PassBy2: Passive Interaction through the Pedestrian Counts and Real-time Weather Information

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Abstract

A proverb in my country says, "Constant dropping wears the stone. " it means even something as small as a drop of water can cut through a stone after a long period of accumulation. It expresses the idea that the small changes we make unconsciously in our daily lives can leave unique traces over time. This project focuses on the impact of people on their surroundings, which concerns a contemporary street scene projected in an open space and captures pedestrians' pass-by counts using a Kinect sensor. Based on the measured counts of pedestrians passing by and real-time weather information, the developed application controls the color of the street scene and gradually decreases as the pedestrians cross. Using the L-system generative algorithm, the trees in the street scene grow progressively as the pedestrians cross.

Keywords: passive interaction, pedestrian counts, L-system, TouchDesigner, art interaction

1. Introduction

The current definition of public art is very vague. It can be government-employed, commercial, voluntary, or even illegal. There are also many creative methods, such as sculpture, dance, lighting, graffiti, etc. Even the recent emergence of digital art, which uses projection technology and expanded reality, etc. However, public art mainly has the common characteristic of being designed for a public audience. However, public art still has some commonalities, such as art forms installed in public spaces and available for public viewing or participation.

With the advancement of science and technology, public art has begun to be created using digital art methods and is presented using technologies such as extended reality and mixed reality. Digital art can use animation to tell stories and show more dynamics than other media. Pass-by uses digital art to combine virtual space with real space through projection and uses digital content to create interactive art [1].

This project, "Pass-by," is a passive interactive public art. It focuses on using passive interactive methods to present elements in life that are easily overlooked, such as the intersections we pass on our way out of our homes or the street trees we see everywhere on the roadside. No matter how small the influence is, it will leave its mark. Even just passing by can have an impact.

In the first version, the visual composition chose the street scene as the primary visual element. A computer-generated tree image is placed in the center of the street (Fig. 1).

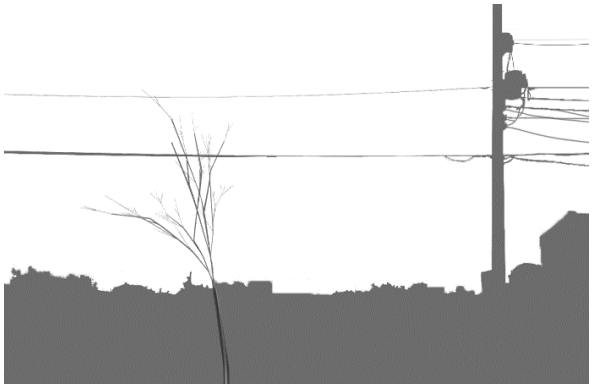


Fig. 1 Streetscape and tree generated from Pass-By [1]

The tree gradually grows through the interaction between the viewer and the work. The viewer only needs to pass by the work during the interaction process. The distance sensors are used to capture the conditions of people passing by, which generates different effects on the growth of the trees. At the same time, the shadows of pedestrians also blend with the street scene due to the light.

After exhibiting the first version, the proposed new version, “PassBy2,” combines the concept of "Site-specific art" and considering location factors. This paper focuses on how local weather affects streetscape and uses a Kinect sensor to explore the accurate behavior of pedestrians. The proposed new version stores the generated image when the exhibition is closed daily. The changes in the streetscape and the growth of trees caused by pedestrians crossing each day will create a unique composition of generated art, just like people working together to create and record their own streets.

2. Related work

The section discusses prior works in two subsections: 1) the technology and development of interactive art and 2) the concept of “PassBy2”.

2.1. *Interactive art*

The distinction between passive art and interactive art lies primarily in the audience's engagement level. Passive art invites viewers to appreciate the artwork without altering it, while interactive art encourages active participation, transforming the viewer into a co-creator [2].

Passive art involves artworks that are meant to be observed. That is, in traditional static works, such as Banksy's Minnie Mouse [3], the audience is not involved in the creation of the work. Compared with conventional passive art, interactive art allows the audience to play an important role. The artwork responds to the viewer's size, movement, and even sound.

In contrast, interactive art incorporates technology to foster engagement, allowing viewers to manipulate or influence the artwork. This can range from simple interactions to complex systems where audience input alters the artistic output [4].

Most of the interactive arts focus on timely and active interaction. For instance, “Plane White” by Carina Ow captures viewer's gestures to allow viewers to actively participate in interaction and produce image changes [5]. Or focus on the current changes such as “Shiny Ball Mirror” by Daniel Rozin, which uses a metal ball to create two reflections in front of the viewer.

With the advancement of technology, interactive art has begun to use electronic sensors to create creations, such as Arduino, Kinect, etc. Interactive art, enhanced by technology, fosters deeper engagement and aesthetic appreciation among audiences [6]. Like “Rain Room” by Random International, which uses motion sensors [7], the interactive art installation detects the presence and movement of individuals, creating a zone where the rain stops above them, providing an uncanny experience of controlling the rain and walking through the rain without getting wet. There are also public places, like “The Tree of Resonating Colors of Life” by TeamLab, that change color due to the impact of someone's blow [8], and a color tone resonates.

Compared with the previous two, passive interaction must conform to the fact that interactive art evolves with its audience, making each encounter unique, and the audience does not notice that. Such as Four thirty-three by John Milton Cage Jr., during the piano concert, no notes are played; only the keyboard cover is opened and closed. A tape recorder is used to record the audience's voices during this silent concert. In this project, "PassBy2" is a passive interaction that downplays the current changes and active interactions, focusing on the long-term accumulation caused by the viewer's unconsciousness.

Passive interaction refers to systems or individuals engaging without direct or active involvement, often relying on inherent properties or feedback mechanisms. This concept is particularly relevant in robotics and human-robot interaction. In art, passive interaction encompasses experiences where the audience engages with art forms without active participation, allowing for emotional and aesthetic appreciation. This concept is explored through various mediums, including traditional portrait art and interactive storytelling [9], where the art influences the viewer's emotional state without requiring direct interaction.

In this project, we combine time with passive interaction to weaken the interactivity of the item and strengthen the feedback generated by accumulation.

2.2. *Concept of “PassBy2”*

The idea of “PassBy2” came from a backpack we used regularly from high school days. The backpack in Fig. 6 faded by long-term use due to personal usage habits. It is faded unevenly, creating a crease-like texture. We never notice the changes in backpacks unless someone reminds us. Likewise, many things are changing unnoticeably, thinking that they will freeze now of pressing the shutter just like the photos, but we fail to notice that the images will also turn yellow and fade.

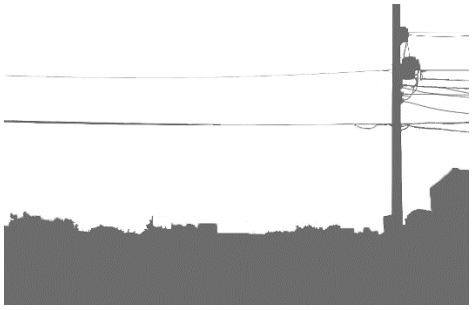
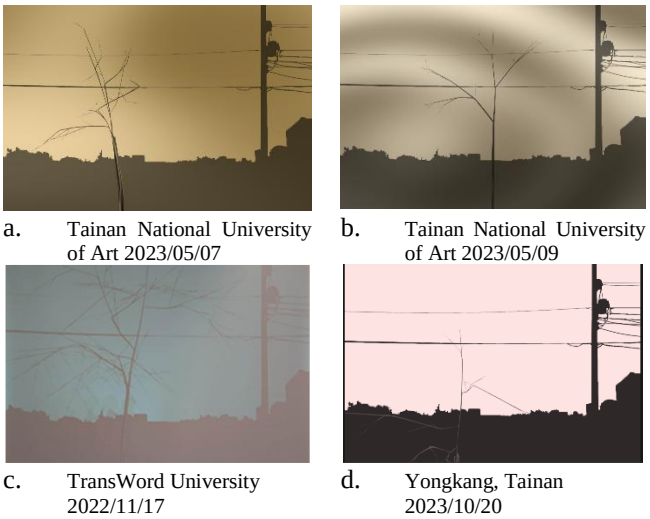


Fig.2 Streetscape filmed in front of my house

The backpack is the emotional connection between someone and his/her hometown, who left to study in college, so “PassBy2” also reflects the emotions of the hometown. The visual focus of this project was a streetscape shot in front of the first author's house (Fig. 2).

Using exhibitions in different places, the street scenes of the hometown were combined with passive interactions to record the local weather and pedestrians

passing by the project. The street scenes were slowly changed by the influence of weather and people, just like a part of the hometown was affected by the local people in a strange place. Slowly wearing it with the environment and exposure to different people and weather would create different results, as shown in Fig. 3.



a. Tainan National University of Art 2023/05/07

b. Tainan National University of Art 2023/05/09

c. TransWord University 2022/11/17

d. Yongkang, Tainan 2023/10/20

Fig.3 Trees growing in different dates and places.

3. System Overview

The interaction of this project, "PassBy2," is divided into two aspects: hardware and software (Fig. 4). In terms of hardware, a Kinect camera is used as a sensor to detect the data of passing pedestrians; the received data is transmitted to the computer for calculation, and then the image calculated by the computer is instantly projected to the wall using a projector. The projector's light path will be blocked by pedestrians, causing their shadows to overlap with the projected view.

Connect the weather API on the Internet and transmit local weather information to the system by Json; the TouchDesigner software is used to integrate the data from Kinect and the weather API, and the built-in L-system algorithm and real-time composition of TouchDesigner nodes are used to generate the final compositions.

3.1. *Hardware*

Set up projectors and curtains on both sides of the crowded path so that when light is projected, people passing by will block the light and mix their shadows with the streetscape (Fig. 5). In this project, we use Kinect as the sensor. Kinect has two built-in sensors: an RGB color VGA video camera and a depth sensor [10].

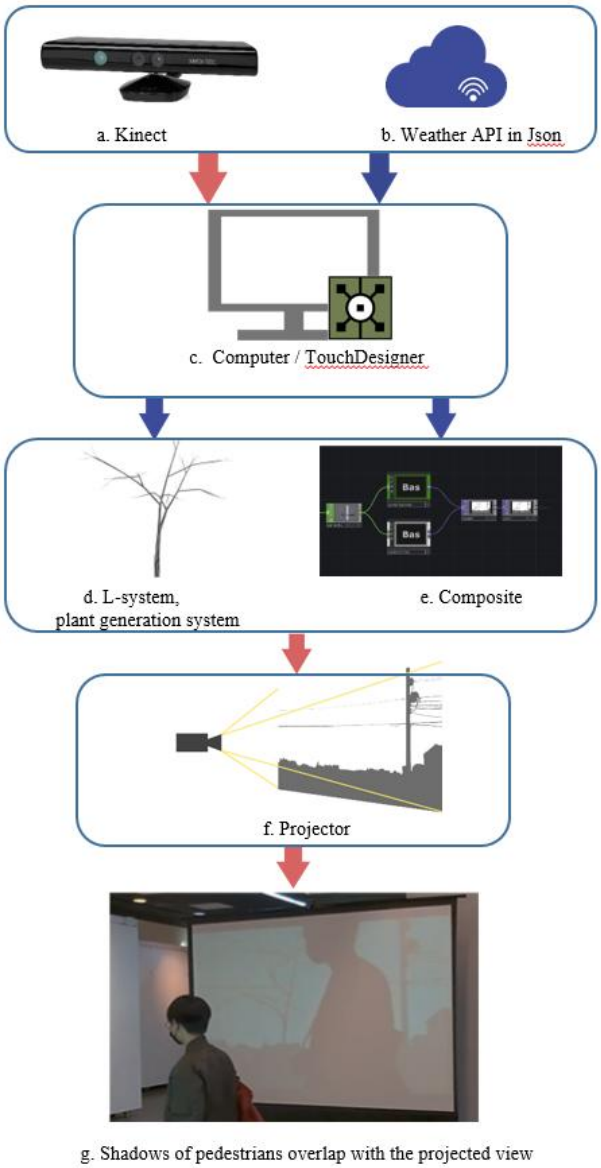


Fig.4 Overview of "PassBy2" installation: The red arrow indicates the hardware connection; The blue arrow indicates the software transfer.

Video camera helps in facial recognition and body recognition; the depth sensor helps create the 3D imagery throughout the room and provides 3D coordinates of the x, y, and z axes of the human body (Fig. 6). The Y-axis is the height z-axis is the normal of the sensor. The x-axis is the designed pedestrian walking direction (Fig. 7). This project mainly uses the functions of Kinect to perform the following three operations:

- Calculate the person's relative position and the detector using the x-axis and z-axis of the person's hip.
- Measure the displacement of the person's x-axis at intervals of 0.5 seconds and calculate the value and direction of the velocity.

- The camera detects the red, green, and blue color components, body type, and facial features. Use this feature to separate the texture of people from the background [11].

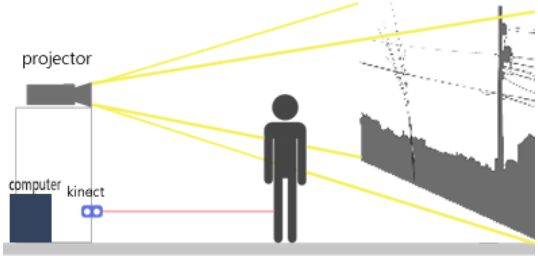


Fig.5 Hardware structure

Fig.6 Kinect can create 3D imagery throughout the room and capture human body contours.

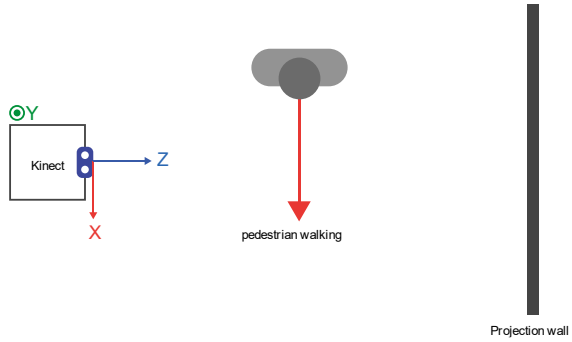


Fig.7 x, y, z axis directions in Kinect from top view.

3.2. *Software*

This project uses a software called TouchDesigner. It is a tool for real-time creativity built for artists, performers, and researchers. It allows them to work freely and efficiently with generative and recorded media [12]. This installation uses TouchDesigner to connect with Kinect.

- “Texture Operators” built into TouchDesigner read the shots from the video camera in Kinect. Select the "Player Index" mode to extract the person’s outline.
- “Channel Operators” built into TouchDesigner read the data from Kinect, which captures the 3D coordinates of the person's hip. Then, they calculate them to get distance and velocity, which transfer data to the L-system so that it can accumulate and use parameters to generate.

In addition, the following two submodules were combined with TouhDesigner's real-time computing function to complete the project: the first one is an L-system-driven tree generator, and the second one captures real-time local weather information by weather API.

- Lindenmayer systems (or L-system) is an iterative function that uses mathematics. The central concept of L-systems is that of rewriting. In general, rewriting is a technique for defining complex objects by successively replacing parts of a simple initial object using a set of rewriting rules or productions. This method is used to simulate the growth of plants and models. As seen from the Algorithm of Plant Beauty, the L system is complete in plant construction. We can create a forest scene, the growth of a vineyard over a house, and a Lily of a valley. In this project, the L-system interacts with pedestrians to generate unique tree shapes [13], [14].
- This time, use the weather API provided by "Visual Crossing." In this API, the following are specified as HTTP query parameters. If you connect to the Internet and set the longitude and latitude, we can get real-time weather information, including description, temperature, cloud cover, etc. Use weather to influence the work and strengthen the connection between the project and the location.

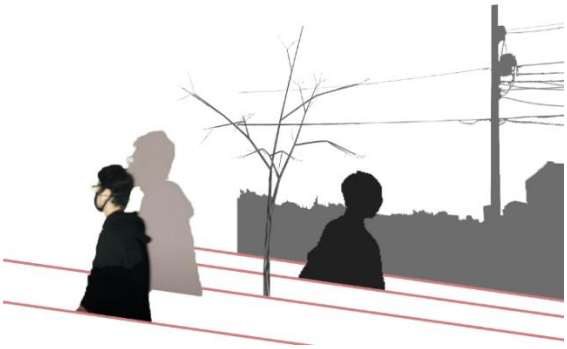


Fig.8 shows layers of visuals sorted from back to front: a streetscape with the weather, a pedestrian silhouette recorded in the past, a tree, and the shadows of current pedestrians.

4. Visual Composition

The feedback generated during interaction is mainly presented visually, and the layered overlap from back to front: streetscape with the weather, pedestrian silhouette recorded in the past, and the tree by L-system. In addition, shadows are caused by people passing by blocking the light from the projector at the front (Fig. 8).

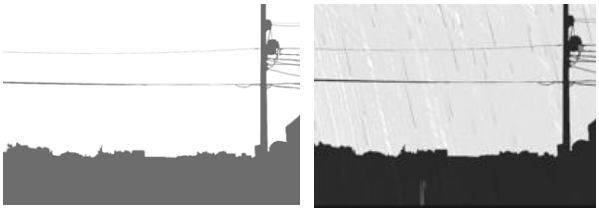
4.1. *Streetscape with Weather*

The streetscape in the project was shot in the alley in front of the station in the first author's hometown. Every time someone walks by the project, some of the colors in the street scenes will be removed, and noise will be added, gradually making the picture darker and rougher. (Fig. 9) Depending on the relative distance between the crowd and the Kinect camera, the increased points and reduced colors will be different when the crowd passes through the work. Although the value dropped by each person passing by is very small and the change cannot be seen immediately, it can produce different looks after accumulation.

Fig.9 Affected by pedestrians crossing, the streetscape becomes rough and dim.

To increase the integration with the local environment, the project introduced a weather API, which can instantly obtain local weather data affecting the project screen:

- When it rains, the number of raindrops will be adjusted based on humidity (Fig. 10).
- The frequency of harmonics that affects the noise generated every time people pass by the project based on visibility.
- Depending on the temperature at the time, the project's color will change when people pass by it.
- Obtain the day's sunrise and sunset time switch works and take screenshots of the project's street view at sunset.



a. Clear day b. Rainy day

Fig.10 Streetscape will produce raindrops when it rains.

4.2. *Catch Pedestrian Silhouette*

In addition to projecting pedestrians' shadows on the street, the motion capture function of Kinect records the outline of pedestrians, and TouchDesigner is used to edit the images into silhouettes (Fig. 11). The image is played back when the next pedestrian passes by, highlighting the traces left by people on the project.

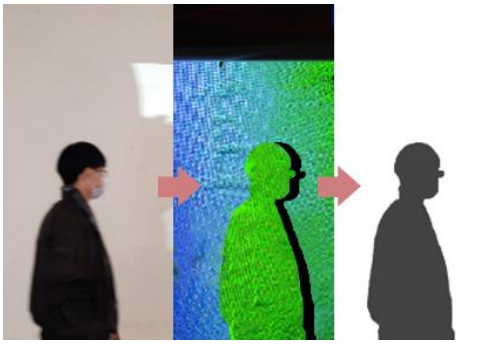
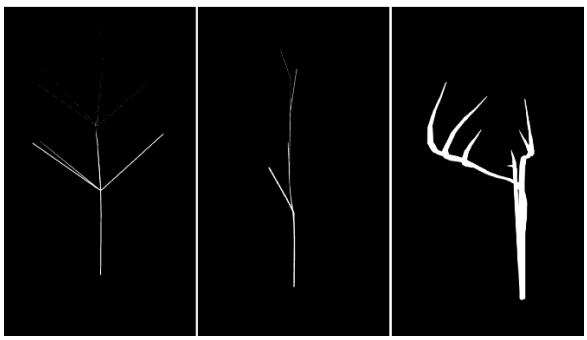


Fig.11 Using the "Player index" mode of Kinect to catch people's silhouettes.

4.3. *Growing Tree by L-system*

In this project, I use the L-system to create a tree; the generation of this tree is defined as the Kinect that calculates the sensed person's ID ordering. Furthermore, designing three models of the different branches (Fig. 12), the corresponding equation is as in [15] (Table 1). According to the current distance between the person and Kinect sensed by Kinect, it is divided into three modes: less than 50cm, between 50cm and 100cm, and greater than 100cm, which affect the growth of the three models, respectively.

Kinect measures a person's displacement within a fixed period to calculate the speed. According to the direction of the speed, it is classified as proper or left so that the model's angle changes to a positive or negative direction; the magnitude of the angle change of the model is determined based on the velocity.



Eq. (1) $< 50\ cm$ | Eq. (2) $\geq 50\ cm$; $\leq 100\ cm$ | Eq. (3) $> 100\ cm$

Fig.12 Three different tree models

Table 1. L-system functions in Fig. 16

$$\begin{cases} A = !F[+F][-F]B \\ B = !\sim(10)"[-F][(b)F]A \end{cases} \quad (1)$$

$$\begin{cases} A = !F[-F]B \\ B = !\sim(10)"F[+(c)F]A \end{cases} \quad (2)$$

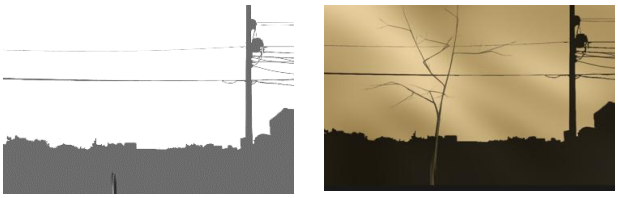
$$A = [\&FL!A]/////'[\&FL!A]/// /'[\&FL!A] \quad (3)$$

5. Conclusion

PassBy2 is a passive interactive work that expresses the accumulation of small things in life. It uses L-system and TouchDesigner to make plants and streetscapes grow and change slowly under the influence of people and record the changes over time (Fig. 13).

When PassBy2 was present at the exhibition, we found that some of the visitors stopped to inspect the trees. Some, especially children, were walking forward and backward to try to speed up the changes in the image. They waved their arms in front of the work to try to control the direction of the tree's growth.

In the future, we plan to directly depict the trajectories of people passing by (Fig. 14) and draw people's trajectories as mountains and street scenes blended instead of noise and color.



a. Beginning at sunrise b. Ending at sunset

Fig.13 Compare the beginning and ending: a is clean and has a tiny sapling; b is turbid and has a great tree that changes under people's influence.

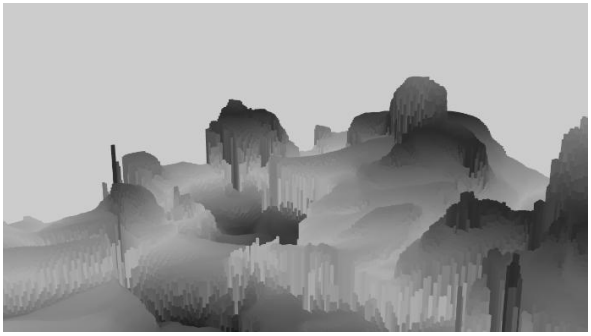


Fig.14 Try to draw the moving track into an image that fits the project style.

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