Approaches to Interactive Art Systems

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ABSTRACT

Artists work with computers and visual interaction in order to create artworks in complex and varied ways. Collaboration between technologists and artists frequently creates new forms of interaction and visualization: it also promotes thinking about new ways of programming such systems. This paper discusses the role of interaction in art systems and some of the new ways in which they are being built. Categories of interactive art systems defined as *static, dynamic-passive, dynamic-interactive* and *dynamic-interactive (varying)* are extended and illustrated by examples of work from the first author.

1 INTRODUCTION

Artists and art theorists have been particularly interested in audience participation with artworks since the 1960s. Interactive artworks that could transform viewers into participants were envisaged and created using the media of the time. In 2004 the opportunities for audience participation are magnified by widespread access to digital technology and the development of generative systems in sound, image and multimedia based art.

The media used in digital art apply to many art forms, including painting, performance, film and participation. Where the medium is static such as printing, the technology issues concerned with the output devices (e.g. printers, video projection) are well defined. However, the situation is quite different when it comes to interaction in art. *Interactive art* is concerned with the way the object *performs*, as well as how it appears. Here, there remain many unresolved issues despite considerable advances in the technological possibilities since the concept of interactive art first appeared.

In today's interactive art, where the artist and the audience play integral participant roles, the computer's role has immense potential. In the past, it was a dream yet to be realized as artworks that could transform viewers into participants. The opportunities for including audience participation have been increased by the advent of intelligent digital technology. Collaboration in art practice has grown significantly, in the sense that the visual arts have developed some of the characteristics of film production, with teams of experts working together on projects.

In the early days of experimental interactive art, Cornock and Edmonds put forward the idea that the computer could have an important role in defining the specification of the art work and also managing the real-time result of that specification. This role is quite different to the computer as a means of producing graphic art images. By 'specifying'' and 'managing', they meant that the computer controls the way an artwork performs in relation to its environment including its human audience, or, arguably the more appropriate term, its 'participants'. Because the role of the computer was envisaged as critical to the experience, they speculated that such work could transform the artist from an art specialist in creating artworks to a catalyst for creativity [7].

Audience participation with artworks was a lively expanding area of interest for artists and art theorists in the 1960s and 1970s. Burnham, for example, argued for the importance of understanding artworks in their environmental context and that all things 'which processes art data,…are components of the work of art' [3]. So by that definition, the audience is part of the artwork. As early as 1966, Roy Ascott had developed a theoretical position in which participation and interaction between the audience and the artwork were central [1]. He later gave up the practice of making art objects all together: 'In California in the 1970s, introduced to the computer conferencing system of Jacques Vallée, *Informedia*, I saw at once its potential as a medium for art and in 1979 abandoned painting entirely in order to devote myself wholly and exclusively to exploring telematics as a medium for art' [2]. In other art forms, such as *Happenings*, participation was also prevalent. Kirby described rather basic examples of participation in Allan Kaprow's *Eat* thus, 'Directly in front of the entrance, apples hung on rough strings from the ceiling. If the visitor wished, he could remove one of the apples and eat it or, if he was not very hungry, merely take a bite from it and leave it dangling' [12]. Participation in the artwork by becoming part of the art system and interacting with whatever the artist provided was becoming a familiar experience, whether it was typing at the keyboard or eating the apple.

2 CATEGORIES OF INTERACTION

Turning to the specific context of art and generative technology, we can envisage several situations that characterize the relationship between the artwork, artist, viewer and environment. The core categories devised by

Cornock and Edmonds are applicable to current examples of interactive artworks. They were defined then as: *static, dynamic-passive, dynamic-interactive* and *dynamic-interactive (varying).*

Static: the art object does not change and is viewed by a person. There is no interaction between the two that can be observed by someone else, although the viewer may be experiencing personal psychological or emotional reactions. The artwork itself does not respond to its context. This is familiar ground in art galleries and museums where art consumers look at a painting or print, listen to tape recordings and talk to one another about the art on the walls and, generally speaking, obey the command not to touch.

Dynamic-Passive: the art object has an internal mechanism that enables it to change or it may be modified by an environmental factor such as temperature, sound or light. The generative mechanism is specified by the artist and any changes that take place are entirely predictable. Sculptures, such as George Rickey's kinetic pieces that move according to internal mechanisms and also in response to atmospheric changes in the environment fall into this category [16]. The viewer is a passive observer of this activity performed by the artwork in response to the physical environment.

Dynamic-Interactive: all of the conditions of the dynamic passive category apply with the added factor that the human 'viewer' has an active role in influencing the changes in the art object. For example, by walking over a mat that contains sensors attached to lights operating in variable sequences, the viewer becomes a participant that influences the process of the work. Motion and sound capture and analysis techniques can be used to incorporate human activity into the way visual images and sounds are presented. The work 'performs' differently according to what the person does or says. There may be more than one participant and more than one art object. An example of this work is the Iamascope, a work which includes a camera looking at the viewers and is connected to a controlling computer. The work reacts to human movement in front of it by changing a kaleidoscope-like image and making music at the same time in direct response to the viewer's movements [10].

Figure 1: Interaction with the Iamascope at the Play Zone, Millennium Dome 2000

Dynamic-Interactive (Varying): the conditions for both 2 and 3 above apply, with the addition of a modifying agent that changes the original specification of the art object. The agent could be a human or it could be a software program. Because of this, the process that takes place, or rather, the performance of the art system cannot be predictable. It will depend on the history of interactions with the work. In this case, either the artist from time to time updates the specification of the art object or a software agent that is learning from the experiences of interaction automatically modifies the specification. In this case, the performance of the art object varies, in addition to case 3, according to the history of its experiences.

When defining these categories, Cornock and Edmonds proposed that rather than talk about 'artworks' it was helpful to think in terms of 'art systems' that embraced all of the participating entities, including the human viewer. It follows from this that the role of the artist is not so much to *construct* the artwork, but rather to specify and modify the constraints and rules used to govern the relationship between audience and artwork as it takes place in the world. This is a view that includes the generative arts as a central concern. Four generative art systems exemplifying one of the categories above are described in the following section. These are examples of an important strand of the future development of approaches to making intelligent interactive art. However, the way that we can interpret them is subtler than it was thirty years ago. They are also all examples of human collaboration and of inter-disciplinary partnerships in practice.

3. WORKING WITH INTERACTIVE ART SYSTEMS

In recent years, a considerable amount of the work by artists operating at the forefront of art and technology involves interaction between art objects and the viewer. Each of the categories mentioned above are currently in use to one degree or another. Artists are also interested in the relationships that exist, or can be developed, between the physical world and virtual ones or between physical movement and symbolic representation. Examples may be found in a publication of work arising from a number artist-in-residencies that were studied and documented [4]. One artist uses swimming to help understand the nature of the water to be modelled in computer animations. Another artist is concerned with the precise nature of the relationships her audience forms with her work. Another artist uses movement in a space as an integral part of his interactive works, so that performance and visual art are brought together. Dynamic systems of one sort or another are often at the core of the artworks produced. The intelligent computer system manages interactions with or representations of physical behaviour.

Implementing artworks of this kind often involves the construction or selection of sensor and control systems. These are ways in which the computer can learn about its environment and affect what happens next. In general, the applications and programming languages available to build and use these systems are much less advanced but substantially more difficult to use than general-purpose software applications. To make things more complex, interactive systems that 'learn' from the gestures and movement of participants are beginning to appear.

The *learning interactive video construct* is a generative art system that evolves in response to the interpretation of participant interaction with the work by a software agent. This is an example of the *dynamic interactive (varying)* category of art system. This recent work in interactive art systems, evolved from earlier *video constructs*, which are abstract generative animations in which a computer program provides the underlying structure that leads to the work. The effect is to produce a sequence of images in which the formation of the

shapes and the colours change over time. The changes are not random and some order can be sensed although the actual rules that generate the sequence are not normally fully clear to the viewer. These works fall into the class of *dynamic-passive* art system. They change, but without any influence from the observer.

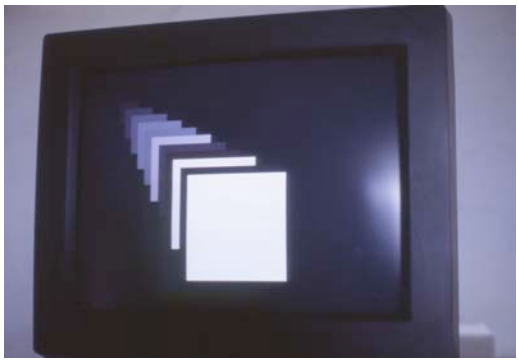

Figure 2: An early video construct by the author: Jasper 1990

The time-based video constructs have been developed into *interactive video constructs*. The artwork can be so constructed as to react to events detected by sensor systems as is done in the Iamascope (see above) [10]. A real time image analysis system is incorporated into the generative program. The performance of the work, i.e. the generative path that it takes, is then reactive to what the participants are doing.

In a video construct, the program is using a set of rules and, as it searches through different ways of using them, it generates the sequence of images that form the work. In the earlier systems, the sequence of images was entirely determined by the search strategy used by the program to explore the rules. In the interactive case, however, the program has available to it a stream of data that is a coded representation of the behaviour of the viewer and this data modifies the way the search is conducted, thus leading to a sense of reaction by the system to the participant.

Figure 3: A Video Construct 2000

Because these interactive video constructs are described within the computer by a set of rules, it is possible to add an agent that uses the history of interactions between participants and the work to modify the generative behaviour by changing the rules used, or changing which rules are used. Through recording and analysing the interactions, the agent learns from experience about human reaction to the artwork. The video construct changes its behaviour in the light of its experience with human participants interacting with the work. At its core, the work is a program, which is a generative system. Hence, as it learns, it changes the way that it *develops* rather than simply changing the stimulus-response rules that govern its behaviour. The *learning interactive video construct* is an art system that evolves in response to the interpretation of participant interaction with the work by a software agent [9].

4. DEFINING INTERACTIVE VIDEO CONSTRUCTS

The generative process is controlled by rules such as:

*interaction*_rule 1: if a person is present and standing still try rule 1 before rule 2 or
*interaction*_rule 2: if a person is present and standing still always use rule 3

Meta rules are rules, such as *interaction*_rule 1 or *interaction*_rule 2, that determine how the generation proceeds in terms, for example, of which rules should be tried next. They can be composed so as to produce learning or evolving performance by associating their conditions with historical information. For example, if T is the number of minutes during the preceding 24 hours that a person has stood still in front of the work, learning could be implemented by the meta-rule:

*learning*_rule: if T>120 then use *interaction*_rule 2

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Heron (2002) is a work that consists simply of a set of coloured vertical stripes that change in time. Physically, it is a projected image on a sheet of translucent plastic hung in space, as seen in figure 3.

In this case, the image is a set of coloured stripes and the nearer the person is to the piece the narrower the stripes become. This creates a sensation of the work retreating as the viewer approaches it. In addition, the rate of change is, up to a point, directly proportional to the amount of movement (e.g. waiving) that is detected. However, too simple a relationship is not particularly appropriate. One point is that there is always some movement (using y=Mx+C rather than y=Mx to relate image rate of change, y, to person movement, x). In addition, when the degree of person movement reaches a particular level, the images revert to the slowest level (if x>*Limit* then y=C). In effect, the piece does not “like” wild articulation. This notion is borrowed from Edward Ihnatovich,

whose piece SAM, moved in relation to sound but stopped if things became too loud (Riechardt, 1968).

As the day progresses, *Heron* builds a simple record of events as a vector in which the degree, extent and variation of movements in front of it are represented. Meta-rules make use of this data to modify the behavior patterns, for example, by lowering the threshold, *Limit,* which is used to define the degree of movement to wish it will not respond. One could say that *Heron* can become tired of people jumping and waving in front of it all day long.

5. ENVIRONMENTS FOR BUILDING ART SYSTEMS

We need computing resources and software to enable the kind of guided or playful exploration of possibilities in which artists engage. But how can we ensure that the artists have access to digital environments that are adaptable to their evolving needs? One solution might be the creation of more software tools that allow the artist access to deeper levels of the computer's programming system, rather than software applications that have been developed for specific tasks such as image manipulation. Such tools could provide a bridge between the use of an environment that requires programming knowledge and the 'closed' application, which does not provide sufficient flexibility.

Our experience suggests that even today, with all the advances in software, the degree of programming and systems expertise is critical to having more artistic control over the developing process. Those artists who had such knowledge were in a position to make more interim decisions during the exploratory process that guided the next course of action. Those artists who depended on a technologist often felt uncertain as to how much control they might have to relinquish to achieve their goals.

There is no one solution to designing environments for creative use. Conflicting requirements, such as accessibility and ease of learning on the one hand, and a high degree of control by the artist on the other, may not be mutually achievable. Ways forward combine new technology, new ways of working and new collaborations. Each artist will chose a personal approach and the intersection of art and technology will lead along different paths in each case. Nevertheless, it is important to understand as much as possible about what is general in art and technology creative processes and how applicable different technologies are.

A fundamental question that we have been considering is, what kind of environments best support the development of digital art? There is one answer to this question which, although it may sound a little strange, is, nevertheless, appropriate. In art and technology environments, we need *environments for building environments.* This approach is analogous to having a store which stocks all of the components that one might need in order to build a carpenter's workbench. The store is an environment that has all of the components that one might need, such as vices, bench tops, tool racks etc. By selecting from them and assembling the items in our own workroom, we can build a specific environment suitable for our particular carpentry needs. The store provides an environment for building the particular environments that its customers need.

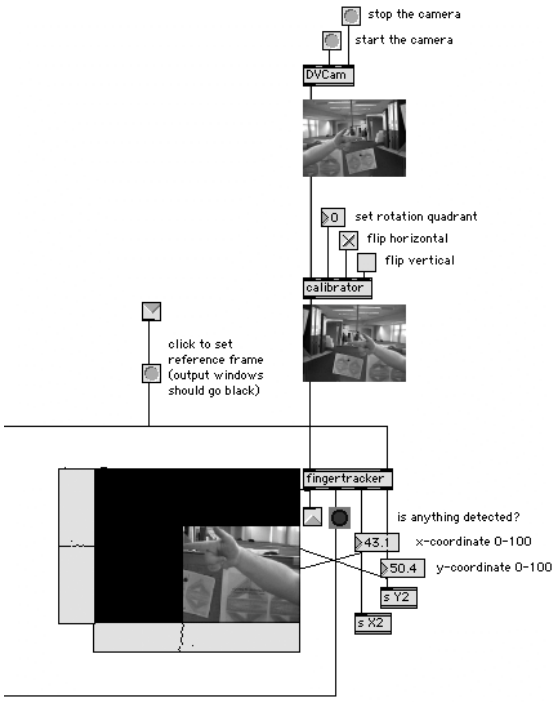

Figure 4: Part of the code for Kyoto Two

Interaction with *Kyoto Two* is provided through the use of a computer vision system to detect presence and motion. The system uses two orthogonal video cameras to construct a 3-Dimenional representation of the position of the foremost part of the body (for example, the fingertip) when it appears in the intersection of the fields of view of the cameras. This form of interface enables both an impulsive, unpredictable response to the body's presence in the space in order to gain the individual's attention, and, if an individual wishes it, more expressive and intuitive control over the piece with a fingertip.

The program behind the artwork, written in Cycling '74's Max/MSP language with the SoftVNS video toolkit, contains prototypical implementations of features designed to encourage interaction with the program in the appropriate media, and hence understanding and *expressive* control of the computer, by both the programmer and the artist. These features were created manually in this implementation, but would in future be created automatically based upon semantic information embedded in the program and program environment.

6. INTERACTION FOR ART

The current direction in digital art involves a significant increase in the role of interaction and innovative user interface technologies. Most interesting, in many ways, for the interactive systems community is the modes of interaction being employed, such as movement in a space or the making of physical gestures as indicated above. For today's artist, innovations in such modes of interaction, and in ways of defining and implementing engaging behaviors, is a central concern. Collaboration between artists and technologists offers a very interesting development path for user interfaces.

This paper has discussed these developments and the role of interface technology in interactive art. Categories of interactive art systems defined as *static*, *dynamic-passive*, *dynamic-interactive* and *dynamic-interactive (varying)* were extended and illustrated by examples of artworks. It was shown that interactive systems are applicable in the domain of art practice. It was then argued that the topic of interactive art system design offers a rich area for future research in user interaction.

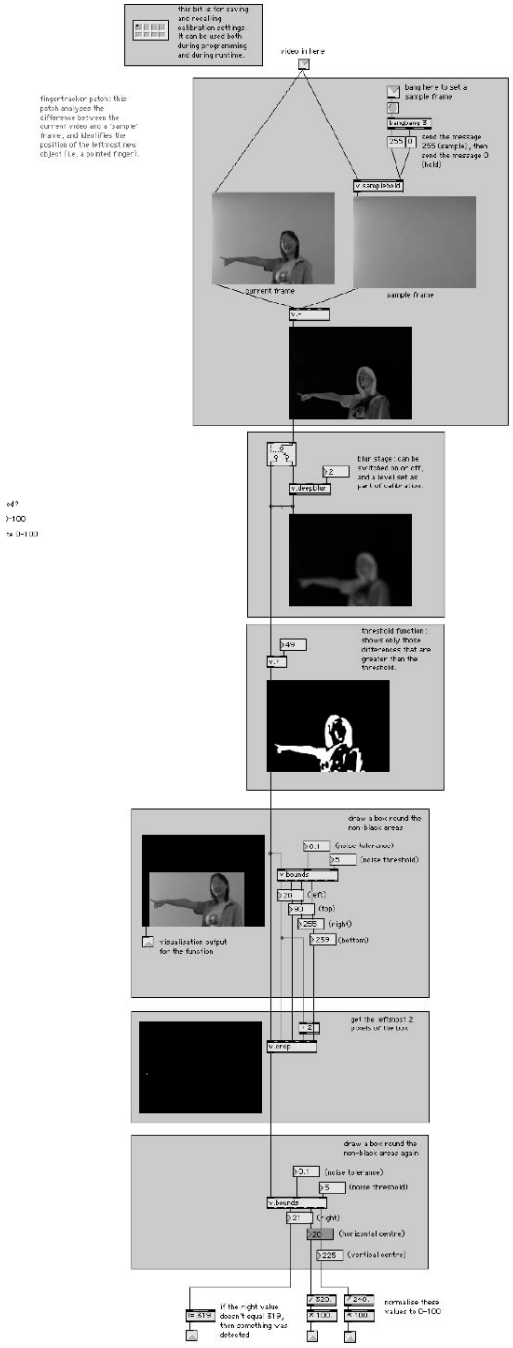

Fig 5: Part of the code for detecting finger positions

ACKNOWLEDGEMENTS

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