AARCs for Interactively Linking Display Elements

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ABSTRACT

In complex displays, various elements can be strongly related in in the sense that if we are interested in one data object it is likely that we also need to know about a number of other objects distributed about the screen. In this paper we report on our preliminary designs for Animated Attention Redirection Codes (AARCs), these are interactive short animated streaks traveling from a moused over symbol that convey information linkages in a transitory manner. We argue that these can be very brief and can support a large set of easily distinguished codes. Also, in some cases they can have an easily understood semantics. For example, directionality, sequence and various kinds of causal relationship can be expressed.

KEYWORDS: visual thinking, graph semantics, causality.

INDEX TERMS: H.5.2 [Information Interfaces and Presentation]: User Interfaces.

1 INTRODUCTION

Sometimes information objects represented by symbols in a complex display many be inter-related in predictable ways. If we inquire about a particular data object, say a node representing a person who is a criminal suspect, we are likely to also wish to know about their known associates. But if the display is complex such links cannot be shown as part of the static design—too much clutter would result. A simple interactive technique can help; touching a symbol causes links to related information to be highlighted. This enables a much more rapid visual search to be conducted. The Constellation system of Munzner et al. [3] provides an example of how interactive highlighting of related information can provide views into very a complex semantic network, far larger than can be displayed with a non-interactive concept map.

The basic function of this kind of highlighting is to provides an aid to the redirection of attention and because attention is dynamic part of the visual thinking process, such redirection aids can be transitory, only lasting for a fraction of second. Previous research has shown that motion highlighting is especially useful for the re-direction of attention [6] suggesting that brief animations may be effective.

The goal of this work is to develop visually compelling, animated, semantically meaningful and easy to learn interactive representations of linkages. Our work is based on an initial belief that in addition to simple attracting attention motion can encode various kinds of semantic information, such as causality, sequences and directionality of links. We call these brief interactive animations AARCs where this stands for Animated Attention Redirection Codes. Before discussing some of our designs we briefly introduce the perceptual theory that lies behind the design concept, as well as research on the perceptual semantics of simple kinematic interactions between objects.

1.1 Perceptual Kinematics

Michotte [4] observed that when a visual object moves into contact with another visual object and that second object moves away, the first object is perceived to *cause* the motion of the second. He also showed that the effect depended on there being less than 100 ms. Delay between the two motions. Since then researchers have created simple animations based on this idea to show causal linkages in network diagrams [2,3,5]. Most of the research has been devoted to showing simple positive effects, although [2] also showed a causal diminishing effect.

1.2 The physicalist theory

If we pull on a string and something immediately moves, we infer a causal relation between our action and the result. Toss a stick into a bush, if something runs out we assume we caused that too. The acts of grabbing, hitting, pressing or squeezing all result in direct contingent visual changes in the state of the world. It hypothesized that it is through such temporal contingencies that infants gain a basic understanding of the state of the world. Furthermore, cognitive scientists propose that such experiences form the conceptual substrate on which even extremely abstract concepts are built [1]. In particular, causal concepts are generally based on a kind of approximate modeling based on everyday physics. This is called the *physicalist* theory. Other suggest that concepts relating to physical causation are processed by a primitive "Theory of Bodies" that schematizes objects as bearers, transmitters, and recipients of primitive encodings of forces.

2 DESIGNS FOR INTERACTIVELY LINKING DISPLAY ELEMENTS.

The key idea behind our design strategy is to create a set of interactive representations using simple brief animations. Unlike previous work [2,3,5] which added animations and highlighting to fixed links in the design these are transitory and consist of very short duration animations, lasting less than a second for the most complex. Such short animations can be effective because we can assume that the user's attention is directed to the starting node they have just clicked on. Our claim is that such animations, if properly designed can have an interesting natural semantics that will allow certain relationships to be expressed in a natural way that is not possible using static representations. We have built two research prototypes to design and evaluate these ideas.

Our first prototype is designed to explore design issues relating to AARCs for use in a complex display environment. It is intended to demonstrate the general proposition that there are brief animated codings, that can represent semantic properties of relationships including causality. These include directed and reverse directed links, sequence, persistence and other motion coding. We believe that we can demonstrate a set of codes that is considerably richer than, for example, color coding. Figure 2 shows a screen shot of a two link animation representing relationships that occur in sequence. Only a 100 msec delay between the first link's animation and the second links animation is needed to convey sequence.

The AARCs are constructed from hermite spline curves and use transparency, they entirely disappear from view when they are not activated. AARCs are activated when a particular symbols is touched or moused over with a hover query. We have so far demonstrated the following with animations lasting less than 0.5 sec.

Simple link: a brief visual link appears to one or more symbols.

Directed link: A brief animation along a path to one or more symbols. This can be either towards or away.

Simple sequence: Two links appear in sequence staggered by 150 msect.

Directed sequence: Two directed visual links appear in sequence

Causal link: A directed link appears, followed by motion of the node it is attached to.

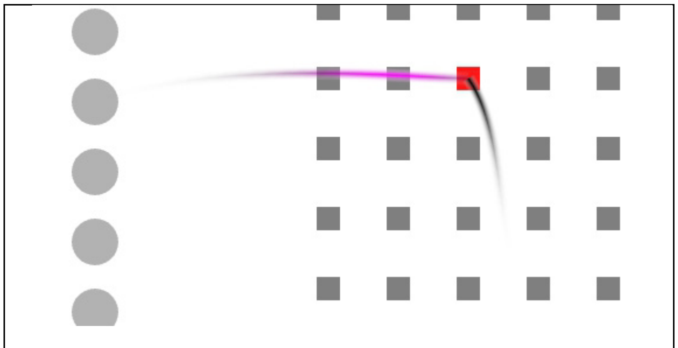

Figure 2. A snapshot of a directed sequence of AARCs resulting from a touch to the second circle down on the left.

Each of the above can have a variety of motion patterns supporting coding semantics. Also, there can be various combinations of link animations and node animation. For example nodes Shrinking, enlarging, or oscillating each convey different semantics.

2.1 Designs for expressing causal realtionships

Our second prototype application uses a multi-touch screen to demonstrate more complex semantics involving three or more nodes. It is specifically designed go beyond the simple positive causation that has been mostly been explored in previous work. The underlying computational model is a Petri net. The following is a list of the various kinds of link we have designed thus far.

Simple causation. A causes B

Positive causation. Increasing A causes an increase in B. Repeated touch increases the weight. – propagated.

Negative causation. Increasing A results in a decrease in B.

Amplification. C increases the effect A→B

Damping. C decreases the effect A→B

Prevention or blocking. C blocks A→B.

Figure 1. shows static screen shots illustrating three of these animations.

3 CONCLUSION

The preliminary design work reported here suggests to us that brief interactive animations occurring with touch, or mouseover, can provide and effective way of linking various elements in a design, drawing attention from a current object of interest to related objects. We propose that these brief AARCs can have a rich, easily learned semantic coding so that different kinds of relationships may be readily perceived. Empirical evaluations are in preparation.

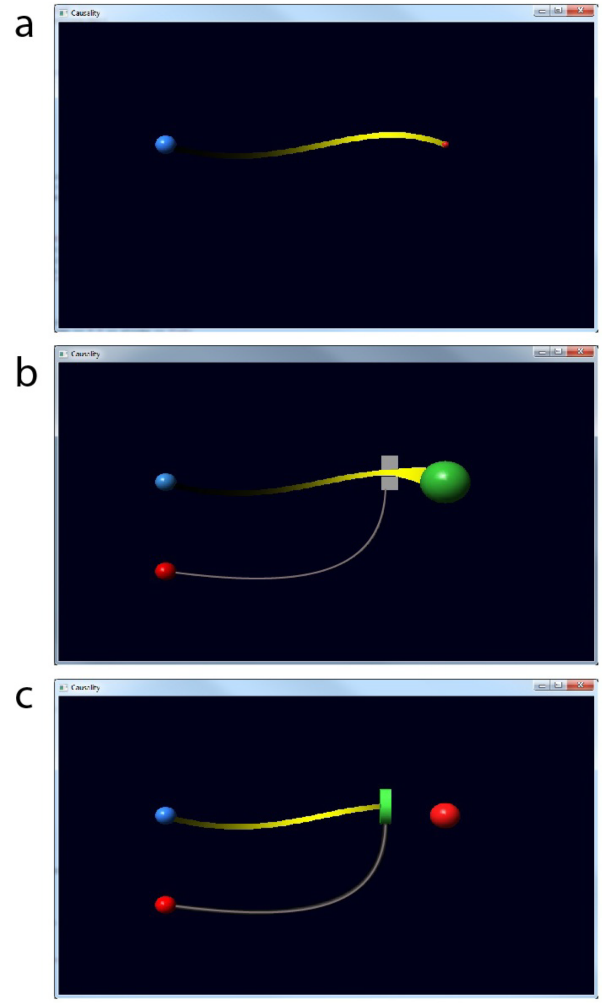

Figure 1. The blue and the red balls on the left can be touched either separately or together. (a) Shrinking of the red ball results from touching the blue ball. (b) Touching the blue ball causes the green ball to expand, touching the red ball amplifies the effect. (c) Touching the blue ball causes the red ball to expand, touching the blue ball blocks the effect.

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