HEURISTIC RULES FOR VISUALIZATION

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ABSTRACT

In recent years there has been increased interest in heuristic methods in artificial intelligence. By and large heuristic research has been used with two modes of thought: mathematics and language (language being the vehicle for scientific research and search strategies). This paper focuses on another mode of thinking - visualization. The process is not to analysize visual perception as in the areas of pattern recognition and image understanding, but the complimentary process - to synthesize. Rather than dissect, the goal is to create. By using a visualization-system guided by heuristic rules, the artist can visualize the invisible. Discover new sets of heuristics for exploring new visual concepts. This paper describes the basis for a visualization-system. It is aimed at two groups of people. Computer scientists and engineers who are currently most influential in research in artificial intelligence and computer graphics, so that they may use visual thinking to better understand abstract concepts. Artists who are ever involved in developing and exploring new mediums (ie: computer technology) to realize their creative ideas.

KEYWORDS : visualization, heuristics, computer graphics, artist, creative seeing

INTRODUCTION

> "Intuition enlightens and so links up with pure thought. They together become an intelligence which is not simply of the brain, which does not calculate, but which feels and thinks. Which is creative both in art and life..."
>
> Piet Mondrian

Important discoveries in science, mathematics, and art are rarely a result of pure scientific logic. They are brought to fruition through visual thinking: exploration of partially formulated ideas, fuzzy mental images and intuitive judgement. Visual thinking then, is a process of synthesis. It combines an understanding of structure, information, and manipulation. It is influenced by seeing and imagining. And is further stimulated through such picture making activities as drawing.

The artist, who copes with life by means of creating works of art is the ideal "expert" for an artificial intelligence based system for visualization. Historically, artists have always played an important role in the development of technologies and tools in order to realize their ideas through a visual medium. Euclid's Golden Section, a:b=b(a+b), was derived from the structural relationships in the Parthenon and the Temple of Athena. Perspective was discovered by the 15th century architect Filippe Brunelleschi. Le Corbusier devised the ordering system Modular, built around three main points of human anatomy: the top of the head, the solar plexus, and the tip of a hand [5]. So, an artistic viewing of reality reminds scientists that most natural phenomena are not described adequately if that description is attained only from accretion of isolated parts.

Computer graphics is an ideal "visual medium" to encourage creative thought through visualization. Aside from the obvious advantages of the computer: memory, precision, ability to perform routine tasks, fast manipulation of data, and network communication, new thinking strategies can be realized. Computer graphics can be used to correlate new visual data with previously stored data to overcome restrictions and develop new structural relationships. It can be used to articulate multiple perspectives through superimposed drawings, while maintaining an overview. It can be used to animate drawings to represent dynamic ideas [7]. It can be used to manipulate parts of drawings to gain a new perspective. Computer graphics allow the artist to simply make a rough sketch of an idea contained in the mind or to change the rules of physical reality.

HUMAN OBSERVATION / CREATIVE SEEING

Observation is the process of matching incoming visual sensations with visual memory. The eye is limited, however, by its ability to see even a small area equally focused at all points. So, it grasps portions that it then collects and stores. Creative seeing is the process, as Cezanne said, "waiting for nature to free his eyes from their camera habits" [14]. It involves using the imagination to see new perspectives. It combines curiousity and a willingness to abandon old classifications for new possibilities.

How is creative seeing accomplished? Through a process of "unlearning". The natural tendency when faced with something new and different is to analyze, categorize and make familiar. This reductive method leads to stereotyping, black or white thinking, and superficial development of ideas. So, imagination must be harnessed to help us "unlearn". Imagination allows ideas to transcent space, time and physical reality by relaxing, looking at the world from different view points, distorting and reclassifying imagery under new categories such as color, roundness, angularity, etc. Man must welcome the insecurity of newness and avoid premature judgement [12].

Memory is essential to creative visual thinking. Aside from matching incoming stimuli, it provides material for recombination. By the aid of the stored visual image the mind can take some part of an image out of its original setting and recombine it with a totally new event to solve a problem. Memory and seeing reinforce each other. Memory forces the ability to focus attention, to look and think about the perceived object rather than something else.

VISUALIZATION AND DRAWING

Although visualization can be illuminated through a number of vehicles (drawing, language, kinesthesia, etc.) Drawing works best within the context of computer graphics. There are two stages of drawing for visual thinking. The primary stage is explorational and the secondary, a more focused form of the first, is developmental [12].

The first stage, exploration can be broken down further. It may be either deductive or inductive. That is, the incomplete, vague mental impressions that usually accompany creativity are recorded quickly through drawing. These drawings are general. They define structure, not a particular element. Sometimes an artist will work from the smallest manifestation of form and interrelationship [8]. Either method is used as a point of departure for the developmental stage.

In the developmental stage. Drawings are chosen, refined and expanded for a more complete understanding of an idea that seems worth following through. (This is not a random activity.) These drawings are more detailed and thorough. Like the first stage these drawings are performed spontaneously and quickly. The approach is a flexible one. Ideas are expressed from as many viewpoints as possible. For example a computer may be represented by a drawing of it outer shell, by schematic drawings of its boards, or abstractly as a node on a communication network.

Drawing to stimulate visual ideas is not to be confused with drawing to explain and present fully formed ideas for communication with others. Visual idea drawing is for the artist's personal communication and is not for judgement. Obviously if these drawings are developed further, over time, they may result in a work of art.

THE PAINT - SYSTEM PARADIGM

A "paint - system" is one configuration of a computer. It comprises a computer, an image buffer, a variety of input devices such as a mouse, digitizing tablet and stylus, or digitizing camera, and a menu-driven user interface. These systems emulate (or attempt to emulate) traditional painting and illustrative operations and allow the artist to create electronic graphics with little or no understanding of computer graphics.

The artist chooses a method for "painting" from a fixed set of basic options. They include: point, line, rectangle, ellipse and so on. He can also create brushes made from the options or from areas of the existing image (rasters: rectangular arrays of pixels). A grid can be used to constrain the painting cursor to incremental locations on the screen for a minimal level of layout precision. Color can be easily altered in various ways, and areas of the screen can be filled with color. Text can be incorporated, although fonts vary from system to system.

Some systems provide more complex options like transformations (scaling, rotating, translating) or Bit Blt operations for "cut and paste" activities, where parts of the screen can be lifted and moved or rubber stamped. Other systems allow even more sophisticated processes like curve fitting, anti-aliased signal processing, or solid modeling [5].

Still other systems have some form of animation capabilities. The artist can create each full screen "cel" as in traditional cel animation, create "sprites" or characters to be moved across the screen as in video games and some broadcast video graphic systems, simple color cycle animation, keyframe animation, and complex algorithmic animation.

Regardless of the level of complexity or number of features, the application for these systems is to create images to communicate well-formulated ideas (usually for commercial purposes). They tend to be idiosyncratic, imprecise, and often complicated to use. The interface is inflexible (only one configuration) and not usually designed by an artist. Paint-systems are unlikely to provide the spontaneity necessary for stimulation of visual thinking.

THE VISUALIZATION - SYSTEM

This system is not a paint system. It is a new type of system for a different application. It combines some of the properties of a paint-system with heuristic methods in artificial intelligence [10,11]. The visualization-system is for the exploration and development of visual ideas. It allows the user to select from a variety of heuristic strategies for creative thinking. Unlike previous visual perception research such as pattern recognition, image understanding or image generating, this system does not analysize, but instead - synthesizes [13,15]. It is to discover new ways to be creative and so, discover new heuristics.

COMPUTER OBSERVER / CREATIVE SEEING

In the visualization-system the computer acts as an "unlearning" tool for creative seeing. It can generate variations on a theme input by the artist, by defining and revealing the structure and then applying associated heuristic operations such as: superimpose, circumscribe, compliment, balance, fill-in, etc. It allows for manipulation of parts of the structure by allowing the artist to select and combine another set of heuristic operations to add dimension, rotate, transform (stretch, compress, scale). It provides image memory for recombination, to isolate a familiar, previously stored image in an unfamiliar relationship. The system can superimpose a grid to achieve or alter proportion.

The artist can stop the system at any point, save an instance, or continue working manually. The artist may retrace his steps because the computer saves an image, as well as, tracking a combination of movements and information (coordinate locations, colors, and function selection sequences).

The artist may also attach notes. The notes may be a part of the drawing or saved in a file related to the drawing. The system will also provide notes, so the artist may watch patterns emerge that he may not be aware of on his own.

The artist can create his own interface to the system by selecting and combining the basic drawing functions and heuristic operations with which he wants to experiment. The interface can be dynamically altered while working to increase flexibility in problem solving strategies. It is stored separately from the image so that it can be reused to develop other ideas/images.

COMPUTER AND DRAWING

The visualization-system includes a drawing tool for quick and intuitive drawing and somewhat more detailed drawing. The interface is flexible so that it may support many drawing styles. The operations available for the basic drawing tool are simplified and modular. The artist is allowed to: select and create brushes, generate: points, lines, rectangles, triangles, and ellipses, select and modify colors and patterns, move areas, copy areas, zoom-in (magnify), and fill enclosed areas. These operations can be combined to produce higher level operations that suit the individual artist. The drawing process is monitored by the system to provide structural information and develop concepts. This information then, defines the concepts to be processed by the heuristic functions.

VISUALIZATION - SYSTEM / HEURISTIC RULES

The visualization-system is still in the system-start up phase. The artist must work closely with it to help guide the selection of the heuristic rules. This allows the system to learn from the artist's selections. Once a rule is chosen, it examines the visual concepts tracked by the drawing tool, modifies them, and alters the original drawing and in turn, creates new concepts [10]. It can continue to branch to other heuristic rules or the artist may intervene, draw, or redirect it to still other heuristic rules.

The syntax of heuristic rules are like the "if-then" construct in many computer languages. The left hand side: IF < CONCEPT >, returns true or false. The right hand side: THEN < ACTIONS >, modifies the concept [11]. Below is a partial list of the heuristic rules used by this system:

IF The drawing contains more than 10 shapes,
THEN group elements together to form simpler shapes.

IF The structure of the drawing repeats the same unit in the horizontal direction,
THEN repeat the unit in the vertical direction.

IF The structure of the drawing has two dimensional direction (moving in both horizontal and verticle directions),
THEN rotate the drawing on its diagonal.

IF The elements of the drawing vary in weight,
THEN arrange the elements so that their value increases toward the center.

IF The lines of the drawing are limited by fixed points,
THEN add secondary lines that intersect the main line without intersecting the fixed points.

IF The drawing is linear,
THEN complete the lines to form planes.

IF The drawing is planar,
THEN fill each plane with color.

IF The drawing contains two or more colors,
THEN create color harmony by balancing them in the red, green, blue color space model.

IF The combination of elements in the drawing are the same as another, previously stored drawing.
THEN superimpose the two drawings.

IF The vertical axis of the drawing is to the left of the viewer.
THEN shift the axis to the right.

IF The divisions of the structural units in the drawing are close to a:b=b:(a+b).
THEN correct the divisions to equal a:b=b:(a+b).

IF The structure of the drawing is not repetitious.
THEN group the smallest recognizable entities.

IF The drawing has two sources of energy: gravity and an obstructing object.
THEN determine which is dominant by projecting a diagonal line.

IF The drawing has no apparent focus.
THEN define paths for the eye to travel along.

IF The horizontality of the drawing is not proportionate to the height of the viewer.
THEN reposition the horizontal elements until they are proportionate.

IF The drawing emphasizes symmetrical balance.
THEN redraw the drawing using a non-symmetrical balance.

IF The balance in the drawing is disturbed in a horizontal direction.
THEN equalize the balance by strengthening the vertical balance.

IF The rhythm in the drawing changes in a non-continuous fashion.
THEN try to impose a rhythm with defined steps.

IF The direction of an element in the drawing ascends.
THEN redirect it to decend.

IF The drawing is static because of excessive amounts of white.
THEN activate it with black.

CONCLUSION

This project is still in the conception stage. The design philosophy is to use the process of discovery, outlined for the system, to define the system itself. This is a process that will work back and forth from artist - computer - artist... over time. At this point, the artist must interject his "expert knowledge" while the visualization-system learns to mimic and eventually think visually on its own. The system acts like the creative imagination "unlearning" to stimulate creativity and subsequently new ideas. It allows the seemingly non-visual person to visualize and the artist to have a new medium with which to bring his ideas to fruition. Eventually, the system may be able to create art without the guidance of an artist.

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