



Design for Connecting People Through Digital Artworks with Personal Information

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Abstract. Nowadays, people often experience physical separation in daily life. The level of social connectedness between people is declining gradually, but social connectedness is much important for human well-being. Communication techniques for people connecting remotely are most aimed at verbal information communication. However, during physical interaction, there is still a lot of non-verbal personal information other than direct verbal information we can perceive that contributes to social connectedness. Therefore, we try to explore if combining non-verbal personal information into digital artworks in a daily context, would influence connectedness between people. In this paper, we present VizArt, a channel that helps people connect through digital artworks with non-verbal personal information. A functional prototype was implemented and a pilot experiment was conducted.

Keywords: Social connectedness · Personal information · Digital artworks

1 Introduction

Nowadays, people often experience physical separation in their daily life [1, 2]. Especially in their relationships with family, friends, colleagues, and others. This is mainly because more and more young adults have to stay in a city far away from their hometown for education and other personal ambitions. Moreover, due to the pressure and stress from people's work and study, there is limited time for individuals to connect with their colleagues. Also, technological development, such as the use of various self-service machines and online social media, while bringing convenience to people makes interaction opportunities get fewer and fewer between people in real life. Because of these separations, the level of social connectedness between people, which is quite important for human well-being, is declining gradually [3].

At present, communication techniques are used for people connecting remotely, which are mostly aimed at verbal information communication, such as sending e-mail, sending messages and talking through the telephone, and interacting through various social media [4]. However, other than direct verbal information during physical interaction. However, during physical interaction, there is still a lot of non-verbal personal

information other than direct verbal information we can perceive that contributes to social connectedness [5] and can make people feel a strong connection with each other and positive emotion of “co-existence” and “we are being together”.

The nonverbal information, including body movements, expressions, emotional states, activity information and accompanying noises with activities [6], can be collected through quantified-self technology [7] and made available for transferring personal information through communication channels. As for the visualization of individuals’ information, we want to try the digital media art form. The advantages of the digital media art form are that it has the potential to be merged into the peripheral scenes of daily life without being abrupt with the quality in both functionality and aesthetics.

We try to provide a new channel for helping people connect remotely through non-verbal personal information that could naturally integrate into daily context. Therefore, in this paper, we explore if combining personal information into digital artworks in a daily context would influence connectedness between people.

2 Related Work

2.1 Social Connectedness and Health

Social connectedness plays an important role in human health and well-being [8, 9]. Social connectedness is defined as the sense of belonging and subjective psychological bond that people feel in relation to individuals and groups of others [10]. Social connectedness and social support that emerges from it provide the individual with core psychological benefits such as a sense of meaning, self-esteem, a sense of belonging and companionship, and an overall positive effect [11]. Lacking social connectedness is always associated with depression, loneliness, and other mental health disorders. These negative emotions are tied to ill-health, such as, it may affect the immune system by buffering the impact of stress [12].

2.2 Work for Social Connectedness Enhancement Remotely

Quantified-self technology is a tool to collect personal information for different purposes [13]. Most research about quantified-self data is currently aimed at gaining self-knowledge and self-health management, such as sleep [14] and blood pressure [15] monitoring, and also for behavior changes, such as physical activity promotion [16, 17] and weight loss [18]. Quantified-self technology can also be used to enhance social connectedness. When used properly, it can not only provide rich nonverbal information about an individual through online communication but also help people stay connected without occupying people’s attention at the same time.

Several studies have explored quantified-self data sharing in a daily social context. HeartLink [19] is a system that collects real-time personal heart rate and broadcasts this data to social networks through numbers and mathematical graphs. Empathy Amulet [20] is a wearable for strangers, and it is anonymously connected for experiencing shared warmth. PiHearts [21] is a tangible heart display that is shaped like a real heart to visualize data of the individual’s heartbeats. Social Flower [22] is a tangible system that presents

the high activity level with a green light color. These studies present personal information in the mathematical form, wearable devices and tangible systems. However, few studies explored digital media art visualization of data sharing in a daily social context.

A few studies have explored digital media art visualization with personal data for improving social connectedness. JeL [23] is a bio-responsive immersive installation art for interpersonal synchronization through a breathing sensor and a VR device to tackle social isolation and disconnectedness in our society. Blobulous [24] is a visualization system shown on a public display that generates visuals according to users' biological data through wearable devices and thereby movements, aimed at improving social connectedness. These studies focused on art installation in public spaces and provided contemporary interaction through wearable devices.

To the best of our knowledge, there is no work yet that aims to explore how to visualize non-verbal personal information with digital artworks in daily scenes for social connectedness enhancement. Thus, we created VizArt.

3 Design

3.1 Proposed Design

VizArt is an interactive and connecting channel that helps people who work in the same building to enhance social connectedness. It aims to the physical separation situation in the workplace. Due to the modern work style and architectural workspace arrangement, people usually work in an independent space in separate seats, rooms, and on different floors. On the other hand, they need to spend most of their time on various and numerous work tasks, so that they have little time for communicating face to face, in many cases except the coffee time during the whole day's work. The VizArt provides a common occasion in public space, a digital art display that presents the real-time personal information collected from individuals working in the same building (Fig. 1).

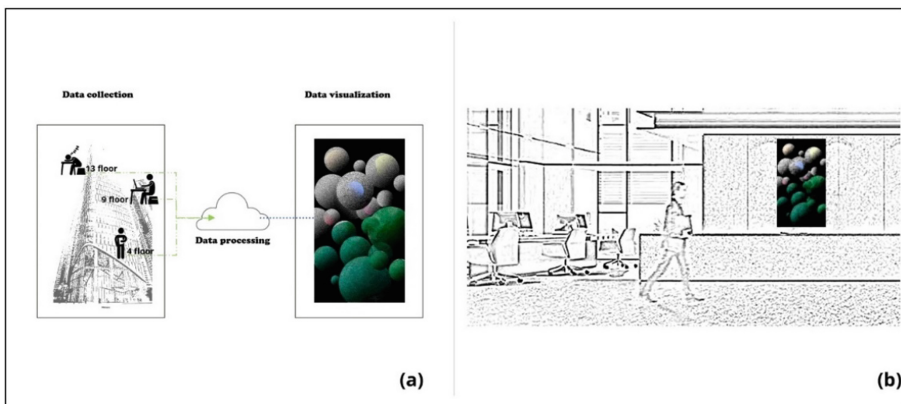


Fig. 1. “VizArt” system: (a) The digital art display with real-time data collected from individuals working in the same building. (b) Application scenario: The data visualization in a public workspace.

3.2 Design Considerations

VizArt is designed for social connectedness enhancement by showing individuals' data through digital artworks in the public workplace. There are three criteria that we need to consider: meaningful data, non-intrusiveness, and privacy concerns.

Meaningful Data. The design should make sense for workers: (1) The design should collect the data that workers are curious and concerned about. (2) Data visualization should be easy to understand. Only when users want to know the data and understand the data successfully can the design work on enhancing social connectedness.

Non-intrusiveness. The design should keep low interference for users: (1) The design should help people keep connecting with the group in the same building, but at the same time integrate into workers' daily routine and not occupy their time from their busy work schedule for reporting data. (2) The design should be integrated into the daily environment while conveying personal information naturally.

Privacy Concerns. The design should protect the privacy of personal data. It is because when personal data are shown in a public space, most people will worry about the problem of privacy leaks naturally. So only when design makes sure that personal data can be protected do users be willing to accept and use it.

3.3 Design Components

VizArt has two parts: data collection and data visualization (Fig. 2). Data collection includes two components: data selection and data input. Data visualization includes two components: data presentation and data output.

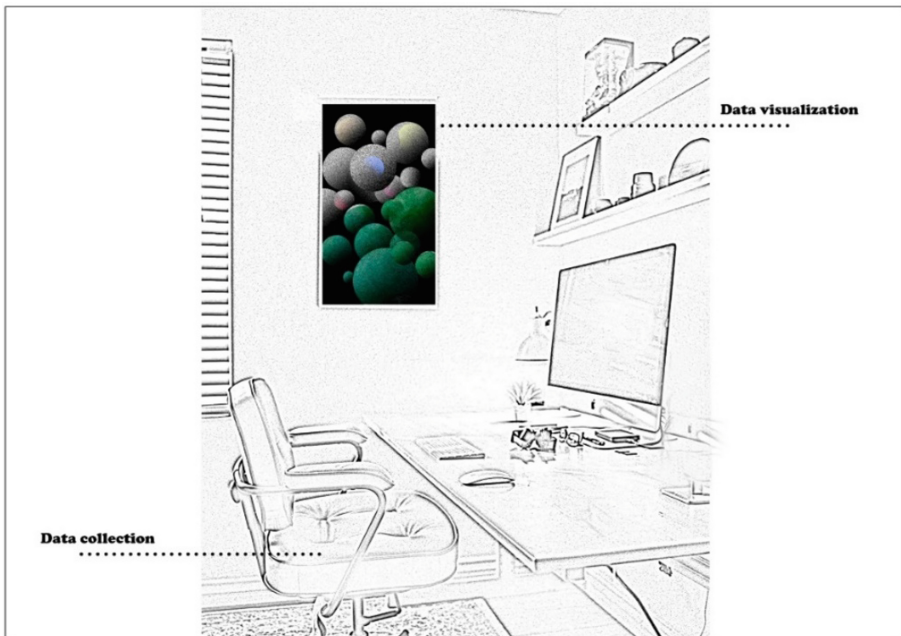


Fig. 2. The design components in VizArt.

Data Selection: Which Types of Data Are Suitable?

VizArt is designed for connecting workers through visualizing personal information recorded when they are working. There is a lot of real-time information in the workplace we can use, such as heart rate, breath, movement, water intake, mood, environment temperature, etc. These sources of information about individuals can be classified into the following categories: physiological, psychological, activity and context. For meaningful design, data should be selected such that workers who are curious and concerned about themselves and others.

Data Input: Which Types of Collection Devices Are More Convenient for Users?

In the workspace context, workers need to spend most time concentrating on their work tasks. So data collection devices should be integrated into their work routine, and workers should not spend extra time and attention on the devices. So individual data should be collected automatically and non-obtrusively. In order to achieve this goal, a convenient way is to integrate the input device into daily work objects and scenarios naturally. Daily objects, such as office chairs, office desks, and water cups that workers usually use in the office are suitable. These daily objects are usually peripheral so as to keep the lowest interference for users.

Data Presentation: How to Present Personal Data with Digital Artworks in Public?

To show individuals' data in public, the problem that users may worry about is privacy leaks. When presenting the personal data in digital artworks, it can be realized in an implicit manner so that the personal identity is not revealed to protect privacy. As for the type of digital art, different forms could be used, such as abstract painting, natural landscape painting, surrealist painting, etc.

Data Output: What Kinds of Presentation Devices Could Be Integrated into the Work Context?

In this work, we decided to use a display that can be integrated into the office environment to show a decorative digital painting, which has aesthetic value and is not abrupt while conveying personal information.

4 Pilot Study

In order to explore whether digital artworks with personal information in a daily context have an impact on users' social connectedness, a pilot study was conducted.

4.1 Experiment Setup and Place

We create two digital artworks as the experiment setups (Fig. 3), "Walk into Broccoli" and "VizArt Bubbles". One is without personal information, and the other is with personal information included.

"Walk into Broccoli" is one of the "Food and Environment" series digital artworks. It is a general digital artwork without personal information. The design of "Walk into Broccoli" was inspired by vegetable waste which has the highest waste rate among all kinds of food waste. The main reason is that the slow growth mode of vegetables reflects that people may ignore their vitality easily. Therefore, this digital artwork chooses

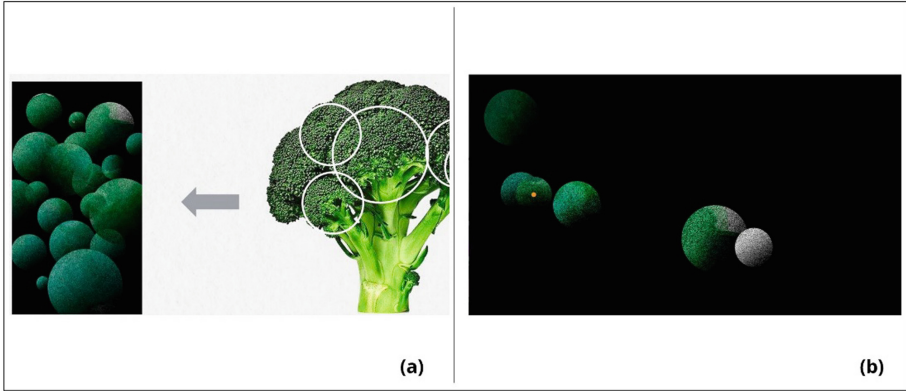
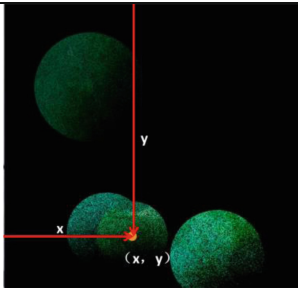
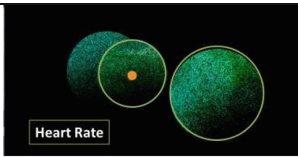
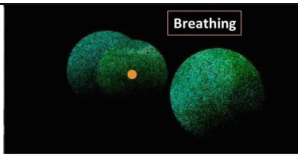
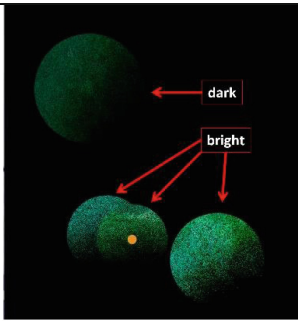
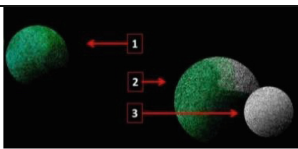
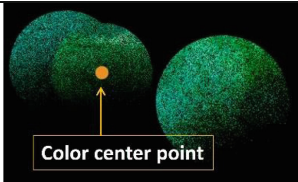


Fig. 3. The experiment setups: (a) “Walk into Broccoli”. (b) “VizArt Bubbles”

broccoli as the design object, emphasizes the symbiotic relationship between people and plants on the earth, and simulates the breathing state of plants to show their vitality. The design elements use noise to express the granular sense of broccoli, abstract the form of broccoli one by one, and develop with the sphere as the primary figure.

“VizArt Bubbles” is a digital artwork with personal information included. The design elements are developed based on the digital artwork “Walk into Broccoli”. It visualizes personal information that is most relevant to the workers collected from a smart cushion on a TV screen. Personal information includes total sitting time today, recent sitting time, heart rate, breath, sitting on the chair or not sitting on the chair, and fatigue state. The study was performed using the smart cushion for office chairs from BOBO Technology. A piece of Polyvinylidene Fluoride film is integrated into the smart cushion to capture the BCG signals from the users. Typically for the smart cushion, the output includes heart rate, respiratory rate, and heart rate variability. The heart rate variability index is usually treated as a valued indication of stress. The graphical expression and description of visualization associated with personal information are as follows (Table 1). The X and Y coordinate of the bubble indicates total sitting time today and recent sitting time, respectively. The dynamic change of the bubble’s outer ring size indicates the frequency of heart rate per minute of the participant. The Dynamic change of the bubble’s contraction speed indicates the frequency of breathing per minute. The bright and dark bubbles indicate people are sitting and not sitting on the office chair, respectively. As for fatigue state, there are green, green and grey, and grey bubbles, which indicate not tired, slight and severe tired, respectively. The color center point is used for the participant to identify themselves in many bubbles, but it won’t show when the bubble turns dark. This is because all real-time personal information is only present when people are sitting on their chairs. All the other personal information data except the participant were collected from part of the workers in advance in the same building to make participants believe that this personal information is real-time between them and the others who are working in an independent workspace of the same building when they attend the experiment and also to keep the consistency of experiment setup in each experiment.

Table 1. “VizArt Bubbles”: the graphical expression and description of visualization association.

Graphical Expression	Description of Visualization Association
	<p>X coordinate of bubble – total sitting time today</p> <p>Y coordinate of bubble – recent sitting time</p>
	<p>Dynamic change of bubble's outer ring size – Frequency of heart rate per minute</p>
	<p>Dynamic change of bubble's contraction speed – Frequency of breathing per minute</p>
	<p>Bright bubble – People is sitting on office chair</p> <p>Dark bubble – People isn't sitting on office chair</p>
	<p>1: Green bubble – State well and not tired</p> <p>2: Green and a little grey bubble – Slight tired</p> <p>3: Grey bubble – Severe tired</p>
	<p>Color center point – Each participant's representative color</p>

The experiment was conducted in a laboratory room (Fig. 4) located on the second floor of the Design Department Building at Jiangnan University.

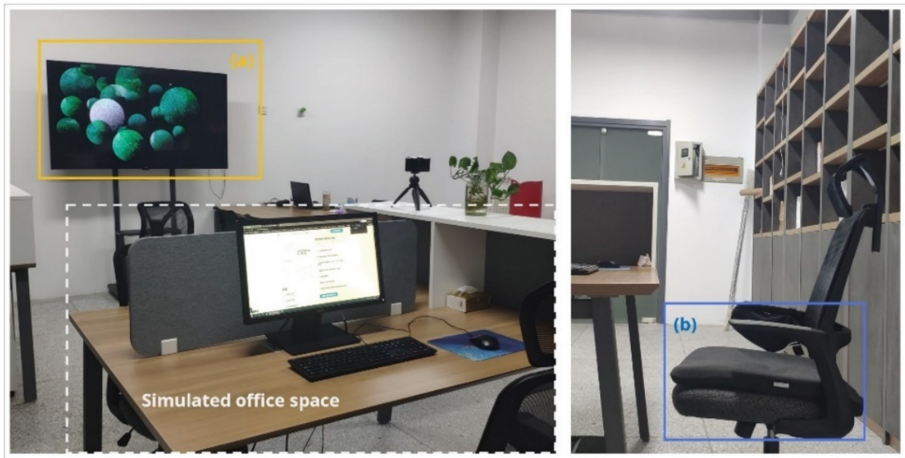


Fig. 4. Experiment room: (a) Digital artworks presentation (b) Personal information collection: smart cushion

4.2 Participants, Procedure and Measurements

We recruited 25 participants (16 females, nine males, age range from 25–38) from workers who work in the same design department building at Jiangnan University of China. Participants' backgrounds were distributed to different aspects of design, including User Experience Design (3), Design Strategy (1), Design Education (1), Design History and Theory (8), Architectural Art Heritage Protection and Utilization (2), Fashion Design (6), Interface Design (1), Digital Media Design (3).

Each participant attended the experiment individually with the independent workspace in the experiment room. The experiment was carried out in three steps (Table 2). The whole experiment lasted for about one hour:

Firstly, the participant needs to fill out a questionnaire with basic personal information, like gender, age, etc. Then before coming to the experiment, the participant was requested to do a questionnaire to fill out a questionnaire to measure their initial level of social connectedness.

Secondly, the participant was requested to complete the assigned task of browsing the introduced web page for 40 min. During this period, the participant needed to perceive and experience two different digital artworks, visualization A: “Walk into Broccoli” and visualization B: “VizArt Bubbles”, each for 20 min, respectively. The researcher will give an introduction about the design background and details of each visualization to help the participant understand the digital artworks before experiencing the process and the description text of each artwork will also be put on their desk in order to help participants know more clearly of the artworks during experience process. In order to avoid the

interference of the fixed experience order of the experiment, the order of presentation of digital artworks A and B was changed during each experiment. After every 20 min of the experience, the participant was requested to fill out the same questionnaire as they filled in the first step to measure the participant's feeling of social connectedness.

Thirdly, After experiencing two different digital artworks, researchers conducted semi-structured interviews with participants to obtain more information from the user experience, perspectives, and suggestions for this design.

Table 2. Experiment procedure

Experiment Steps		Duration
First	Basic information questionnaire + Initial questionnaire	10 min
Second	Browse web page + Experience (A) or (B) + questionnaire	20 min
	Have a break	10 min
	Browse web page + Experience (B) or (A) + questionnaire	20 min
Third	Semi-structured interviews	10 min

This experiment chose the Social Connectedness Scale-Revised (SCS-R) questionnaire [25] and the Inclusion of community in Self Scale (ICS) questionnaire [26] to measure the level of social connectedness of participants.

SCS-R consists of 20 items (10 positive and 10 negatives), asking people to grade from 1 to 6 depending on whether they agree or disagree with the statement. Then, the mean score is calculated using 10 positive scores and 10 negative reverse scores. A higher mean score of the SCS-R indicates a stronger feeling of social connectedness. ICS has six options, each option composed of two circles, the S (Self) circle and the C (Community) circle. The different part is the changes in the intersection surface. The more intersection surface indicates a closer feeling of Inclusion between self and people in their environment.

4.3 Preliminary User Feedback

Quantitative results (score of SCS-R and ICS) and complete qualitative results are being analyzed. So in this paper, we only present preliminary user feedback. Results are summarized as follows:

Perspectives for design: Some participants think the design with personal information is novel and interesting. *“This design is really novel and interesting (P13).”* *“I have never seen a design like this which is quite interesting (P14).”* The other participants hold the view that this design is useless. *“I don’t care about other coworkers at all (P2).”* *“I don’t think people have the requirement for this design because social and strong connections make me feel tired in my point of view (P5).”*

Feeling of social connectedness: Some participants had a strong feeling of connectedness changes when experiencing two different digital artworks. *“Even though I didn’t*

do anything and didn't take the initiative to contact others, I felt a strong sense of connection with others. I think this design is very successful (P7)." *"I just feel like I'm being with the people around me (P19)."* The other participants thought the impact on connectedness was weak and even had no impact. *"It has only a little impact on my feeling of connection, probably because of anonymity (P23)."* *"It doesn't impact my feeling of connection, probably because the experience time is too short (P2)."*

Data privacy concern: Some participants are worried about privacy. They are mainly worried about what if their boss uses this design to monitor them. *"I feel that the employers will use this design to check their employees' attendance and post (P2)."* *"I always feel like I'm being watched by my boss when I use this (P21)."*

5 Discussion

This paper tried to explore how to help people connect remotely and influence connectedness between people through combining non-verbal personal information into digital artworks in a daily context. As highly social animals, all human beings have a fundamental need and desire to belong, so it is important for people to feel a connection with others, just as the famous line says "No man is an island".

The VizArt aims to provide an interactive and connecting channel to help the people who are working in the same building, but in a different workspace to enhance their social connectedness. In the work space, most people are experiencing stress because they are under too much pressure from busy kinds of tasks during work time. But it will be helpful for releasing stressful state if we can have good relationships and strong connections with colleagues, those people we can have a chance to meet in the workplace.

However, people don't have many opportunities in the workplace for face-to-face communication which usually needs both space and time consistency between people. VizArt provides a common space in public which includes real-time personal information collected from individuals who worked in the same building, to help people keep the feeling of connecting without occupying their time from their busy work schedule at the same time.

The pilot study explored whether digital artworks with personal information in a daily context have an impact on users' social connectedness, by keeping in touch with knowing other people's real-time information remotely. The result of preliminary user feedback shows opposite perspectives from the participants. It may be because the feeling of social connectedness is entirely subjective, and it has a great difference between individuals' different personalities and social attitudes. Regarding experiment design, the reason why those participants felt little feeling changes in social connectedness could be that the experiment was conducted in a laboratory rather than in a real daily work environment, and maybe the experience time is too short for the participants to have the feeling of changes in social connectedness.

6 Conclusion and Future Work

In this paper, we explored the influence of social connectedness by combining non-verbal personal information into digital artworks. VizArt was presented as a new channel for

people who work in the same building to connect non-intrusively. An experiment was conducted with VizArt system with 25 participants. We found that the VizArt system indeed influences the feeling of social connectedness, although it is quite different from person to person as far as preliminary user feedback can tell.

The system needs to be further developed according to the quantitative and complete qualitative results. Moreover, the information-sharing perspectives of target users are found to be very important in this system, so we plan to understand the target user group and their daily context better for further design and development.

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