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# A Study on Information Visualization in the Form of Interactive Art Focused on Protection of Sensitive Data

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Abstract

Information visualization, which expresses information analysis results is an easy-to-understand manner, is useful for capturing and conveying information at a glance. However, in the field of information visualization, care must be taken when providing information that contains sensitive information, such as sex offenses. For example, if you provide visualized information on the areas where sex crimes often occur to promote people's safety based on only clarity and accuracy to provide information, you might reduce the value of the real estate in that area, and compromise the privacy of individuals, causing a secondary social problem. Therefore, we tried to integrate information visualization with interactive art as a complementary information visualization method that can provide information to people while protecting sensitive information. Herein, we studied how to visualize the information through phased visualization of the interactive art and application of aesthetic elements of the art.

Keyword : Information visualization, Interactive art, protection of Sensitive data

## 1. Introduction

Information visualization research involves the expression of the information visually so that the analysis results can be easily understood. Information visualization is used in various fields to catch and convey information at a glance. It is frequently used to help address various social issues such as safety and disasters.

Traditional information visualization is mostly focused on visualizing large amounts of data and delivering information clearly and effectively. It is based on intuitiveness, clarity, and immediacy. Information visualization is being investigated for many types of information transmission, such as allowing large stock price fluctuations to be understood at a glance or communicating the consumption patterns of people through SNS(Social Network Services) at a glance[1-3].

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Apart from research focusing on the purpose of delivering information, research on how visualization relates to social problems is still lacking. Of specific interest is the protection of sensitive information (which increases daily) that may cause discomfort and problems if it is released.

Care must be taken when providing information that contains sensitive data such as sexual offenses. Providing information related to the area where sex offenses often occur visualized based only on clarity and accuracy may have a goal of promoting safety. However, it can also reduce the value of real estate in the area and compromise the privacy of others who are not protected, resulting in secondary social problems.

Therefore, we proposed to integrate information visualization with interactive art as a complementary information visualization method that can provide information to people while protecting sensitive data. In other words, we seek to reduce the possibility of secondary social problems that could be caused by information visualization by (i) using interactive features and phased visualization of interactive art and (ii) utilizing the aesthetic elements of art. At the same time, such a strategy can expand the role of art.

Section 2 explains the concept of information visualization, and Section 3 explains the features of interactive art. Section 4 explores information visualization in the form of interactive art while protecting virtual sensitive data. Section 5 provides the conclusion.

## 2. Information Visualization

Information visualization refers to the process of visualizing and delivering the results of an analysis of large amounts of data in a way that is easy to understand by human cognitive functions.

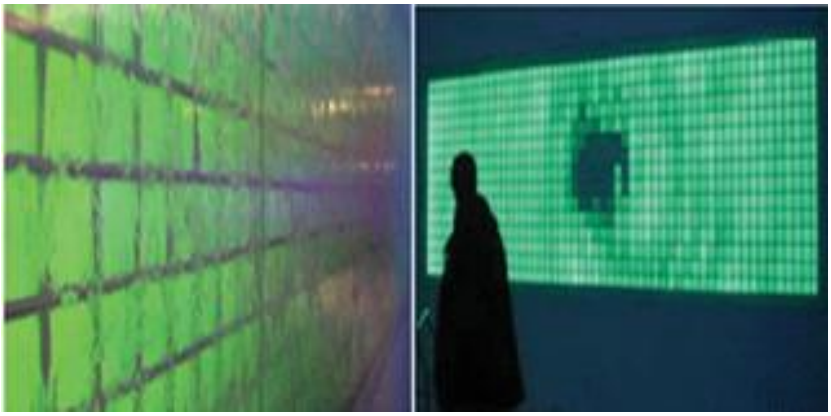

[Fig. 1] Name Voyager, 2010, ©The Baby Name Wizard[6]

This area has been studied and used in various fields such as human-computer interactions, computer science, graphics, visual design, psychology and business methods[4][5].

[Fig. 1] is an example of data visualization called 'Name Voyager', which is a big data visualization project of the Baby Name Wizard[6]. This project allows you to see at a glance how frequently baby names have been selected over a period of hundred years based on the Baby Name Database. The project uses two axes: time and size. When the user enters a baby name in the text box, it displays the size of the area as how many babies have the name on the 'time' axis. In this way, the information visualization shows abstract information in an easy-to-understand and effective visual form so that it can be easily perceived by human beings.

## 3. Features of Interaction

[Fig. 2] is an interactive work of art called Waterfall of Forman, C[7][8]. An infrared camera mounted on the workpiece measures the changes in people's movements and generates waves (similar to when a stone is thrown in water) when they move in front of the work. The spectator becomes a part of the natural phenomenon and becomes immersed in the work, feeling that they caused the wave.

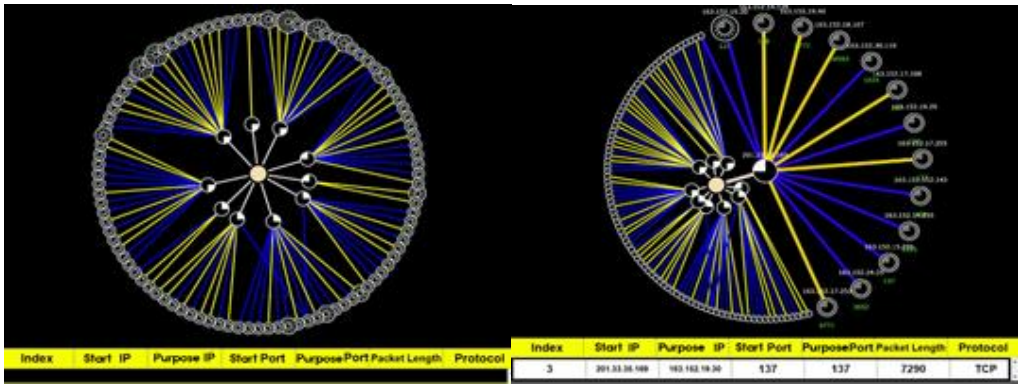


[Fig. 2] Waterfall, Forman Calis, 2007[7][8].

[Fig. 3] is an instance of information visualization about preventing a network hacking attack[9]. This visual image shows how much information is exchanged between the external and the internal hosts. Clicking the mouse indicates the range of Destination IP addresses of the internal host.

[Fig. 3] also provides an objective-oriented linear interaction to determine the needs of the user under the intended purpose, and the linear interaction is displayed in the form of a hard graphic in accordance

with the purpose of the user. The interactive art example, on the other hand, included beautiful and abundant aesthetic elements of nature through the movement of chaotic water. Above all, the viewer (or user) can instantly visualize real and artistic play.




[Fig. 3] Information visualization for network monitoring[9]

Laurel, B, in her paper, 'Good Human Interaction', explained that successful interactions must have a reactive element in the initial action, and that the interaction is successful due to the continuation of the first incident[10]. In the case of [Fig. 2], when the spectator (or user) moves in front of the work, the spectator becomes a part of the natural phenomenon. That is, the behaviors of the spectators include reactions that cause the water wave. In other words, the initial behavior of the interaction includes the following reaction.

## 4. Interactive Visualization with Sensitive Data

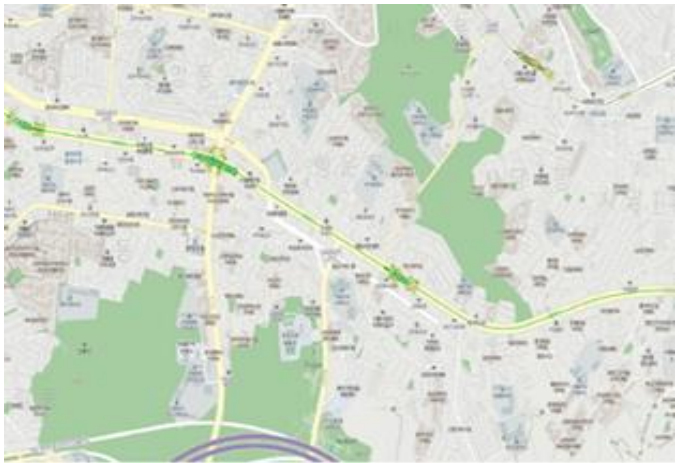
[Table 1] shows information requested by the relevant agencies and the answers of the persons responsible to obtain sensitive data related to regional assault, robbery, theft and rape.

As shown in [Table 1], crime data related to the local area were requested by police stations and public data disclosure sites in each region. However, crime data by region and village could not be provided since such data could be used for various crimes. As shown in [Fig. 4], the area and the crime data were arbitrarily set and applied to an interactive art form.

[Fig. 4] shows that some areas of Gwanak-Gu, including Seoul University Station, Nakseong-Dae Station of subway line 2 and Namseong Station of subway line 7 are arbitrarily set for the study by applying sensitive data (i.e., local crime information) to the interactive art form. The number of crimes in the region was set to eight, and the patterns in Table 8 are the eight patterns of crime.

[Table 1] Answers to the request for sensitive data

| | Answers to crime data requests, including assault, rape, theft, robbery by region | Answering organization (respondent) |
|---|---|---|
| Answer 1 | - There are 112 datapoints and kicks data. The 112 datapoints refer to criminal data for the area of the 112 report telephone call, and the kicks data refers to the data close to the actual data excluding imaginary information such as prank calls from 112 data. There is a way to request the kicks data to visualize the accurate regional crime situation. | - Advised by A University Police, Professor A |
| Answer 2 | - Current kicks data are processed using other local information, and 112 datapoints contain the crime data by region. Each has advantages and disadvantages.<br>- The scope of disclosure of data can be requested from the police website or public data portal. | - B Visit the police station, consult with the person in charge |
| Answer 3 | - 112 Data or kicks data cannot be disclosed.<br>- Disclosure of information in a specific area or neighborhood may be exploited for speculative purposes or for crimes.<br>- Regardless of the purpose of research, it is illegal under the current law to disclose information based on the Personal Information Protection Law. Therefore, information disclosure is not possible. | - Telephone consultation with public data portal information disclosure officer<br>- Seoul, Korea ** Telephone counseling with police officer M<br>- Telephone consultation with the person in charge of C office of Cheonan S police station |

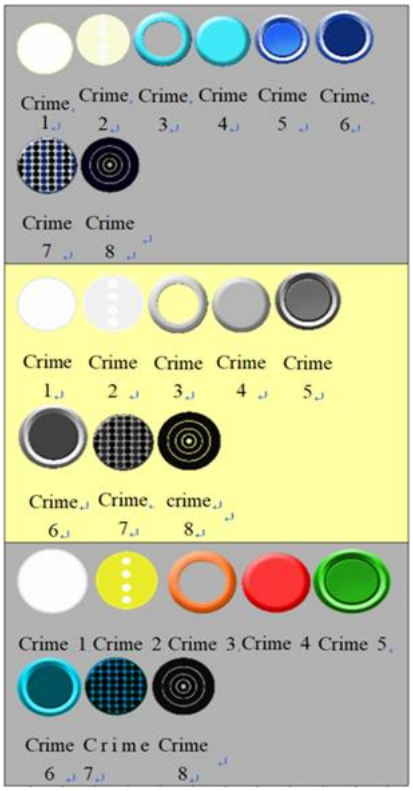


[Fig. 4] Gwanak-Gu area set randomly

In interactive art, visual information is expressed according to the principles of visual art[11][12]. In

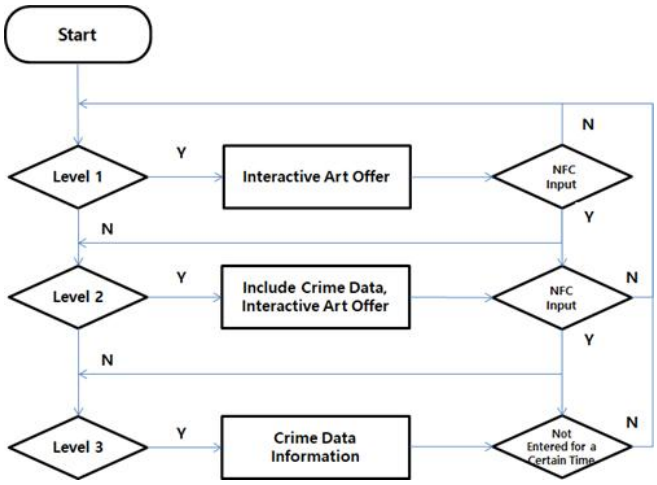
other words, the repeated use of a simple form created visuals that provided a sense of change and unified rhythm on the screen through overlapping and concentration control. [Table 2] shows simple visual patterns. Crime 1 is rape, Crime 2 is robbery, Crime 3 is assault, Crime 4 is injury, Crime 5 is blackmail, Crime 6 is violence, Crime 7 is indecent assault and Crime 8 indicates a kidnap/entice event.

[Table 2] 8 Crime Patterns



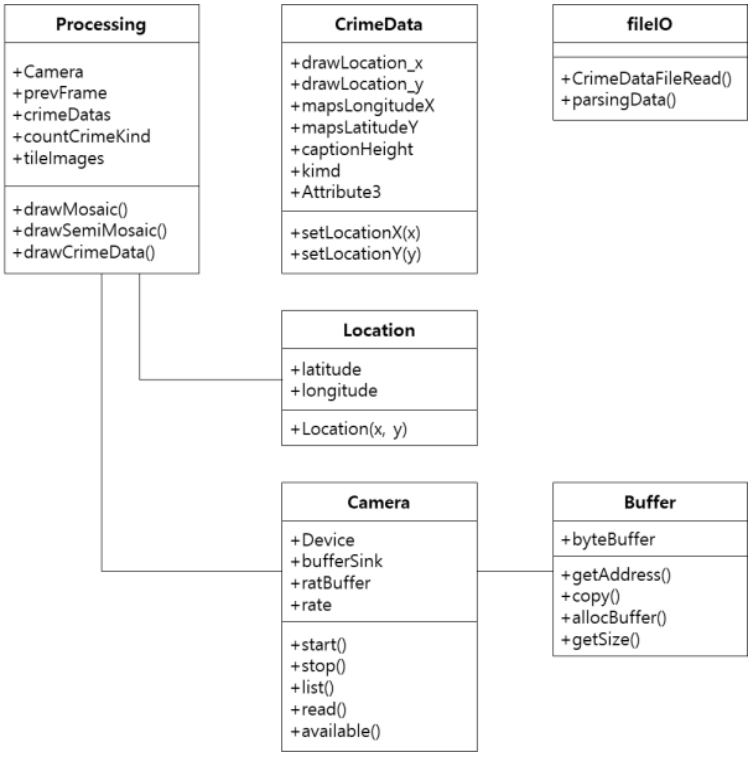

[Table 3] shows the information visualization of the eight crime patterns in the interactive art form in [Table 2]. This was implemented as a processing program developed for media artists in MIT Media Lab[13-16]. Level 1 in Table 3 is expressed only by interactive art images in which crime data information cannot be confirmed. Level 1 corresponds to a stage just before a visitor (or user) inputs personal information. Level 1 relates to the 'Draw level Mosaic () function in the Draw function of pseudo code'. Eight kinds of crime data were combined into interactive art images as shown in [Fig. 5]. The movement and the appearance of the visitor are projected on the image in the form of a real time photo mosaic.

[Table 3] Table Label Information Visualization Phase in the form of Interactive Art




[Table 4] Pseudo code and the drawMosaic function divides the projected image of the input viewer into small tiles and maps them to the visual patterns of the crime type.

[Table 4] Pseudo code



[Fig. 5] Image of Result_Level 1

Generally, interactive art has features that pique the interest of the viewer, rather than merely being an objective or descriptive interaction, as compared with the interaction of other domains [Fig. 3, 4]. It is therefore important that the initial action, rather than a rationally interpretive and responsive interaction, should include the concept of a reaction that will occur next. So, at Level 1, the researcher opted not to interact linearly with the object but to project the subjects to a real-time image before the spectator thought and questioned it. When a person's face or figure is projected onto a screen on a street (or the like), he or she is more interested in seeing another object. Therefore, the person reacts by shaking his hand or moving his leg to confirm that the image is himself. This is similar to the phenomenon in psychology wherein people seem to find their faces first when they take group pictures. Accordingly, Level 1 does not directly display the crime data of the area in the form of questions and answers but acts only as interactive art content in which the user (or the viewer) can interact with interest.

[Fig. 6] Individual Information Entering Phase utilizing NFC

[Fig. 6] shows the phase of entering personal information before proceeding to Level 2. As shown in Table 3, NFC (near field communication) is used in the personal information entering phase. This is the phase of verifying the identity of the individual to compensate for any problems that may arise if the criminal data is directly visualized.

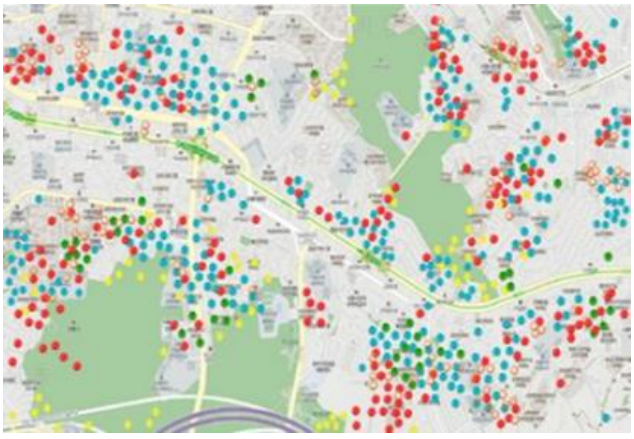
[Table 4] Pseudo code, draw function, 'Execute drawSemiMosaic () function if level is 2'. At Level 2, the identity of the individual, such as sex and age, is checked.

If the viewer (or user) does not enter the personal information, as seen in [Table 4] Pseudo code, the Draw function is set to Level 1, resetting the picture configuration level (int level = 1).

The personal identity must be obtained before proceeding to the second stage (Level 2). [Table 4] Pseudo code, specific regional crime data (i.e., type of crime, incidence, the detail region) in the drawSemiMosaic function does not have detailed areal crime data (including the type of crime, incidence and relevant area). Rather, it provides some criminal offenses including frequency of how often the crime happens in the entire region. The tiles representing the crime are mapped into the real-time captured video image, and the number of crimes is displayed.

In other words, this step can only indicate the number of tiles representing each crime, providing only rough information based on the quantity of information (crime type and frequency). Therefore, this stage corresponds to the middle of art and information provision. If the spectator wants to be provided with more detailed information, the spectator once more [Fig. 6] must verify personal information over the NFC. Once the personal information details are confirmed, it proceeds to the third step.

The [Table 4] Pseudo code, drawCrimeData () function description is conducted. Using this function, it is possible to obtain all the areas, types of crime, and frequency of occurrence as shown in [Fig. 7].



[Fig. 7] Level 3 (Information Visualization Phase)

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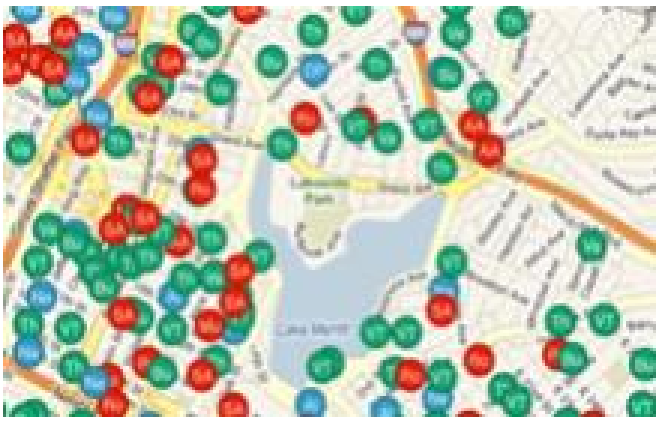

[Fig. 8] Crime stats in Auckland

After entering the personal information phase two times, the spectator (user) can receive information (such as the number of crimes in the relevant area [Fig. 7, 8]) via information visualization. Each crime datapoint is taken based on the latitude and longitude of the area. If no additional personal information is entered, the screen configuration level is initialized (int level = 1).

[Fig. 8] is an information visualization that shows the actual crime situation in the Auckland region.

## 5. Conclusion

Information visualization is largely focused on clearly and effectively communicating large amounts of information (or data) through visualization. Therefore, it is based on intuition, clarity, and immediacy with a goal of grasping information at a glance. However, research on visualization expressions complementing social problems (such as protection of increasing sensitive data and a decrease of discomfort and disharmony) is still lacking. Therefore, we studied the use of interactive art for such a purpose.

Interactive artistic features (including phased visualization and artistic aesthetic elements) were utilized to supplement information visualization.

This study can contribute to a methodological study that addresses the shortcomings that may cause secondary social problems by concentrating only on clarity in the field of information visualization. This work also contributes to related fields of technology development, which require the protection of sensitive information. Finally, it can also help expand the role of art in the field of information visualization, because public art has not been employed to address social issues in a fun and pleasurable way.

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