        digitalWrite(sound1,HIGH);
        digitalWrite(sound2,HIGH);
        Serial.write("f");
    }
    if((button1==HIGH)&&(button3==HIGH)){
        digitalWrite(sound1,HIGH);
        digitalWrite(sound3,HIGH);
        Serial.write("g");
    }
    if((button1==HIGH)&&(button4==HIGH)){
        digitalWrite(sound1,HIGH);
        digitalWrite(sound4,HIGH);
        Serial.write("h");
    }
    if((button2==HIGH)&&(button3==HIGH)){
        digitalWrite(sound2,HIGH);
        digitalWrite(sound3,HIGH);
        Serial.write("i");
    }
    if((button2==HIGH)&&(button4==HIGH)){
        digitalWrite(sound2,HIGH);
        digitalWrite(sound4,HIGH);
        Serial.write("j");
    }
    if((button3==HIGH)&&(button4==HIGH)){
        digitalWrite(sound3,HIGH);
        digitalWrite(sound4,HIGH);
        Serial.write("k");
    }
    if(sound>=512){
        Serial.write("e");
    }
}
```

Figure1. Code of Arduino

Figure2. Required materials and manufacturing process
5.2 preliminary preparation
Through the combination of the switch button, radio module, built-in speaker and projection device, with an overall layout of the entity's external hardware and open source programming software, this installation realizes the interaction between the art work and the audience. With the Arduino technology chip and Processing program used as the technical support, the multi-dimensional interaction between the audience and the device is achieved by identifying information from the buttons pressed by the audience and from human voices.

5.3 programming
At first, when no one is near the device, the animated characters played on the device's projection device show happy expressions and actions, accompanied by relaxing and pleasant music. When someone is near, the radio module starts to work to collect the voices of people passing by. According to the decibel sizes of the human voices, the animated characters make corresponding and different reactions such as "dizziness", "covering ears", "anger", etc. When the audience starts to operate the device, by pressing the four different noise source buttons of "industry noise", "traffic noise", "construction noise" and "society noise", the built-in speaker will emit corresponding sound sources. After the end of the audio file, the animated characters on the projection device make corresponding actions according to the decibel sizes of both the sound sources and the human voices passing-by at this time. In addition, the device can also support multiple buttons to be triggered at the same time, achieving a superposition effect. When the voice DB reaches the highest value of 180, the characters in the animation will make a responding expression of being deafened, to show the seriousness of noise pollution.

```java
void draw(){
    case 'a':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act0,0,0);
    break;
    case 'b':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act1,0,0);
        break;
    case 'c':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act2,0,0);
        break;
    case 'd':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act3,0,0);
        break;
    case 'e':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act4,0,0);
        break;
    case 'f':
        image(loud1,0,0);
        image(loud2,0,0);
        image(loud3,0,0);
        image(loud4,0,0);
        image(loud5,0,0);
        image(loud6,0,0);
        image(loud7,0,0);
        image(loud8,0,0);
        image(act5,0,0);
        break;
}
```

Figure3. Code of Processing

5.4 final presentation
The scale and form of the interactive device have been determined before the exhibition, and the packaging, fixation and placement of the device components have been completed before the exhibition. AI vector drawing software is used in the drawing. Cartoon characters of comic styles make it easier for people to accept and recognize while appreciating the work of art. After making sure that the logic of the computer programming code file is correct, a test run is carried out, and the audio is played while the projector is connected. Finally, the originally exposed components are decorated with color cards and decorative stickers to improve the aesthetic effect of the device. This interactive installation work can be displayed in exhibitions related to sound and noise pollution, so that more people may understand noise pollution and its harm to human bodies better. More attention may be paid to strengthen prevention and control.
6. Summary
As a comprehensive and powerful form of art, the interactive installation art has become an indispensable way of creation for art designers now and in the future. With the addition of open source programming language, interactive installation art seems to have been empowered with unlimited possibilities of development. The interactive device, supported by a variety of media hardware, has stronger interactivity and more participation possibilities. It realizes the effective communication among designers, audiences and the art works, so that people can feel immersed in the works, understand the designer's creative ideas, and receive the information that the installation works want to convey to the audience. *Arduino, Processing* and other intelligent hardware platforms of development and design perfectly integrate art and technology and help explore new art exhibition forms. This will become an orientation of development for the installation art in the future, and is worthy of continuous exploration and study.

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