

# Display of Interactive Artwork: Pilot Test of two Different Interfaces

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## ABSTRACT

The display of interactive artwork plays an increasingly important role in modern museums and galleries. However, the reaction of visitors has not been extensively tested to date. We present a pilot study that investigates viewer's reactions towards two interactive display prototypes that were designed to present famous artwork in a new and more engaging way. We describe the first iteration cycle of a questionnaire we composed which especially targets viewer satisfaction in a gallery context. The results of our first pilot study indicate that (1) interactive displays in galleries can create an engaging and exciting experience and (2) that they can be especially suitable to present education about art in a new and more involving way.

**Keywords and phrases:** Human-Computer Interfaces, Augmented Reality, Ubiquitous Interfaces, Situational Awareness, Proximity

## 1.0 INTRODUCTION

### 1.1 Background

Digital media has proven to be a legitimate art form ranging from the simple computer generated pictures displayed such as in the Howard Wise gallery in the early 1960's through to immersive virtual reality worlds of the 90's and the projection of three dimensional worlds.

Digital displays of art in galleries fall into three general categories.

1. Digital Art: Where the artwork itself is in digital form.
2. Art display: The use of digital media to display existing art created with non digital media.
3. Education: The intention is to educate about the art rather than display the artworks in another media.

The distinction concerning “Digital Art” made here by Paul (2003) describes a distinction between (1) work that uses technology as a tool to produce traditional forms of art, and (2) work that uses digital technology to create new types of art. Our concern in this paper is not with creating new art but with creating a new way to display existing artworks in an interactive way to enable us to evaluate user reactions and acceptance of digital displays.

Observation of gallery visitors indicated that there is no clear profile of the “typical” patron. Visitors make up all ages and obviously a wide range of art knowledge. Typically, patrons do not expect to be “educated” about the work or to be entertained other than by the obvious aesthetic looks of the work. Unless attending a special exhibition or event, patrons tend to “browse” past items that arouse little interest and stop only at those exhibits that catch their attention either through an appealing content or through an engaging presentation of the content. This is where interactive digital displays have the potential to go beyond the traditional static form of art presentation.

Therefore, art galleries and museums are increasingly paying attention to new interactive display technologies that take the viewer into account unlike multimedia systems that follow static set patterns.

Many situational aware systems have been created that respond to the location of the user. Typically these systems are triggered by a hand held tour guide device or location identity button. Some ubiquitous elements can be observed when a change in lighting or a recording or display starts at the entrance of a viewer. Often these triggers are as simple as an under-floor pressure detector or a security sensor.

One recent and interesting approach was taken by the Bauhaus University in Weimar/Germany (Bimler et al; 2005). In their system, images are projected directly onto the canvas of an existing pictorial work providing multiple content in one single frame. In other scenarios, visitors can influence the content in such a display system by pushing buttons, making noise such as talking or by clapping hands.

## **1.2 Acceptance of digital and interactive art displays**

Research into innovative ways to display art in a digital or interactive manner usually focuses on the technical issues to create the system. It should be expected that the operational success of these systems are evaluated but there is little evidence on measuring user acceptance and enjoyment of these systems.

However, discovering the acceptance or otherwise of patrons to digital art displays is essential if the development or the deployment of these systems is considered. However, the only form of feedback a museum normally receives in terms of a metric for visitor’s enjoyment of an exhibition is the actual number of visitors. Galleries rely on the expertise of their staff and public reviews to determine success. Reliable data on patron acceptance to digital displays of art would therefore be of benefit to the gallery and other similar institutions.

In this paper we present the results of a first pilot study on two interactive displays that were designed to be used in an art museum context. With our approach we try to (1) determine the overall appropriateness of our display prototypes for education in arts and (2) hope to gather some experience to establish a framework for future digital display evaluations. The pilot study we are presenting here will be followed by a field study in an actual art gallery.

## **2. Experimental Interfaces**

Two experimental interfaces have been created for the proposed testing of user reactions to interactive digital displays. Our systems detect the location of the user in front of the artwork and change the content based on the proximity of the user. That way the user can interact with the system by moving closer or further away respectively, animating the artwork with their movement.

### **2.1 Augmented Reality Interface**

The first of our two interfaces was used initially to showcase an Augmented Reality application by Hauber (2005). We chose to include the interface for our experimental setup as it contained content suitable to that of an art gallery, and because visitors’ general feedback was very positive. This indicated that the interface created an engaging and involving experience.

### 2.1.1 Setup

The user looks at a picture frame through a Head-mounted display (HMD), which was modified to be used as a handheld video-see-through display. Video-see-through means that the live video of a camera is directly fed back to the display so that the user has the impression that he/she could see “through” the display. Markers (black squares with a pattern) are located at the center of the picture frame (see figure 1). These markers are detected by the camera and a relative position from the camera to the marker is calculated using the ARToolkit tracking software (Kato & Billinghurst, 1999). The information of this position can be used to overlay virtual content over the real world video, a technique typically referred to as Augmented Reality. In our example, once the markers were detected, a virtual painting appeared with the correct position and orientation in the real frame, as seen through the hand held HMD. In addition, the same content was also displayed on a large plasma screen, so that more than one person could share the viewer’s experience at the same time.

Figure 1 shows the complete setup. The user is looking through the hand held display while facing the picture frame with the markers. On the plasma screen we can see that the virtual portrait of Mona Lisa appears in the real frame (see inset in fig. 1).



Figure 1. The Augmented Reality Interface

### 2.1.2 Interaction

The relative position of the picture frame to the user holding the handheld HMD with the integrated camera was furthermore used to introduce a simple interaction mechanism. The content of the virtual painting changed based on the proximity of the user towards the picture frame (see figure 2). In the original demonstration, the user could morph a series of famous portraits into the faces of their creators by moving the towards the picture frame. Instructions for the use of the interface were as simple as “have a closer look to see who is behind the painting”.

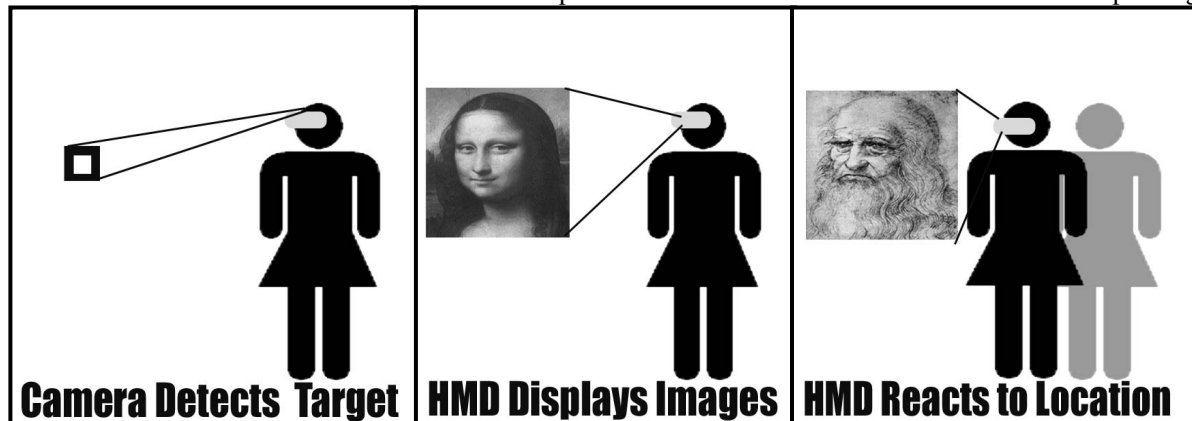


Figure 2: Software detects target within camera and displays image within the HMD

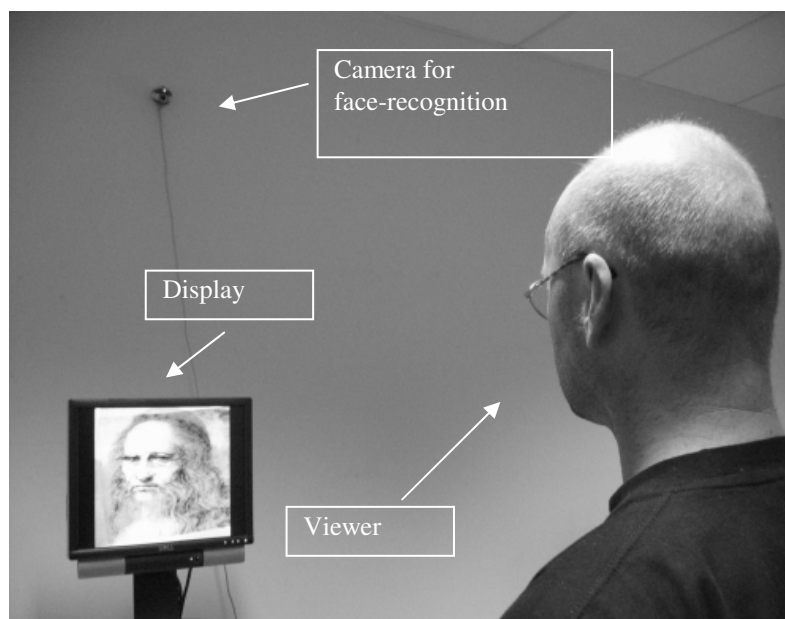
While visitors could immediately “operate” the interface according to this simple instruction, the main disadvantage turned out to be that this setup required users to observe the changing content through the HMD which was bulky and awkward to wear and drastically reduced the peripheral view. Therefore, inexperienced visitors felt uncomfortable wearing it and often rejected it. Instead, they frequently favored to move the display with the integrated camera with their hand towards the picture frame while watching the changing content on the plasma screen, which was initially meant for other people in the background.

## 2.2 Ubiquitous Interface

With the development of a ubiquitous display (UD) interface we tried to provide an experience nearing that of the augmented reality system without the need of a head mounted display. The image content (portrait morphing into artist) remained unchanged.

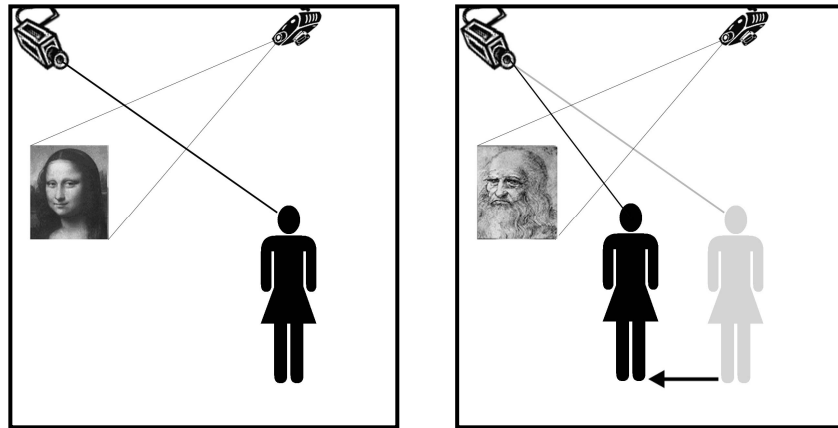
### 2.2.1 Setup

The proximity detection system uses face recognition instead of predefined optical markers and can be seen as a reverse of the AR system. The camera is removed from the viewer and is placed on the wall above the display (see figure 3).



*Figure 3: Ubiquitous Interface setup*

OpenCV face recognition software is linked to the display software. If the viewer is outside the selected face detection range either the first or last image is shown. Within the morph range the location of the viewer determines which frame of the morphing sequence is displayed – this enables the effect to run forwards or in reverse depending on direction of movement of the viewer (see figure 4).



*Figure 4: Proximity change detected by camera*

Figure 4 shows how the content of the display changes depending on the proximity of the viewer.

The display can either be projected on the wall or displayed within a standard 17"(1280x1024) computer monitor. The use of a monitor does appear to have the advantage of providing a focal point for people to look at easing face detection for the face detection software.

One characteristic of the UD interface is the transparency of operation. The viewer does not need to be made aware of its interface presenting the researcher with an additional opportunity. We can observe patrons reactions to the UD to observe their reaction to a system that has no obvious affordances. There are for instance no buttons to push. The feedback given by the system (altering display content) may not necessarily lead to a user's perception of actually controlling the content themselves. Without any testing the reaction to such a "affordance-poor" interface can hardly be predicted.

### **2.3 Content chosen**

Appreciation of artworks is a personal and subjective process. This raises concern that test systems could be judged on content rather than on the interface as intended. We tried to choose a content that was universally accepted and known to make sure the effects of the systems and not a reaction to the art works themselves would affect the results.

As the most classical example, we picked the famous portrait of Mona Lisa with its creator Leonardo da Vinci. This pair is especially suitable as it takes on the discussion as to whether Leonardo sees himself in the Mona Lisa as for example depicted in the 1987 Mona/Leo image by Lillian Schwartz (Paul, 2003) or in the famous best seller "The Da Vinci Code" (Brown, 2003) .

As the viewer gets closer to the image the proximity of the viewer is detected and the Mona Lisa will slowly morph into Leonardo. The effect reveals the morph gradually and seamlessly due to carefully chosen morphing points and small incremental steps between the morph images displayed. This particular image invites the viewers to make judgment for themselves revealing more as other static approaches.



*Figure 5: Example of Content Displayed*

The morph sequence was created with the Software “WinMorph” (WinMorph, 2005). Two images are required to create the transitional morphing frames. By Selecting common control points between the two images (Mona Lisa and Leonardo, see figure 5), the software automatically generated 40 incremental morphing images, finally displaying a very smooth transition between both initial faces.

Other artwork could be inserted into the system without difficulty. Dunedin Public Art Gallery staff has already indicated, that this type of display would be a very appropriate and innovative method to demonstrate an upcoming restoration project. Having the unique ability to show full sized and microscopic views of restoration, including the ability to provide a flip view (the back) of the painting, which of course is not possible with the original artwork.

### 3. Pilot Study

The pilot study provided insights on how well the two systems work and on first user reactions. The pilot study was successful in assisting us to develop an approach to answer the following questions:

What general user reaction can we expect to this kind of art display? Of particular interest is whether the general feedback from the first test (Hauber, 2005) is supported and which additional explorations first time users will report.

What is the appropriate method to assess user reactions in this context? Which instruments need to be developed and validated? (in particular questionnaires, interviews, observations)

Will there be an acceptance of an interface with poor affordances, as it is the case with the UD? Is the UD interface a usable one?

How will visitors rate the appropriateness of this kind of technology in the context of art galleries?

In particular, is the display of proximity-controlled artwork content useful. And, is the presentation of transitional, morphing content an appropriate form of art display.

#### 3.1 Procedure of Pilot Study

The two systems have been set-up side by side in a laboratory at the University of Otago in a controlled experiment. Participants for the study were recruited by personal invitation: staff and students of the Information Science department. Twelve subjects participated with an approximate mean age of 33.

Each trial lasted for a maximum of 15 minutes with some respondents showing little interest in either the art or technology while other respondents returned several times to each display and cycled several times through the available image files asking questions about both the display system and the artworks.

Participants viewed each interface and rated them one after the other using an (almost) identical questionnaire for each condition, the order viewed was randomly assigned by tossing a coin. Participants were introduced to the system with a simple scenario explanation, that they were at an art gallery to “look at the pictures”.

After filling-in the questionnaire participants were asked if the questions were appropriate, ambiguous or if important questions appeared to be missing.

#### 3.2 Instruments

The questionnaire prepared for acceptance testing was based on Likert-like scales, which Preece et al. (2002) describe as common for measuring user satisfaction, opinion and beliefs. Questions were grouped into four sections comprising a total of 39 questions. An abbreviated version of the questionnaire can be found in Appendix I.

The first group on **background questions** aims to gain an insight into the respondent and to enable us to determine if results possibly relate to user demographics. Gender and age were assessed as well as the number of visits made to a gallery in the past year.

The **display specific question** group consists of 14 items in three groups: (1) Images: questions focus on perceived quality of digital images and transitions. (2) Interaction: questions focus on the level of understanding

the patron had concerning the interface reaction. And (3) Personal preference: asking for the subjective opinion of the suitability of the specific interface.

The last group of **overall impression questions** ask for the suitability of digital displays in general and for art and art education in particular.

### 3.3 Results

The results presented here are of anecdotal evidence only because of the relatively low statistical power of the data collected. Although it was not intended to come up with statistically relevant data in this pilot study, some interesting findings can be reported.

In the following, we summarize the most relevant results that six of our questions were able to reveal (see figure 6).

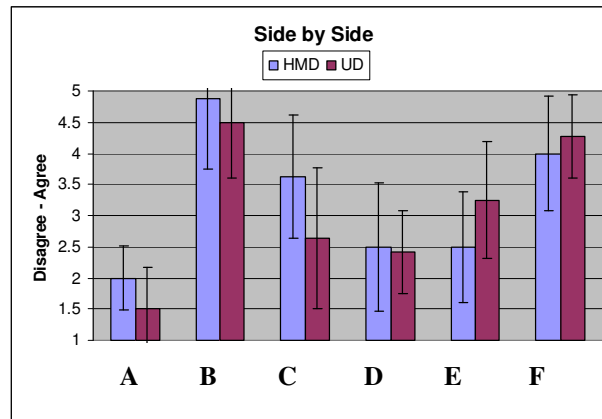


Figure 6: Results

*A. The image transition was unnecessary – swapping from start to finish images would have been just as good:*

The average score for both interfaces is below 2. That means that the majority of participants disagreed with this statement. This indicates that our approach of adding the smooth transition between the images was considered as beneficial.

*B. I understood how the display was changing to my position:*

The average score of this question was higher than 4.5 for both interfaces which means that almost every participant agreed to that statement. This clear result indicates that the respondents had no difficulty in understanding the interaction method – to change the displayed content through varying the proximity. It must be noted however that seeing somebody else using the display makes the interaction immediately obvious but this is not always the case when the respondent is alone and has not seen anyone using the systems before. Clear instructions next to the interface therefore are compulsory in a real gallery context.

*C. The interaction was distracting from the content:*

With an average score of 2.64, the mean score of the Ubiquitous display is remarkably lower than the result for the HMD (mean=3.63). This clearly indicates, that the Ubiquitous display was considered less distracting than the Augmented Reality approach which relied on the Head mounted display. Future displays in galleries should therefore follow the same strategy and avoid these or other constraining hardware elements.

*D. I found this dynamic projection display boring*

This question achieved an average score of approximately 2.5 in both interface conditions, showing that for most of the participants the displays presented were not boring. Here the important observation is that while the HMD may have been distracting from content, it is clearly interesting to use in itself. Just the fact that the displays were new might have been of such interest that the viewers were willing to accept minor technical flaws.

*E. This is a good way to display artworks:*

This is perhaps the most interesting response. While the average is reasonably centred the wide distribution of responses shows a polarisation of views. This is as we suspected and anticipate that results like this will continue and could be linked to either or both artistic knowledge and age. In the direct comparison of both interfaces, the Ubiquitous Interface seem to be considered the better way to display artwork digitally.

*F. This is a good way to educate people about art:*

With average scores of more than 4.0, both systems were clearly rated to be suited to educational use. Especially this result is encouraging as it supported the overall concept of our test systems.

#### **4. Future work**

The initial testing has uncovered some weak questions in the original set and shown that a questionnaire alone will not be sufficient for data gathering. Because viewing art depends a great deal on personal tastes and preferences, data obtained will be of a qualitative nature rather than quantitative. It now appears the appropriate data collection methods would cross the boundaries of the “Phenomenological” study (Leedy and Ormrod, 2005) and so require observation and post evaluation interviews.

#### **4.1 Test Preparation**

Improvement of the instrument (questionnaire) will be carried out according to experiences made with the pilot Study.

We have determined the need for an observation record to match each questionnaire where possible. Due to the unexplained nature of the ubiquitous interface there were cases of unanticipated user difficulty even with technically capable respondents. Problems that are observed will be recorded according to Dumas et al (1993, p. 292) and noted on a Problem List.

#### **4.2 Confirmatory Test**

In preparation for the next test we will re-write the questionnaire to address the problems uncovered in the original test set. An observation record sheet to note unusual interactions or difficulties has been prepared so an observer can clarify any unusual interactions after the evaluation by the patron.

Re-testing (confirmatory testing) of the revised question set in conjunction with the observation record will determine if the instruments are ready for field use.

#### **4.3 Acceptance Test (Field testing)**

Prior to final field testing we will develop additional artistic content in line with the requirements of the Dunedin Public Art Gallery. We are going to set up the hardware in a suitable situation for running the test.

Run the test and gather data through the prepared questionnaires and observation of an on site reviewer.

Once testing is complete we shall prepare statistical analysis and report findings.

### **5.0 CONCLUSIONS**

We have presented an initial pilot study that indicated that (1) interactive displays in galleries can create a engaging and exciting experience and (2) that they can be especially suitable to present education about art in a new and more involving way.

Furthermore, we found that the proximity based reaction of a system to a viewer provides an easy and intuitive form of interaction which was well understood by most viewers who used the system for the first time without any complicate instructions. Also, we found that the acceptance of awkward special hardware (in our case a head mounted display) is distracting for first time users and should thus be avoided in an art gallery.

While it appears that interactive digital displays are an enjoyable and engaging medium to educate patrons about art, the acceptance of digital systems for art displays is in no way conclusive. The reactions of patrons to an

unexplained ubiquitous display was not always clear due to the lack of interface affordances. This will be interesting to explore further.

The ambiguity and wide dispersion of some of our initial results can not all be attributed to a few flawed question from our original question set and demands further investigation.

Uncovering empirical evidence as to the real acceptance or otherwise of interactive digital displays would provide concrete data for galleries to base decisions on the future use and deployment of these systems. People who are required to make these decisions have previously had to rely on their own judgment without the benefit of clear evidence to base and justify their decision. The information resulting from this study should be of great value to those people when making future display decisions.

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## Appendix I

### Abbreviated Questionnaire

#### Questionnaire Introduction.

In front of you are two displays that contain the same artistic content. Please stand in front of each display and rate each one using the following questionnaire. Please select which display to try first by tossing a coin. The content of each display can be changed by selecting from the keyboard.

Each question can be answered as to how strongly you agree or disagree with the statement. Circle your preferred choice.

Strongly Disagree 1      2      3      4      5 Agree  
Strongly Disagree      Strongly Agree

#### Background Questions

I am                      Male                      Female  
My age range is  
0-10 yrs    11-20 yrs              21-30 yrs              31-40 yrs              41-50 yrs              51+ yrs

In the last 12 months I have visited Art displays or Galleries \_\_\_\_\_ times.

I consider myself to be quite knowledgeable concerning art:

Disagree 1      2      3      4      5 Agree

#### System specific repeated for each display.

##### Images

I liked the images used in this display:

The image quality was very good:

I found the images were unstable:

The image transition was smooth:

The image transition was too fast:

The image transition was unnecessary – swapping from start to finish images would have been just as good:

Either    The image vividness of the Head mounted display system made wearing it worthwhile:

Or        The image vividness of the screen display was good:

##### Interaction

I understood how the display was changing to my position:

The interaction was natural and obvious:

The interaction was distracting from the content:

I could have done with proper instructions on how this worked:

##### Personal preferences

I found this augmented reality display boring:

This is a good way to display artworks:

This is a good way to educate people about art:

##### Overall

The order I viewed the displays is:

\_\_\_\_\_HMD      \_\_\_\_\_Dynamic

The Display I prefer is:

HMD    Dynamic              No Preference

I think interactive media displays are only suited to education or for museum objects and are not generally suitable for art:

I would attend exhibitions of art comprising only interactive media displays:

I think interactive media displays of art are only useful to augment the display of regular art:

I would only attend exhibitions of art comprising interactive media displays where the original art could not be seen locally:

I think interactive media displays are more suitable for educating people about art than viewing art:

Please make any comments or suggestions here in your own words.....