An Interactive Anxiety-relieving Deep-breathing Art Installation Based on Arduino and Processing Programming Language

Qianyi Wang
Corresponding author's e-mail: 22868678052@qq.com

School of Design, East China Normal University 200062, P.R. China

Abstract. In recent years, according to a brief released by the World Health Organization, the global prevalence of anxiety and depression reached 25% in just the first year of the epidemic. In March 2022, the COVID 19 outbreak suddenly broke out in Shanghai, with a cumulative total of over 200,000 confirmed cases within a month. Difficulties in work and activities due to the epidemic have led to a constant negative psychological state and rising psychological stress [1]. How to relieve stress and maintain a relaxed mood has become a challenge for people. Meanwhile, it's universally acknowledged that deep breathing in the right way can be effective in relieving stress. This device aims to combine the use of two open-source electronic platforms - Arduino and Processing - to break the traditional way of interaction through programming tools. It translates the data standard into the form of a dynamic art installation by setting the appropriate breathing rate and breathing volume, and uses good visual effects and interactive experience to promote people to participate in the interaction, which guides people to improve their mood and reduce stress while interacting with the art installation through proper breathing.

Keywords: interactive device; anxiety relief; breathing; Arduino; Processing

1 Introduction

With the technologies like intelligent programming lower the barrier in recent year, these examples that technology empowering the arts are becoming common. Diversified means of expression and ways of presentation allow the views of artists to be conveyed to people more strongly and intuitively. However, the function of most art installations only stay in the level of conveying ideas, during the interaction, draw people's attention on the pattern of manifestation, as the same time, the actual utility brought by the installations themselves is also a topic to be explored. Through the form of interactive art installation, the attention of people will be focused on artistic expression in the process of interaction, and subtly play a role in improving people in some certain aspects. It is of great significance for interactive device design to explore the relationship between artistic concept expression and practical utility. This paper designs the device for the interactive behavior of deep breathing, explores the balance between the artistic expression of deep breathing and the function of breathing guidance, and uses programming to complete the prototype of the interactive device.

ADDT 2022, September 16-18, Nanjing, People's Republic of China

DOI 10.4108/eai.16-9-2022.2324891

2 Design background research

2.1 Psychological crisis in the epidemic state

2.1.1 Causes and manifestations.

Since the start of the covid 19 in 2019, people's lifestyles have changed dramatically, as reflected in the rising uncertainty and risk in people's lives, the increasing economic pressure. Thus, the Internet became the only reach to engage with the outside world for most of people. However, information on the Internet is uncertain. When facing sudden outbreaks and an overload of information, ordinary people will have a fear of the unknown, worrying about that they and their families will be infected and that the epidemic will continue, which invariably generating negative emotions. When someone is in an emotional state of stress, anxiety, fear, sadness and loneliness for long periods of time, he or she will develop mental health disorders such as anxiety disorders or depression. According to the study on the analysis of the mental health condition and influencing factors of college students under the epidemic, the incidence of depression among college students after the COVID 19 was as high as 21.16% [2]. From the above, it can be concluded that human beings are not only facing a physical disease crisis, but also a psychological crisis, which is becoming more and more prominent.

In the epidemic situation, human psychological crisis is manifested in the following four areas - emotional, cognitive, behavioral, and physiological [3]. The manifestations mainly include:

Emotionally - anxiety, depression, anger, etc.

Cognitively - decline, inattention, disrupted thinking and irrational thinking, etc.

Behaviorally - delaying behavior, withdrawal behavior, avoidance behavior, compulsive behavior, self-injury, etc.

Physiologically - sleep issues, pain problems, neurological endocrine problems and digestive problems.

All the above four aspects are interacting with each other. Improving one of these areas will have a positive effect on the others as well. This device starts from the physiological aspect and relieves emotional tension through physiological means.

2.2 The principle of deep breathing to relieve stress

2.2.1 Physiological Principle.

As a basic human physiological function, breathing is not only responsible for the exchange of oxygen, but also inadvertently assumes a person's emotions. Changes in mental states such as relaxation, excitement, happiness, and tension are reflected in the act of breathing, reflected in significant specific behaviors such as sighing and snorting, as well as in small changes in breathing rate. The act of adjusting one's breathing to changes in mood is accomplished through the action of tiny neurons located deep in the brainstem. The role of abdominal breathing exercises on the autonomic nerves has been gaining attention in recent years, and abdominal breathing has been used as an adjunct to the treatment of anxiety disorders [4]. Therefore, changes in breathing patterns are of great importance to stress relief.

The nucleus accumbens in the brain is a tiny structure located in the brainstem, and the entire cell mass is only 15 mm in size. It primarily produces norepinephrine - a key neurotransmitter in the brain, which serves to regulate overall arousal and anxiety levels. When a person feels stressed, the nucleus accumbens area of the brain produces more norepinephrine, and the attention network is prone to dissonance leading to reduced concentration and productivity. By managing breathing, the excessive production of norepinephrine in the nucleus accumbens can be effectively improved, allowing the attention network to be re-coordinated and synchronized and able to function properly [5]. Abdominal breathing is slower and deeper than chest breathing, resulting in a rise in lung ventilation and pulmonary circulation blood volume, and a rise in blood oxygen levels, effectively relieving tension.

Meanwhile, breathing control is also used in the treatment of patients suffering from panic disorder. Familiar with the Pranayama method in yoga and meditation exercises, it is able to shift one's heart from manic and anxious to a relatively quiet and calm state. Therefore, controlling breathing and taking appropriate deep breaths during anxious states can effectively improve anxiety and relieve the psychological stress of the moment.

2.2.2 Psychological principle.

Psychological control is an important branch in the field of social cognitive research. The concept of "mental control source" comes from Rotter's social learning theory. The source of psychological control is an important factor in regulating mental health, and the tendency to control determines the psychological state of the person, which is the basic need for people to understand and transform the world [6]. The responses to the loss of control include pursuit of information, increased response to tension, confrontation, and helplessness [7], while the external manifestations include fear, avoidance, etc.

In dividing the hierarchy of needs, psychologist Abraham Maslow named people's most basic needs as health, food and sleep. Human beings in modern society have a stronger source of internal control over these three needs, and whether the needs can be satisfied is positively correlated with the effort they put in. However, the social environment of the epidemic is not under individual control, and people have a weaker source of intrinsic control over the epidemic. As a result, it is easy to produce a bad psychological state in the weak control source state, which generates frustration and stress.

Using this principle, the interactive experience can be improved by enhancing the human sense of control over the interactive experience when guiding the interactive action. On a psychological level, when people achieve the desired results through their own operations, the feeling of stress could be relieved by the sense of control, competence, and security that comes from the operation process.

3 The ideas in creation design

The inspiration for the installation came from the sudden outbreak of the epidemic in Shanghai, which led to the quarantine of the entire city and the inability to socialize for a long time. For most of the citizens, constant anxiety and loneliness was occurred by the destruction of original plans and other factors. When considering how we can alleviate epidemic anxiety, the author

hopes to combine it with our profession to achieve the alleviation of transient anxiety in the social environment of the epidemic through art installations, and combine it with an analysis of the achievability and ultimate effect of the solution.

By comparing conventional means of anxiety relief - psychological relief, medication and relaxation training - deep breathing was found to be a solution that was both simple and very efficient. While the problems with autonomous deep breathing training include difficulty in knowing whether the breathing meets the training standards, inability to control the duration of breathing, and poor control of frequency. Combining above two points, the author decided to start with an art installation to guide people to complete a set of correct breathing behaviors actively. In the process, the breathing state can be judged by sensors, and combined with the design of a rich interactive experience effect. By the combined use of Arduino and Processing -the two open-source programming platforms, to achieve the principle of interaction of this art device through the processing of background data. The final result will be a good visual experience combined with the correct breathing behavior, while the person controls the picture, to complete the effect of relieving and improving the anxiety psychological state.

4 Programming principles

4.1 Interactive Programming of Processing and Arduino

As a development platform combining open-source hardware and software, Arduino can realize the intelligence of the device and provide technical support to the art interactive device. The program can be run by just two operations - the external sensing device receives the signal and the Arduino IDE writes the code. The combination of which can complete the effect of device and human interaction.

Processing, an open-source programming language enables electronic art and visual interaction design, which assists in teaching programming through visualization and allows for easier visual interaction design. Processing and Arduino share a common programming ease and similar syntax. By integrating them with each other, we can realize a richer interactive design experience by combining electronics, microcontroller technology and graphic programming technology.

The interactive device in this paper is implemented by the action of deep breathing. The simple actions of blowing and inhaling are mainly performed by the lungs inside the body, while outside the body they are mainly manifested by changes in the flow of gases and changes in air pressure. Using this principle and phenomenon, the action of breathing can be transformed into an electronic signal by using an Arduino sound sensor to receive signals from changes in airflow. Thereby, it is possible to obtain whether the person's deep breathing state is reasonable or not. The front end of the art installation designed in this paper relies heavily on the Arduino to translate behavior into data. While in the feedback section, the visual animation effect is used, which requires the application of Processing programming language. By drawing artistic graphics and arranging and making them according to deep breathing patterns and target-guided breathing states. When interacting, visual information is mainly delivered to guide people to use the correct way of breathing, and to complete breathing behaviors that are beneficial for relieving anxiety while getting a good visual experience.

4.2 Guidance

Different from traditional installation art, intelligent interaction can better bring the experience into the work. Through the different feedback people make to the sensors, it is possible to get a clearer picture of the state of the experiencer and the effectiveness of the device. In this device, the visual experience of the feedback is changed to guide people to breathe continuously. The lotus flower in the image changes, from which the user can realize the change of the image is closely related to his breathing after the first breath. Meanwhile, allowing the user to complete the whole process of deep breathing on his own, transmitting the breath size the device wishes to achieve through the degree of flower blooming, making the act of deep breathing spontaneous and reaching the goal driven by the subconscious.

The average number of various institutional indicators for adults in the fifth national fitness monitoring

gender	Age group (years)	body shape					body function	
		height (centimeter)	weight (kilogram)	waistline (centimeter)	hip circumference (centimeter)	body fat (%)	lung capacity (ml)	Cardiorespiratory endurance test (ml/kg/min)
male	20~24	172.6	70.4	82.4	95.8	20.2	3751	44.1
	25~29	172.1	72.8	85.3	97.2	22.5	3729	42.5
	30~34	171.4	74.3	37.6	97.8	23.7	3607	41.5
	35~39	170.4	74.0	88.5	97.7	23.9	3467	41.3
	40~44	169.4	73.2	89.0	97.3	23.9	3322	40.1
	45~49	168.7	72.5	89.3	97.1	23.9	3182	39.5
	50~54	167.9	71.6	89.5	96.9	23.8	3009	34.1
	55~59	167.5	71.0	89.8	97.0	23.8	2845	33.6
female	20~24	160.6	55.7	72.8	91.4	24.9	2557	39.2
	25~29	159.8	56.7	74.4	92.2	26.5	2528	38.3
	30~34	159.1	58.0	76.5	93.2	28.1	2470	37.4
	35~39	158.6	59.1	78.3	93.8	29.1	2405	36.5
	40~44	158.0	59.7	79.3	94.3	29.9	2313	34.1
	45~49	157.5	60.1	80.4	94.5	30.7	2215	33.4
	50~54	157.2	60.8	82.2	94.9	31.6	2124	29.8
	55~59	157.0	60.7	83.7	95.1	31.9	2018	29.5

Fig. 1. Average of the indicators for adults in the Fifth National Physical Fitness Monitoring Report

At the same time, in order to avoid differences in lung capacity among people of different ages and weights, the respiratory guidance system needs to be designed in such a way as to avoid breathing intensities that are not achievable by most people. According to the Fifth National Physical Fitness Monitoring Report [8], the respiratory lung capacity of men and women ranged from 2000 cc to 3700 cc(Fig.1),while the target was set at 2400 cc (female) and 3600 cc (male) in combination with the designed target population (youth)

4.3 Advantages of programmatic interaction

The interaction in this paper will be done through the action of deep breathing and blowing in combination with the programming language. More dimensions of experience can enrich the interactive experience, not only at the physical level of interaction, but also at the emotional level of the user has a good interaction effect. As the user's interaction proceeds, signals are received between breaths and at the visual level, transforming from the original anxious and agitated mental state to a calm and tranquil state. The interactive art installation is not only able to accomplish simple physical interaction, but also enriches the meaning of the installation with multiple experiences of behavior and emotion.

Meanwhile, the interactive device takes advantage of the subconscious behavior of people, when they do not get the complete information with the usual perception, they will voluntarily increase the amount of breathing, in order to get more complete information, which is a more active way of interaction and also enables people to actively complete the interactive experience with a good visual experience.

5 Design practice

5.1 Preliminary image design

The image design is inspired by the lotus, which represents purity in traditional Chinese painting. Being praised as “Rooting in the very mud without mess, spoiled by the neat treasure without sluttery”, the lotus is a symbol of innocence and purity. While the purpose of this interactive device is to relieve anxiety and to play a calming and soothing role, which is in line with the image of the lotus as innocent and pure. The design takes lotus as the object, and uses watercolor expression to reflect the breathing of the experiencer through the number of lotus flowers, the degree of flowering, and the growth of leaves, and to guide the breathing pattern through images (Fig.2&3).

To control the number of respirations and the depth of respiration, a total of three respiratory processes and several interval shallow respirations were designed, corresponding to three more lotus flowers and several lotus leaves. Each deep breath will open a lotus flower. Depending on the depth of the breather's breath, the degree of opening of the lotus will change, and when the breather's exhalation time reaches the mark, the lotus will completely unfold. While when the standard time is not reached, the breather will be reminded to increase the breathing intensity to achieve the target deep breathing effect. During the rest of the time, the lotus leaves will sway with the wind.

Fig. 2. Image design of the pre-respiratory process

Fig. 3. Image design of the late respiratory process

5.2 "Breathing" and "growing"

After the user's first breath, feedback from the growing lotus leaf is obtained to suggest to the user that the key to the program is “breathing” and “growing”. Respiration is a necessary act of life on Earth, which provides nutrients needed by the human body, as well as a necessary life activity for plants. As the core of this interactive device, breathing and growing allows users to feel the beauty of nature in breathing and release stress and reducing psychological pressure. Meanwhile, the use of watercolor in the design is in line with the theme of "calm" and "purity".

5.3 Design of breathing guidance system

The respiratory guidance system mainly adopts a 5-3-8 breathing pattern, which means 5 seconds of inhalation, 3 seconds of breath-holding and 8 seconds of exhalation. Since sympathetic nerves dominate inhalation and parasympathetic nerves dominate exhalation, the body is normally sympathetically dominated. The time difference between inhalation and exhalation causes parasympathetic nerves to dominate, lowering blood pressure and heart rate while increasing serotonin secretion and making people feel calm. And a 3-second interval of breath-holding time speeds up lymphatic circulation and gives a clear distinction between inhalation and exhalation.

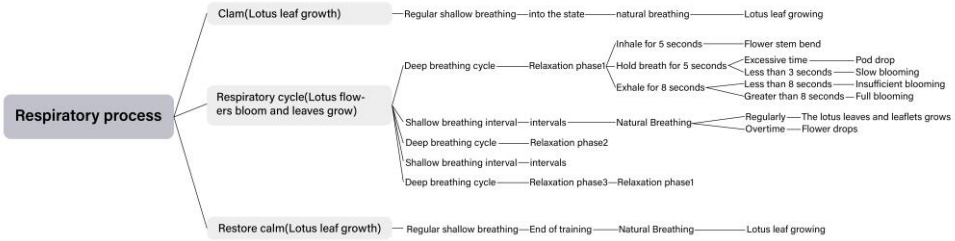

Fig. 4. Mind map of respiratory guidance system

After starting the interactive act, the user will first receive a prompt to take a shallow breath. After 2-3 shallow breaths to adjust the heart rate, the users will start taking deep breaths. When inhaling, the flower stems also bend backwards to simulate the state of a person inhaling. After the sensor receives the exhalation signal, the flower stem slowly straightens and the lotus flower blooms. One lotus flower represents a deep breath. The time of breathing determines whether this breathing is up to standard. Say if the time is less than 8 seconds, it will result in an incomplete lotus bloom. After completing the first deep breath, a shallow breath will be cued again as an interval. All breathing exercises will be completed with the flow of "shallow breathing - deep breathing - shallow breathing - deep breathing - shallow breathing - deep breathing - shallow breathing"(Fig.4).

5.4 Programming implementation

```
PImage img;
import processing.serial.*;
Serial myPort;

void setup()
{
  myPort =new Serial(this,"COM4",9600);
  size(435,1079);
  noLoop();
}
int data;

void draw()
{
  if(myPort.available()>0)
  {
    data=myPort.read();
    if(data>255)
    {
      img =loadImage("1.jpg");
    }
    else{
      img =loadImage("2.jpg");
    }
    println(data);
  }
 // println("");
}
```

Fig. 5. Implementation code in Processing

The coding of image changes is mainly completed in Processing (Fig.5), which realizes the process of changing lotus flowers from closed to open from the left side of the screen to the right side of the screen in sequence. The animation will be played frame by frame when the received data reaches the value corresponding to the breathing standard. During playback, if the data is encountered to be less than the standard value, the animation will be terminated and the screen display will stay at the last displayed screen. The corresponding effect that the lotus flower is not fully bloomed.

```
int sensorPin = 0;
int val = A0;
void setup()
{
  Serial.begin(9600);
}

void loop()
{
  val = analogRead(sensorPin);
  Serial.println(val);
}
```

Fig. 6. Implementation code in arduino

The reception of breathing sound signal is realized by Arduino (Fig.6). When the user does not start breathing and the hardware does not receive a signal, the screen will remain unchanged and the invitation message "Try taking a deep breath!" will be displayed at the bottom of the screen. When the user starts to breathe as instructed, the hardware receives an audible signal and the screen will start to play an animation and display "keep going" at the bottom to guide the user to continue breathing.

5.5 Effects testing and presentation

The effect of the device is presented through the display and sound sensing module together. It is based on the sound signal received by the sound sensor to stimulate the device each step of the guidance screen to achieve the effect of visual change (Fig.7&8&9&10).

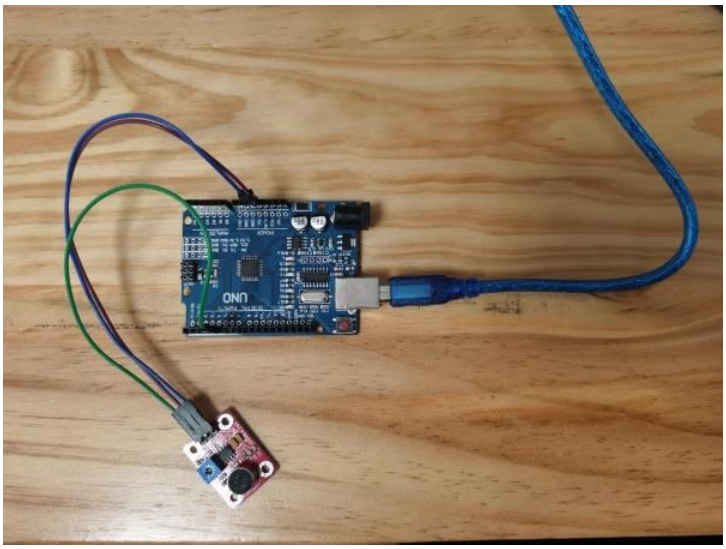

Fig. 7. The external hardware build of Arduino development board

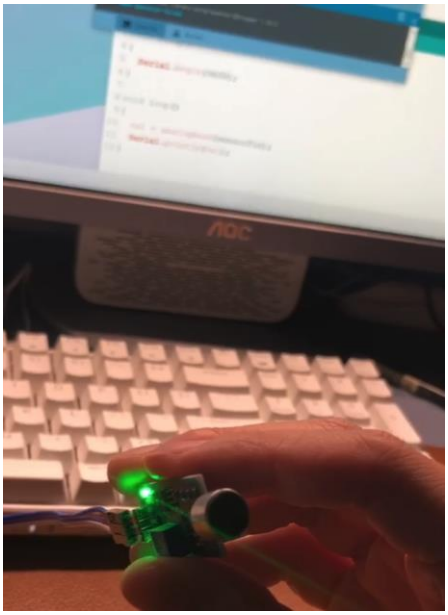

Fig. 8. Breathing action on the sound sensor

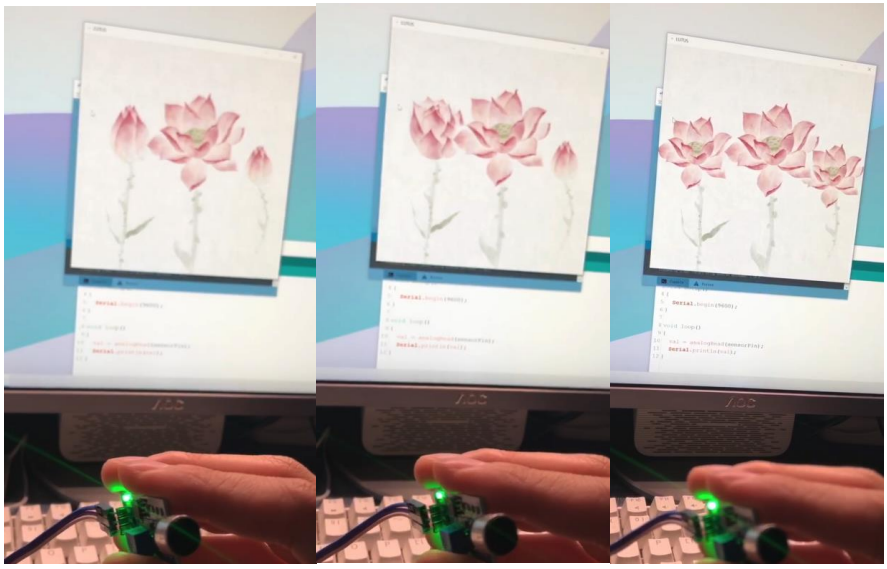

Fig. 9. Three flowers open sequentially according to breathing

Fig. 10. Experience the actual effect

6 Conclusion

With the continuous diversification of interaction methods and the continuous development of sensor technology, the combination of technology and art installations has more possibilities and development potential. The use of smart hardware development platforms such as Arduino can not only provide artists and designers with the possibility of realizing their creativity, but also provide a good platform for artists to join the digital design field.

In the context of the current global epidemic and the crisis of human survival, it is valuable to improve the psychological state of people and relieve anxiety for the development of society. This installation aims to promote healthy breathing through interesting interactive devices, using lotus flowers as design imagery to guide users to take regular deep breaths, improve mental anxiety through deep breathing, and promote the solution of psychosocial problems in the context of the epidemic through artistic techniques.

References

[1] Wang Y, Gao JL, Chen H, Mao YM, Chen SUH, Dai JM, Zheng PF, Fu H. Public media exposure during the coronavirus disease (COVID-19) outbreak and its relationship with mental health [J]. Fudan Journal (Medical Edition), 2020,47(02):173-178.

[2] CHANG Jinghui, YUAN Guixin, WANG Dong. Analysis of the mental health status and influencing factors of college students under the coronavirus disease (COVID-19) [J]. Journal of Southern Medical University,2020,40(02):171-176
[3] Liu Xuelan. Causes and interventions of psychological crisis among adolescents under the coronavirus disease (COVID-19) [J]. Modern Education Series,2020, (05):29-35+96.
[4] Liu P, Song LQ, Zhang GX. Application of slow rhythm breathing method in postoperative pain care [J]. Journal of Changzhi Medical College,1998(04):73-74.
[5] Kevin Yackle, Lindsay A. Schwarz2, Kaiwen Kam, Jordan M. Sorokin, John R. Huguenard, Jack L. Feldman, Liqun Luo, Mark A. Krasnow. Breathing control center neurons that promote arousal in mice. 2017. Science. DOI: 10.1126/science.aai7984
[6] WEN Gusen, WANG Yiqiang, ZHAO Guoqiu, SUN Jiansheng. A study on the relationship between social support, sense of psychological control and mental health[J]. Chinese Journal of Mental Health, 2000, (04):258-260.
[7] Zheng, Quan-Quan. Research on social cognition in and psychological control [J]. Applied Psychology, 1994, (01):33-39.
[8] Institute of Sports Science, the Fifth National Physical Fitness Monitoring Report, 2022