Design of Interactive Device on Climate Warming Based on Arduino, an Open-source Hardware

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Abstract. Nowadays, new media art has flourished as the focus of contemporary art and its creative potential has been greatly unlocked by Arduino, a convenient and fast open-source electronic prototyping platform. It is the application of Arduino that makes artworks more dynamic and appealing, so it is easier for viewers to resonate with the emotions that the artworks convey. Moreover, as the relationship between human society and the ecological environment has become increasingly closer, environmental issues have sparked heated discussions, in which designers and artists also participate with their unique artistic language. The device, “City Countdown”, stands as an artistic creation and it is designed in accordance with the reflection on the current global warming and is supported by Arduino, an open-source hardware platform. This artwork intends to achieve the interaction between viewers and itself, so as to guide people to realize the negative impact of human activities on climate change, and to further reflect on the today’s human life.

1. Introduction
New media art is an emerging art discipline based on technology, and its combination with programming language has enriched the art’s expression forms. For instance, platform-based applications represented by Touch Designer and Unity 3D can build up a connection among visual content, interaction methods, logic implementations, and special effects in new media art creation; code-driven applications represented by Processing and openFrameworks have simplified the expression of digital art that requires the alignment with the syntax of programming languages; hardware tools marked by Kinect and Arduino have promoted the interactivity of new media art. Therefore, the interactive device art integrated with programming languages involves a wide range of fields and multiple media, which enables it to break through the expression form of traditional device art and enhance the interaction between participants and artworks. The take-off development of interactive device art can be manifested into two aspects. One is the experimental exploration of technology in the field of art; the other reflects the new media art’s efforts to narrow down the distance with the public and involve social public topics.

2. Research on artistic interaction based on Arduino
Arduino serves as a very convenient open-source electronic prototyping platform, mainly composed of the Arduino electronic control board and the Arduino IDE. Given its simple hardware control and programming methods, Arduino has now begun to be widely employed in the field of art. In addition, “device art” refers to a certain field where artists can subjectively select, transform and combine various materials and ready-made products in daily life under a specific time and space. Such
device art symbolizes the artists’ personal emotions and contributes to creating a comprehensive art form filled new spiritual and cultural meanings.

Nowadays, with the booming development of science and technology, it is common to witness the collision and integration between new media and other fields. Thanks to its openness inclusiveness, the device art interacts with new media, thus presenting a more diverse, multi-sensory and feedback language. Furthermore, the interactive technology, as it matures increasingly, has blazed a new path for the development of device art.

Arduino has a unique strength in developing interactive products, for its ability to control the corresponding electronic hardware while reading a large number of sensor signals. Thereby, the combination of this technology and device art can completely change the static relationship between the artwork and the audience. Specifically speaking, the audience can engage in creating art through the interaction of body movements and sensory perceptions. Such participation also constitutes part of artwork and it can be believed that the interesting, active and feedback interactive technology turns the audience from passive viewing to active engagement during art activities, and enables an immersive experience.

3. Current situation and development trend of global climate

Since the 1880s, human activities have further led to a significant increase in greenhouse gases emission, thus causing abnormal changes of global climate, and even directly threatening the living environment of both human beings and wild animals. Thus, under the current situation of global climate change, ecological and environmental protection issues have become a global frontier topic.

It is reported that the global temperature increase rate (0.13°C.10a-1) in the past 50 years doubles that of the past 100 years, and global temperature is expected to climb by 1.5-4.5°C (Gilman et al., 2008) by the end of this century [1]. The most direct consequence of global warming is sea level rise and it is estimated that the sea level has risen by 1-2mm.a-1 over the past 100 years. By 2030, the global sea level will grow by 18cm (Gilman et al., 2008), and the rate of global sea level rise is still predicted to increase (Church et al., 2004; Church & White, 2006). If humans do not take preventive measures, by 2100, the global average surface temperature will increase by 1.4-5.8°C, and the sea level will rise by 0.09-0.88m, compared to 1990. This will seriously threaten low-lying coastal areas and island countries [2].

4. Design concept of the interactive device artwork called “City Countdown”

4.1. Design theme of “City Countdown”

With the speeding-up development of the world, cross-border cooperation with technology has gradually become a mainstream in creating artworks. Meanwhile, new media interactive device art serves as the product of cross-border integration between technology and art. Supported by technologies such as somatosensory interaction and virtual reality, the interactive new media art can better empower the spreading of ideas blended in artworks. To a certain extent, it encourages interactive device art to engage in discussing today’s social issues. And such type of artworks enables the viewers to think deeply about their own interactive behavior through the interactive experience.

The theme of "City Countdown" is based on the reflection of global warming and the creation of artworks with the support of Arduino. This artwork aims to guide the viewers to realize the negative impact of human activities on global climate change via their interaction, and to further reflect on the status of human existence. Therefore, regarding this theme, “City Countdown” contains three major elements, first, an abstract urban landscape composed of temperature sensors, acrylic rods and LED lights, second a poster with a city and iceberg in the background, and third, an hourglass with a built-in miniature city model. The combination of the above-mentioned materials is to build a scene where various elements can interact with each other, so that the viewers can obtain abundant sensory experience when interacting with the device.
4.2. Interaction and visual design of City Countdown

This artwork is an experience interactive device for the audience, coupled with temperature sensing technology for art creation. Hence, the interactive design shall prioritize interactive methods, and take into account the viewer’s feelings and usage habits, in order to provide a smooth experience. First and foremost, when it comes to designing scenes, the city and glacier in the poster serve as a connection between the various elements of the entire device. In addition, the abstract urban landscape made up of LED lights and acrylic rods is positioned in front of the city at the bottom of the poster. Before the glacier is an hourglass with a built-in miniature city model. In terms of experience design, the temperature sensor with the “ice cube” as the appearance acts as the direct medium for interaction between the viewer and the work. When the viewer places his hand gently on the surface of the “ice cube”, the temperature sensor will detect the increase in temperature, which will brighten the LED lights gradually. During the gradual changes of lighting, the hourglass hanging on the abstract urban landscape also rotates from the vertical state little by little. When the fine sand in the hourglass begins to leak from one side to the other through the narrow connecting pipe, the LED lights below will go dim gradually. In the end, when the fine sand completely covers the city model in the hourglass, the LED lights are all turned off.

4.3. Design Concept of “City Countdown”

The research on global climate change is always a heated discussion topic for scholars from all walks of life for its crucial influence on the future of all mankind, so the in-depth study on this topic has extraordinary significance. Human activities have now become one of major contributing factors of global climate change. Specifically, they are reflected in the following aspects. First, the ever-increasing population has intensified carbon dioxide emissions, which has put tremendous pressure on the ecological balance of the earth. Second, human activities have brought about air pollution. Emissions of harmful gases such as methane and nitrogen oxide have been greatly on the rise, which has quickened the pace of global warming. Ultimately, global warming definitely causes the sea level to rise. According to experts’ predictions, by the middle of the 21st century, the entire sea level will rocket by 50 cm, and a large number of coastal cities are going to be confronted with crisis. “City Countdown” aims to remind the participants of the urgency of how to solve the global warming, a common crisis for all mankind. This artwork is dedicated to arousing each participant’s in-depth reflection to actively participate in protecting the ecological environment.
5. Development and realization of interactive device art, “City Countdown”

“City Countdown” applies an Arduino controller to link between the temperature sensor, LED lights and the steering gear, thereby forming complete interaction between the artwork and the viewer. First of all, the temperature sensor acts as the medium through which the viewer triggers the activation of the device, and the ice-cube appearance of the sensor represents the current situation in which human behavior accelerates global warming and leads to the melting of glaciers. When the program begins, the breathing light in the “ice cube” starts to flash, and the viewer is guided to touch the “ice cube”. When the viewer puts his or her hand on the “ice cube”, the inside temperature sensor can detect the temperature of the viewer’s palm and drives the device to start. Then the LED lights gradually change from dark to bright, and move from the center to the sides, which symbolizes the continuous expansion of the town. While the LED lights continue to brighten, the steering gear drives the hourglass slowly, and the blue fine sand falls down through the narrow passage, flooding the city in the end. The outer wall of the lower side of the hourglass is painted with the contour of the iceberg. When it is still, the blue fine sand in the hourglass will fill the inside of the contour, presenting the image of a small iceberg. A miniature city model is positioned on the upper side of the hourglass. When the hourglass is tilted, the fine sand will gradually flow to the city model while the sand in the contour of the iceberg will decrease. The blue fine sand in the hourglass stands for sea water, which was originally frozen into a solid form and locked in the glacier. However, with growing human activities, the glacier gradually melted and the city was submerged by sea water. While the mini-city model is covered little by little, the LED lights below go dim as well. When the model is thoroughly enveloped by fine sand, the lights are all switched off. This part of design demonstrates that the destruction of the natural environment by mankind is constantly fighting back against mankind as well. When natural resources are developed to a certain extent, cities can no longer continue to expand.
Instead, similar to the fate of the ecological environment, they are heading towards ultimate devastation.

```c
#include <Servo.h>
Servo myservo;
int d = 0;
int sand = 9;
int ledchain = 10;
int led = 11;
int t ;
void setup() {
  myservo.attach(sand);
  pinMode(ledchain,OUTPUT);
  pinMode(led,OUTPUT);
}
void loop() {
  ledbreath();
  t = analogRead(0);
  if (t<512){
    for (int d=0; d<=180;d++){
      myservo.write(d);
      delay(10);
      analogWrite(ledchain,255);
      delay(30000);
      for (int i=255;i>=0;i--){
        analogWrite(ledchain,i);  }}
  void ledbreath(){
    for (int a=0; a<=255;a++) {
      analogWrite(led,a);
      delay(10);  }
    for (int a=255; a>=0;a-- ) {
      analogWrite(led,a);
      delay(10);  }
}
```

Figure 3. Arduino code

6. Summary
During the common development of science and technology and humanistic spirit, contemporary art shall be created on the primary foundation of cross-discipline and integration[5]. “City Countdown” is an interactive device artwork created in accordance with reflections on the status of global warming. It
combines with the Arduino controller to provide participants with innovative experiences and discusses the relationship between human and nature in modern society.

Given the design and practice of “City Countdown”, the research believes that as the boundaries between art and other disciplines continue to be broken and multi-dimensional integration builds up a brand-new trend where new art forms should not be simply defined as a certain art category. Instead, we should pay attention to what kind of experience a certain new art can bring to people, and what kind of feedback, behavior and thinking can be stimulated from it. This also stands as the embodiment of the humanistic value of contemporary art [3]. The interactive device art represents the product of the integration between technology and art. With interaction as a medium, the sort of art connects diversified artistic elements and unlocks the infinite possibilities of artistic expression, and thus playing a far-reaching role in developing humanistic spirit and society.

References
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