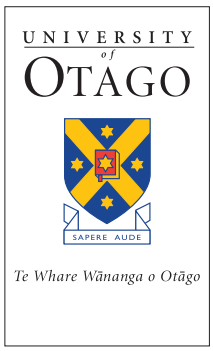

Ubiquitous Interactive Art Displays: Are they Wanted, are they Intuitive?

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Ubiquitous Interactive Art Displays: Are they wanted, are they intuitive?

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Abstract

The purpose of this study was to create a ubiquitous proximity activated interactive digital display system providing adjusted artworks as content for evaluating viewer reactions and opinions to determine if similar interactive ubiquitous systems are a beneficial, enjoyable and even an appropriate way to display art. Multimedia used in galleries predominately provides content following set patterns and disregards the viewer. Interactive displays using viewer location usually require the viewer's conscious participation through carrying some form of hardware or using expensive sensing equipment. We created an inexpensive, simple system that reacts to the user in a ubiquitous manner, allowing the evaluation of the usability and suitability of such systems in the context of viewing art. Results from testing show that interactive displays are generally enjoyed and wanted for displaying art, however even simple ubiquitous displays can cause user difficulty due to the transparency of their interaction.

Keywords

Interactive, Digital displays, Art, Proximity, Ubiquitous, Gallery, Intuitive interfaces.

Introduction

Galleries displaying artwork and artefacts already take advantage of technology to give added value to the viewing public. However are such systems suitable or desirable for use in art displays? It is difficult to discover evidence concerning research in this area .Multimedia used in galleries provides content that predominately follows set patterns and disregards the viewer, interactive systems are expensive or fragile and not often used.

In this study we created a ubiquitously interactive digital art display system to answer the questions associated with our hypotheses-

- Does a display that reacts to the interest shown in the subject and changes to support the viewer’s curiosity enhance the enjoyment or learning

experience and therefore are such interactive displays suitable for gallery and museum exhibits?

- Does a display that transparently provides additional information, depending on the proximity of the viewer, appear natural to the viewer and not require learning or prior explanation of the interface? Do users, even when surprised by the reaction of an apparent ubiquitously altered display content realise that it is their actions determining change in the content displayed?

This research addresses these issues by providing a test system for users to experience and record their opinions and actions as a response to their interactions with the system.

Depending on the resulting analysis of data, this method of providing additional information to a user in an obvious and interactive manner could find uses in galleries, museums and education as well as possible commercial or entertainment uses. The information gathered should be of interest to gallery and museum staff for the planning of possible future displays.

Literature review

Digital art display

One of the major objectives of this research was to determine acceptance of digital displays. It has been stated that gallery visitors may not expect technology in a gallery environment (Ndiwalana, 2003) and this, combined with the loss of personal experience, could cause users to resist the technology (Gay & Hembrooke, 2004).

The intentions of the test display should be obvious and is unlikely to be confused with the artistic viewpoint that "sometimes simply displaying existing art in a new way can in itself be considered art" as commented by Genevieve Webb the Registrar Dunedin Public Art Gallery (June 2005) and backed up by Bolter& Gromala (2003, p. 88) in their discussion concerning Remediation (making of new media forms out of older ones).

Appropriate data collection methods discussed in research literature indicate that our system will cross the boundaries of the "Phenomenological study" and "Case study" methods described by Leedy and Ormrod (2005 pages 139 and 135) requiring questionnaire and observation and where problems observed should be recorded (Dumas et al, 1993) and noted on a Problem List. Due to the subjective nature of the problem questionnaires based on Likert Scales which Preece et al. (2002) describe this grading method common for measuring user satisfaction, opinion and beliefs with the opportunity for users to include their own comments. Design considerations for questionnaires discussed by Dix et al (2004) were followed to provide some validity to the tests.

Ubiquitous displays

An important consideration in designing ubiquitous interfaces is the appropriate assessment of user types and their needs, which is difficult due to the variety of possible users. Marke Weiser stated "the profound technologies are those that disappear"(cited in Dix et al, 2004, p.181). This raises the question of whether we should we aim for our system to disappear when this appears to conflict with traditional HCI views (Nielsen 2000, p. 73) and even experts on Digital Art (Bolter and Gromala, 2003, p. 27) who contradict the idea of total transparency.

Dix's (2004, p.185) idea of "Be right as often as possible..." concerning interaction is obviously a compromise position but does provide justification for our initial intention to provide a ubiquitous system without instructions. It is asserted that the interface, should be so simple that most users will discover the method of operation by themselves.

Abowd and Mynatt (2000, p. 42) list areas of particular concern for our prototype system, such as starting and end points and interruptions which are considered possible critical factors for interface failure. Also useful are two of the four ubiquitous design paradigms (numbers 2 and 3) discussed by Ndiwalana et al (2003) as being consistent with "mainstream HCI thinking" are-

> "2: People will be more willing to start using ubiquitous interfaces if they perceive them as trustworthy and intuitive.
> 3: The effort required to understand information conveyed by the ubiquitous interfaces inhibits willingness to use."

These concerns are due to the fact that users will not be expecting a computer interface in a gallery situation and may not be trusting of computers in general.

Dey (2001) mentions Ubiquitous computing systems have a greater potential for unpredictability, which is important when users are initially unaware of the system and predictability is an important evaluation metric.

Error tolerance, satisfaction (as contained in the evaluation standard ISO9421) and the transparency of systems (Burnett & Rainsford, 2001: Bolter, 2003, p. 74) are also key evaluation factors. Error tolerance is expected to be critical as the exposure to the system will be short and it is possible that if users need to consider the interface then the use of ubiquitous systems is not natural as predicted in the hypothesis.

One difficulty in evaluating ubiquitous systems is the lack of affordance or feedback and the affect this may have on users. Affordances are described by Norman (1990) and as there are no buttons or visible controls and it is hoped that the obvious reaction when coming across something interesting is to step closer to enhance visual perception. This natural action will need to be confirmed through observation as questionnaires will not provide enough insight into user reactions.

The literature review provided us with some important criteria that were considered during system design.

Design Considerations

- Users will be diverse so design for simplicity.
- Design for use without instructions where possible.
- The use and interaction modes should be immediately apparent even if the method is transparent. (ubiquitous)
- Interaction should be appropriate for the context of the gallery. (Closer examination provides more detail)
- Content of the system should be appropriate for the context in which the display is set or located.
- Allowances should be made for interruptions of display interaction. (Temporal and inadvertent user action)
- Ensure that recovery of system interaction is appropriate.
- Ensure that system feedback is obviously in response to user action.

Of interest is the conflict between the two schools of thought concerning the idea of ubiquitous interfaces combined with transparency of the system countered with the possible breakdowns of communication between the user and the system which may occur as a result of this transparency. The proposed test system can perhaps provide insight into these trade off's between obvious communication, and transparency.

Research Methodology

Research design overview

Create a suitable test system: the display uses basic computer hardware components including a Web camera to capture the viewer to determine location. The display content alters based on the viewer location (figure 1) and is delivered as a smooth transition of a movie file (.avi). The viewers may be unaware they have triggered the change as they are located remotely - no hardware carried or obvious sensor equipment used. OpenCV face recognition software detects the viewers face from the camera and the location of the viewer is passed to the display software. The display software and art content is based on the augmented reality project "Morpha Lisa" created by Joerg Hauber (HITLabNZ. Christchurch). Hauber's augmented reality system used a head mounted display (HMD) with an integral camera to capture what the viewer would normally see. When looking around the camera view would be displayed inside the HMD but when looking at a picture frame a target shape within the frame would be recognised by the computer and the instead of displaying the target the computer projected a screen from a movie. Recognising the shape and size of the target provided the computer with the viewer positioned allowing the change of content with the movement of the viewer. Approaching the target it would slowly run through each frame of the movie providing a seamless morph image, stopping your approach would freeze the action and stepping back would run back through to the start.
To provide a similar user experience in a ubiquitous manner it was decided to reverse the working of the augmented system, taking the camera off the user and putting it on the wall above the display and taking the target off the wall and

putting it on the user. In this case the user already had a target in the form of their face, the web camera was linked to a computer that had simple open source (Open CV) face recognition software installed. In effect this is a video display that uses the face of the viewer as the control "button".

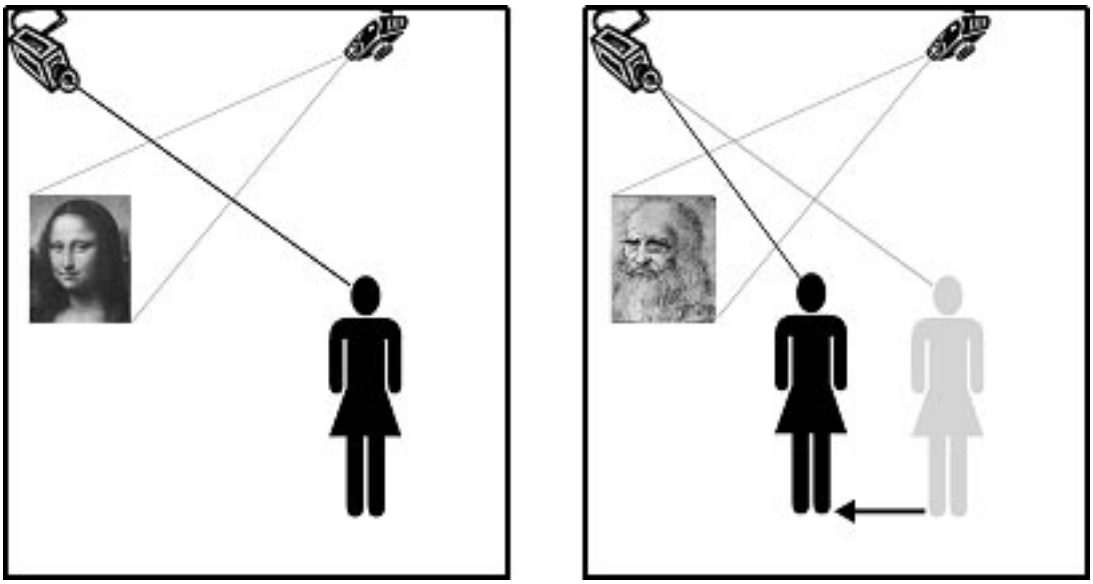

Figure 1: Display content alters based on the viewer location

If the user ignores the display (looks away) the system will not respond, if the user comes closer it runs incrementally through a video sequence (image "morphs" from one to another) as you approach, stopping will freeze frame and stepping backwards while facing the display will rewind. Turning away or leaving the area resets the system.

Determine Content: After taking on the advice from Dunedin Public Art Gallery staff for suitability, the display content chosen was the morph video sequence from Hauber's Morpha Lisa project where the initial screen shows the Mona Lisa. As the viewer approaches a seamless morph occurs changing from the face of the Mona Lisa to that of its artist Leonardo da Vinci. This was chosen as it is well known so the respondents will be reacting to the system and not some unknown artworks.

Run the system in appropriate environments: First an exploratory study (pilot study) was carried out in a controlled lab (figure 2) to determine if the system created was suitable for use or if further development was required. Respondents were aware that a test was being carried out but were not be informed as to what was being tested or given information about how the system worked. Initial testing uncovered problems with the questionnaire and affirmed the view from the literature review that observation records would be required due to the unexplained effect where the interactive interface caused unanticipated user difficulty.

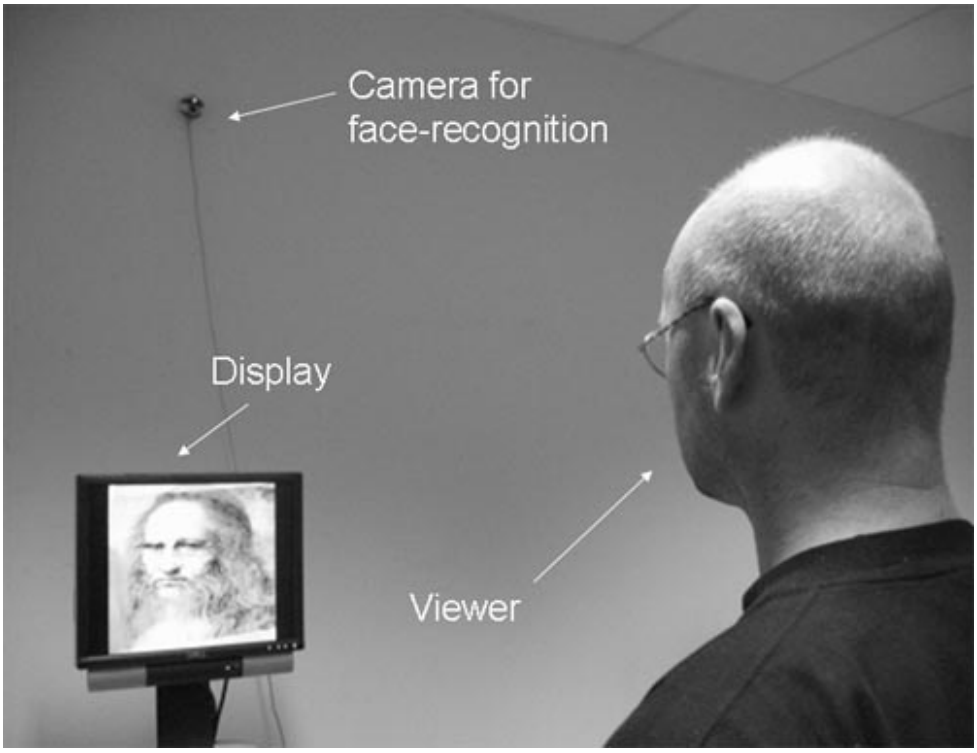

Figure 2: Controlled Laboratory testing set up.

Secondly, a naturalistic study was carried out to gather suitable data for analysis to determine if the hypotheses are supported. Focus shifted from testing the system and research instruments to testing user interaction and acceptance. Naturalistic observation is required for ecological validity as the controlled laboratory environment may influence results. The equipment and software were set up in the atrium of the Otago University Commerce building. Respondents were randomly selected from passers-by and were asked "we are testing an interactive art display - would you like to see if you can interact with it?" No instruction or indication of the interaction was given. After experiencing the system the participant answered the questionnaire. As the answers to many questions were subjective this was done prior to any interview questions to provide an unbiased response. After the initial questions were answered the interviewer could ask further questions that arose from observation.

Gather Data

Test instrument one: The questionnaire
The two focus points are how usable the system is and how appropriate the system is within the context of an art display. The questionnaire covers the following four topic areas:

- Background: questions that may supply possible independent variables – such as age or prior artistic knowledge, gender and number of times the respondent attended a gallery in the last year.
- Images: System specific questions to determine that the system worked for the person and they were evaluating the interaction not the images or system.
- Interaction: Usability considerations primarily appear to be concerned with the intention to provide a ubiquitous interface which may itself cause some

difficulty. Areas for concern are the transparency or lack or of affordances, and visibility of feedback. Questions determined if the feedback was visible to the user, that they understand that the reason for the feedback (altering display) was actually a response to their action and then knew what to do next.

- Personal Preference: Questioning the appropriateness of the system as an art display and user enjoyment. Data such as age, sex, knowledge of art or subject content can be compared to responses to determine if there are dependencies with demographic variations as this information could be considered important to the results.

Opposing question pairs were used for contentious issues for validation against each other. For example "Is this a good way to display art" contrasted with the question asked later "this is NOT a good way to display art". If consideration was given to answering the questions rather than just ticking a favourable response these questions should inversely reflect each-other. This correlation was in fact the case.

Test instrument two: The observation record
The test respondents were observed prior to and during their test of the display. The record was used to record if the respondent had prior knowledge by seeing someone else using the system, was numbered to match the corresponding questionnaire. Any anomalous behaviour observed was recorded and if this required supplementary explanation the tester could ask for clarification.

Statistical evaluation determined the accuracy of the results and attempted to identify patterns and investigate whether similar clusters of independent variables such as age and gender create any meaningful stratified grouping of samples, as described by Nemeth (2004, p. 302) and allow comparisons between these groups and the overall population.

Distribution statistics assist in determining how valid the results are for making value judgements and whether there is confidence to accept or reject the hypothesis. The level of significance testing to see if results for the sample data are sufficient to support the hypotheses, and Pearson's correlations coefficient was used to determine if variables were interrelated. There were 45 survey responses from the 2nd test series to base our results on.

Results

How appropriate are interactive digital displays of art

To discover the appropriateness of digital displays requires asking subjective questions of users. When asking such subjective questions it was considered that respondents may quickly answer what they perceived was the "correct" answer wanted by the researcher. For this reason the more important subjective points were asked using the opposing question pair method previously discussed and separated from each other to ensure that correct consideration was given to answering them carefully. The results from the paired questions could be

compared and the inverse trend for matching questions assists in providing some validity to the result.

Q. This is a good way to display artworks. (Art)
Q. Interactive digital media are NOT appropriate for displaying art. (Not Art)
Q. I consider myself to be knowledgeable concerning art. (Artistic Knowledge)

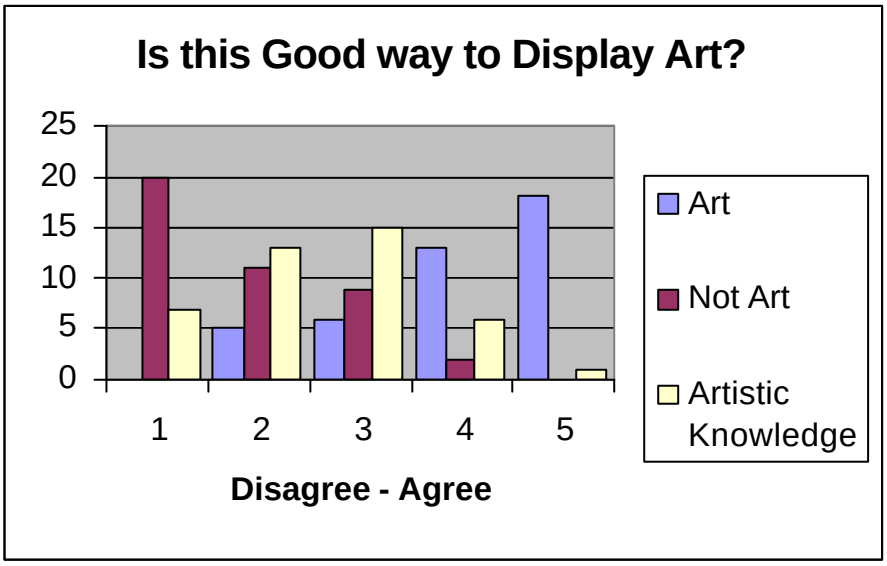

Figure 3: Appropriateness for art displays

It was considered possible that the answer to the two subjective questions could be affected by how the people perceived their artistic knowledge – while this correlation does appear it is not significant.

Table 1: Correlation of Art display and artistic knowledge questions

Correlations

		VISITS	Art Knowledge	GOOD_ART	NOT_ART
VISITS	Pearson Correlation	1	.195	-.179	-.156
	Sig. (2-tailed)	.	.216	.256	.323
	N	42	42	42	42
Art Knowledge	Pearson Correlation	.195	1	-.095	-.184
	Sig. (2-tailed)	.216	.	.550	.244
	N	42	42	42	42
GOOD_ART	Pearson Correlation	-.179	-.095	1	-.294
	Sig. (2-tailed)	.256	.550	.	.059
	N	42	42	42	42
NOT_ART	Pearson Correlation	-.156	-.184	-.294	1
	Sig. (2-tailed)	.323	.244	.059	.
	N	42	42	42	42

An interesting point is the trend of people to the question “is this a good way to display art” was not nearly as polarised as originally anticipated and shown in

controlled testing using Information Science staff and students, possibly because technically knowledgeable people were not surprised by the interaction and so could be more critical.

Q. Interactive media displays should be used to augment or enrich art displays.
Q Interactive media displays should be used to replace traditional art displays.

There was the anticipated inverse correlation between the views question results. Most seemed to concur with was that while this is a good way to display art – very few thought it possible to replace traditional displays with digital ones. However it is notable that some thought this an acceptable possibility.

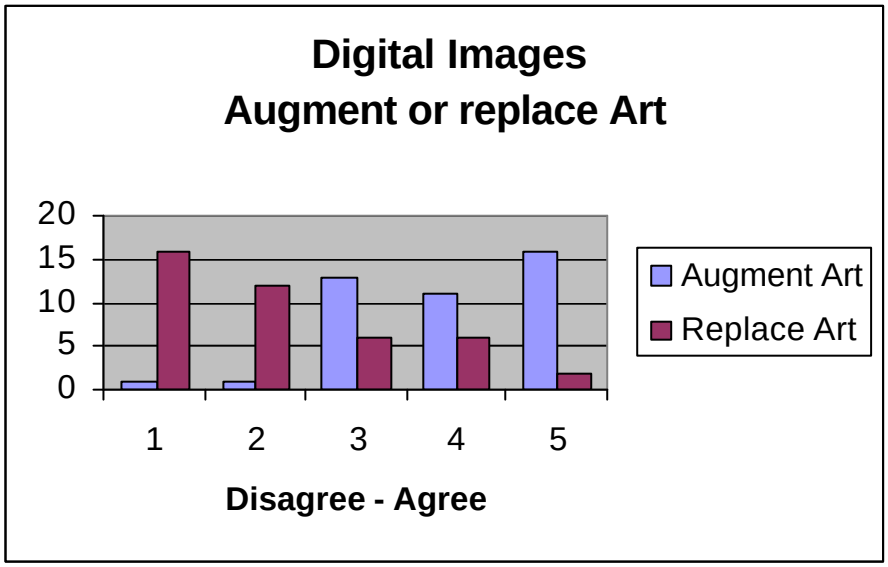

Figure 4: Digital Images – augment or replace traditional art display

Q. I enjoyed using this display.

This question provided a chance to answer a subjective question about enjoyment of the system without qualifying the answer to a specific context such as art display. The result was positive and encourages further work in developing similar interfaces.

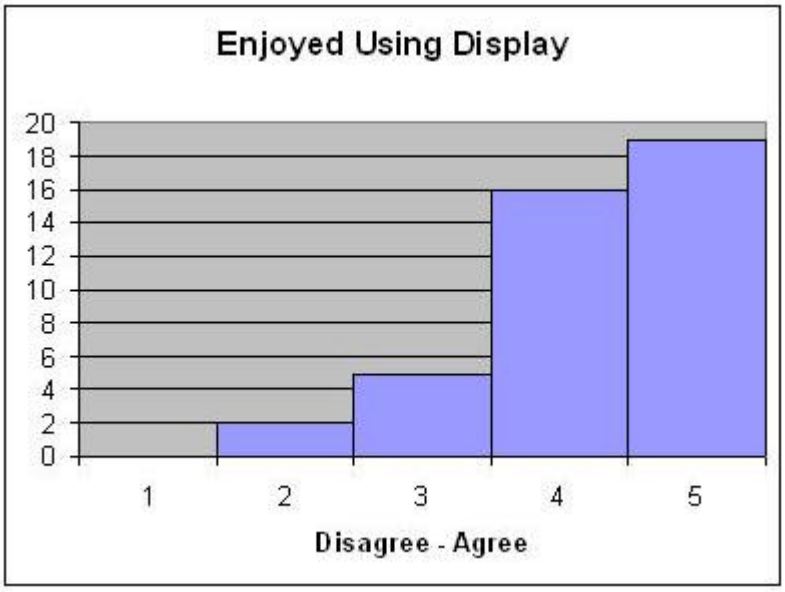

Figure 5: I enjoyed using this display

Q. This is a good way to display artworks.
Q. This is a good way to educate people about art.
Q. This is a good way to provide additional information about museum objects.

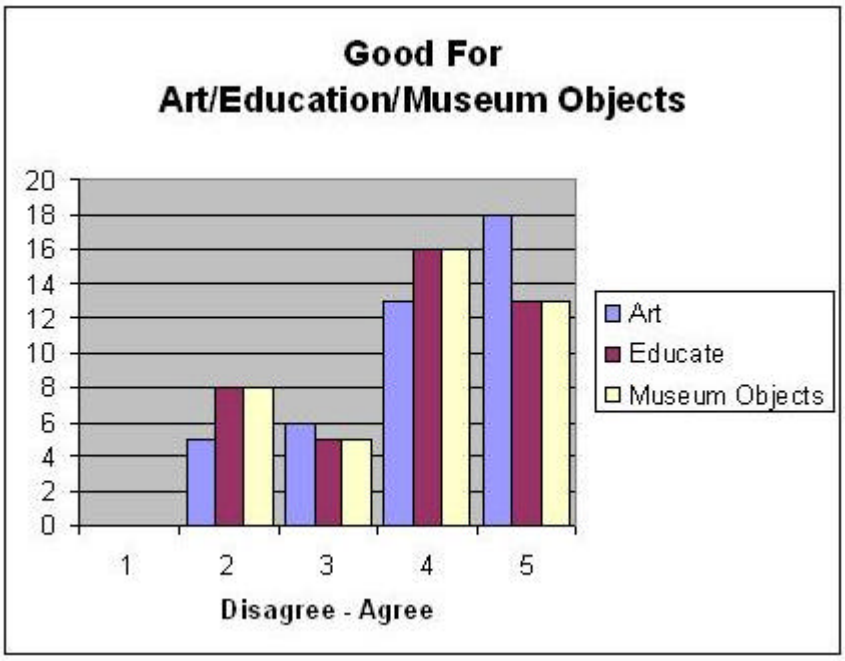

Figure 6: Digital displays good for Art/Education/Museum objects.

These questions were prompted from comments made by Genevieve Webb, the Registrar of the Dunedin Public Art Gallery. Her thought was that the system described would be ideal for educating people about art by providing additional information. The system was considered particularly appropriate for demonstrating restoration of artwork being carried out by the gallery.

Are ubiquitous interaction systems intuitive?

A question related to interaction is – did they understand the operation of the system without instruction? This is the important question to determine if a ubiquitous interface, when discovered is intuitive to use when no instructions are provide. This issue was considered critical so was tested with a question pair for validity. In this case the reason for using paired questions was proved justified due to the conflicting result.

Q. The interaction was natural and obvious.
Q. I need proper instructions on how this works.

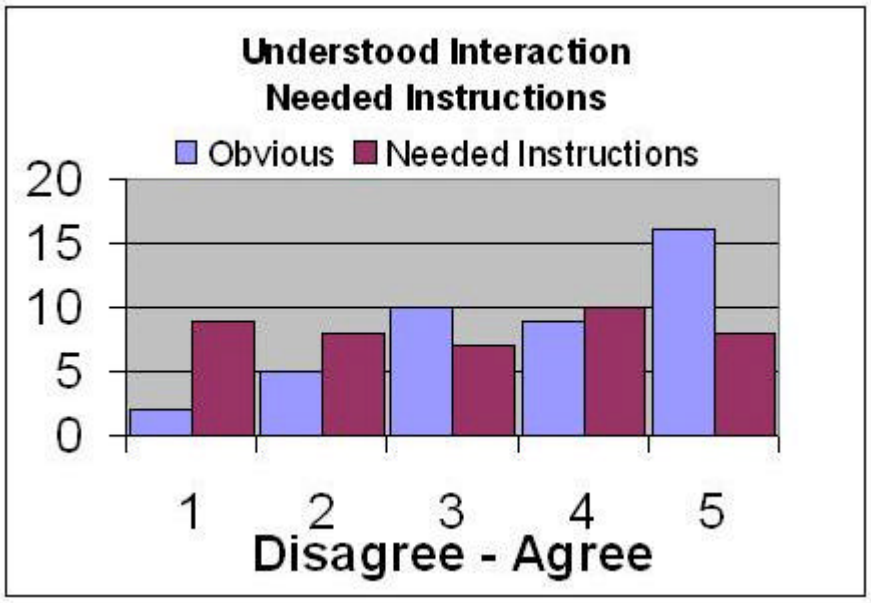

Figure 7: Understood interaction or needed instructions.

When asked if they understood the interaction with the display users predominantly agreed it was obvious. However there is a validity problem with the results of this response due to two points. First, that this response was filled in after experiencing the display. The confidence shown in the answer does not reflect that observed by the researcher during the tests and if asked this question part way through the examination (say after 20 seconds) a much poorer result would be expected. This observation is backed up by the question asking if instructions were needed, the respondents then were not so positive about the "obvious" interaction. There is a significant negative correlation (table 2) between these questions however as would be expected.

Table2: Correlation between understanding and requiring instructions.

Correlations

		Understood	OBVIOUS	Instruction
Understood	Pearson Correlation	1	.543**	-.548**
	Sig. (2-tailed)	.	.000	.000
	N	42	42	42
OBVIOUS	Pearson Correlation	.543**	1	-.357*
	Sig. (2-tailed)	.000	.	.020
	N	42	42	42
Instruction	Pearson Correlation	-.548**	-.357*	1
	Sig. (2-tailed)	.000	.020	.
	N	42	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The second validity problem is that it is possible that less positive results would have been achieved with the observer not being present, as many looked for confirmation that what they were doing was correct after triggering the display interaction. It would be advisable to run the same question with the observer not visible to the users to see if there is a different result before relying on the current evidence.

There is sufficient evidence from the second question regarding the need for instructions. The even spread of responses indicate that there would be sufficient numbers of people requiring instructions. This was not as good as hoped for with such a simple display interface and is insufficient to even consider the "being right as often as possible" compromise position mentioned by Dix et al (2004). Evidence suggests that to provide this display without instructions would cause at least some initial confusion to at least half of the users tested.

Future Research

These include:

Potential commercial uses such as the trade shows or window displays where more sophisticated recognition software could target the user more precisely, perhaps by interpreting face expressions or detect general physical attributes to provide targeted advertising. Eyesight direction detection could determine which of an array of products hold the interest of the viewer tailoring the display to that product.

Mechanical artefact displays would obviously be of use in a museum situation, for example, a clock could be the feature of a display and as the viewer approaches the exterior of the clock would disappear to reveal its inner mechanism.

Due to the face recognition results screen being able to fix position within the results screen it could be possible to increase the content trigger areas and provide angles allowing display depth variations for a 3D “fish tank” like view.

The test system as it stands while not up to commercial standards is suitable for use in environments where the lighting can be controlled. Deployment in an environment like the Dunedin Public Art Gallery would be the next appropriate step to demonstrate the use in a suitable environment. Of particular interest to the gallery would be the ability to incorporate content reflecting the gallery’s interest, such as current art restoration work or local artists.

Conclusion

This research set out to answer the following two questions.

1. How appropriate or valuable are interactive digital displays of art?
2. Are proximity triggered (ubiquitous) interaction systems intuitive?

Through the experimental study described in this paper we found that :

1. Interactive digital displays are suitable for art display – provided they are used to augment and not replace the traditional displays, and that overall people enjoy using digital display considering them appropriate for displaying art, and especially for use in educating about art and museum objects.

2. While many found the test system intuitive there were a sufficient number of poor responses and requests for instructions that confronting people with a transparent system like this would not be recommended without making instructions available. The system created for testing provided a simple form of interaction, however even this caused at least short term confusion in many cases.

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