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Title- **A Video Paint System for a Real Time Animation Processor**

Date- **November 3, 1980**

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Animation

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ABSTRACT

An interactive system for "drawing" 2D images on a video screen has been developed. The system is called **Paint** and consists of software which controls a hardware display generator[1] and user interfaces. Interaction with the system is accomplished primarily via a pair of joysticks, a bit pad digitizer and a small group of buttons and sliding controls. Some of the capabilities are :

Filling in polygonal areas.
Selecting colors via red, green, blue and intensity mixtures.
Drawing with patterns.
Drawing with a selectable width "brush".

The display generator has a **256 x 256 x 4** bit pixel memory, a **16 word x 24 bit** color map, and display translation and rotation capability. Of the total **256 x 256** pixel area available a **160 x 120** pixel window is visible at any one time. This system is part of a real time three-dimensional animation system[2] and is used to produce static or partially animated foreground and background scenes.

Pages Text 4	Other 5	Total 9	
No. Figures 3	No. Tables 1	No. Refs. 3	

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MEMORANDUM FOR FILE

1. Introduction

The **Paint** system is a software tool written to provide a facility for producing background images for the more dynamic foreground 3D processor. The creation of images in this frame buffer is basically like most memory mapped imaging devices with a few additions. There is enough memory for a 256 x 256 pixel image of which only 160 x 120 can be viewed at a time. This 160 x 120 window can be moved around quite easily. The window can also be rotated by simply entering an angle in a hardware register. One unique characteristic of this frame buffer is that one can associate a Z value with a particular color. The Z value can be used to position portions of the background image in depth relative to the foreground image. By using this technique one can create a 2D image which has several 3D layers which are quite useful when used with the 3D foreground images.

The hardware presently consists of an LSI-11 (soon to be an 11/23), a special display generator, and interface hardware. This is a standalone system and is currently running under LSX. The software is written in C and is quite dependent upon the particular display and interface hardware being used.

The display generator contains 4 bits per pixel for color which is an index into the 16 word by 24 bit color map. This 24 bits of the color map, 8 bits for red, green, blue and intensity, can be directly manipulated with the Paint system via 4 sliders on the slider board.

Another capability of the system is to draw a contiguous boundary of any shape and then tell the system to fill in the interior of the shape. While drawing one can tell the system to vary the width of the "brush" being used by simply moving a particular slider. One can rapidly fill in large area of the screen by using a wide "brush". By selecting one of four drawing patterns available one can also fill in large area of the screen with vertical or horizontal lines, or a dotted area.

This system provides a flexible means of generating background images. These images can subsequently be used as part of the 3D animation system. One can easily design images which represent views from inside a spaceship or crude landscapes, which can provide additional elements of realism for the 3D animations.

2. Starting Up

The Paint system is primarily operated by interacting with the sliders and joysticks of the animation processor. There are also a few supplemental commands available from the terminal keyboard. The system can be loaded with the command:

load /usr/sys/paint

the message:

erase (e), file (f), back (b), color (c), quit (q), solid (s) ?

will appear on the terminal's screen. Also the LEDs above the active sliders will light up on the slider panel. A typical initial action is to type **e** , (for erase) on the terminal. You will then be presented with the message:

selectively (s), all (a) ?

At which point you would then type **a** , to clear the screen. Typing an **s** , would let you draw with the background color which is effectively an erasure in those parts of the drawing. To leave selective erasure mode simply hit any key on the keyboard to return to the top level menu.

3. Joystick Drawing

So now we are faced with the stark reality of a blank tv screen. Please refer to figure 1 which illustrates the numbers associated with the joysticks and their buttons. Figure 2 shows the joystick in use. Moving joystick 2 will cause the cursor to appear and move around. The farther off center you push the joystick the faster the dot moves around. The speed of this moving dot can also be further affected by moving *slider 49* which lets you select one of two overall speeds for the moving dot. See figure 3 for a full list of the sliders and their associated numbers.

At this point we still have a blank screen but with a dot on it. Moving joystick 1 will cause this dot to leave a trail behind it thus starting you off on your way to your first masterpiece. At first the color will probably start out as white which can get quite boring. In order to select what color you want to draw with, the first four sliders are essentially color mixing devices. *Sliders 32, 33, 34, and 35* are red, blue, green and intensity controls for the trail you are presumably drawing. The first time you use the controls you should move all four sliders completely up and down so that the system is aware that they have interrupted and are active. Otherwise you may get some unexpected colors. The system can handle 16 colors, and since you will probably get tired of drawing with only one color all you have to do is push *button 3* to be drawing with another color. After pushing the button you will not immediately see a change in color because the old color mixture is still in effect. So start playing with the four color mix sliders and (lo and behold) a new color will appear. The next thing you may (or may not) want to do is to change the width of the "brush" you are using. Moving the width *slider, number 36,* will cause the trail left behind the cursor to become wider. Along with the widening of the trail, the speed of the cursor will slow down due to the increased work.

4. Viewing Window

Remember that 160 x 120 window into the larger frame buffer's memory? Well if you move *sliders 37 and 38* you will see the entire image move in the x and y directions. Each of the sliders will cause both positive and negative movement. To stop the motion just center the slider. The window can be rotated about the cursor's position with *slider 39*. Another way of moving around the window is by using *buttons 12, 13, 14 and 15*. These buttons will let you instantaneously select a view of one of the four possible quadrants of image memory.

5. Line Drawing

So let's say you want to draw a line between two points. Two buttons located on joystick 1 will let you do this incredible feat of artistry. *Button 7* will select the current cursor position as the start of the line. Pushing *button 6* will cause a line to be drawn from the starting point, to the current cursor position. By the way pushing *button 5* will place the cursor in the center of the screen.

6. Area Filling

Another capability of the system is that of filling in a closed area with a solid area of color. All you have to do is draw the boundaries of that area, making sure that you don't leave any gaps in that boundary. Next place the cursor anywhere inside the area and then type an **s** , for solid on the terminal. The area will than be filled up with the current color. The filling algorithm will occasionally mess up and seep out if your boundary has a weird configuration and is very thin in spots. So if your trying to fill in something very strange save the picture first, just to be on the safe side. Basically the stuff works well[3].

7. Drawing with Patterns

If you've become tired of drawing with solid areas try *button 11* on joystick 2. This button enables you to draw with one of four patterns. Initially you started out with a solid, one push and you have vertical lines, another push for horizontal lines, another for a dot pattern and one more push to get back to a solid pattern.

8. Saving and Restoring your Picture

Speaking of saving a picture .... You are now sitting there staring at your masterpiece and would like to save it for all time. Type **f** , for file and you will be asked:

restore (r), save (s) file name ?

At which point you would type s and then be asked for a file name, where you would then type a reasonable UNIX file name. If you have previously saved a picture, type **r** and a **file name,** to restore that picture to the screen.

9. Digitizer Tablet

Use of the digitizer is available anytime without having to tell the program anything, just start drawing on it. The digitizer acts, as far as the program is concerned as just another joystick type device, so all those wonderful things like brush width, colors and patterns are all available when using it. The digitizer does have a few new things to offer. First of all there are three modes available for use: *point mode, switched stream mode, and stream mode.* In point mode the tablet will only transmit a point at a time. In switched stream mode the tablet will transmit continuously only when you push the pen down hard enough so that it is in solid contact with the tablet surface. In stream mode you only have to place the pen very close to the surface, or just graze it slightly to transmit data. These three modes are selected by touching the pen to the menu area of the tablet in the lower left corner of the surface labeled **P** for point, **SS** for switched stream, and **S** for stream mode.

The size of the pad corresponds to the entire image memory area so if you're dealing with only one screen of the image you only have one quarter of the tablet's area to deal with. One very useful function of the tablet is to quickly place the cursor at some location. This is much faster, but less accurate, then using the joystick to position the cursor somewhere. For this purpose *slider 50* controls the tablet's drawing or non-drawing mode. If the slider is up then the tablet will leave a trail. If the slider is down the pad will only position the cursor and not draw anything. If not touched, initially the pad comes up in non-drawing mode. One "known bug" that you should be aware of when using the tablet is that if you try to use the tablet and a slider (any slider) simultaneously the tablet will essentially take control and the entire slider board will cease to function. This is easily checked by moving a color mix slider. The way to avoid this problem is to simply lift the pen up before you move the sliders. If this does occur simply hit any key on the terminal once or twice and the board should spring back to life.

10. Acknowledgments

The original paint system and indeed a large majority of the code still in it was written by Mike Baltrush as a summer employee a year ago. A great deal of assistance came from Stu Brown on the video board itself. The picture saving routine was written by Carl Christensen.

MH-1356-SPR

S.P. Ressler

Attached
References (1-2)
Table
Figures (1-3)

References

[1] H.G. Alles, W.C. Fischer *An Animation Processor for Action Oriented Three Dimensional Color Graphics* TM 81-11356-1.

[2] S.G. Brown, *Video Background Generator for a Real Time Animation Processor* TM 78-1356-11.

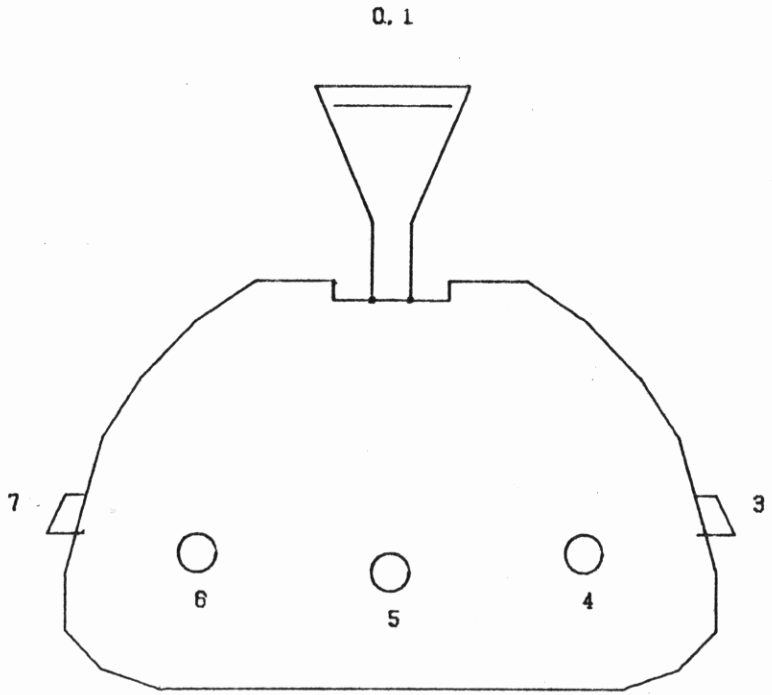
[3] Henry Lieberman, *How to Color in a Coloring Book* Sigraph '78 Proceedings, pages 111-116.

Reference Table for Mover Numbers

Mover number	Function	Location
0,1	Joystick in the x and y directions of the drawing cursor, "brush"	Joystick 1
3	Color register select button	"
4	Stop the rotation of the background button	"
5	Put the cursor in the center of the screen button	"
6	Select the current location as the start of a line button	"
7	Select the current location as the end of the line button	"
8,9	Joystick in the x and y direction of the non-drawing cursor	Joystick 2
11	Switch to cycle through the 4 drawing patterns Solid, Horizontal lines, Vertical lines, or dots	"
32	Slider for amount of red	Top row of slider board
33	Slider for blue	"
34	Slider for green	"
35	Slider for overall intensity of current color	"
36	Slider to change the width of the drawing cursor	"
37	Slider to move the window in the x direction	"
38	Moves window in the y direction	"
39	Slider to rotate the entire picture about the location of the cursor	"
48	Slider to select whether drawing and non-drawing cursors are together	Bottom row of slider board
49	Slider to select a slowing factor to slow down the movement of the cursor for those of us with shaky hands	"
50	Slider to select digitizer tablet for drawing or non-drawing mode	"

Joystrcks

joystrck 1



joystrck 2

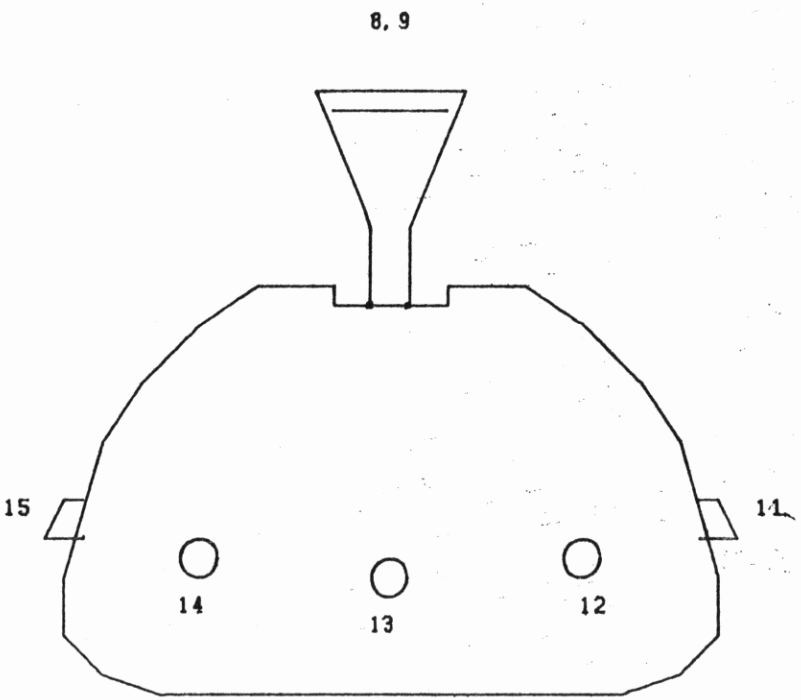
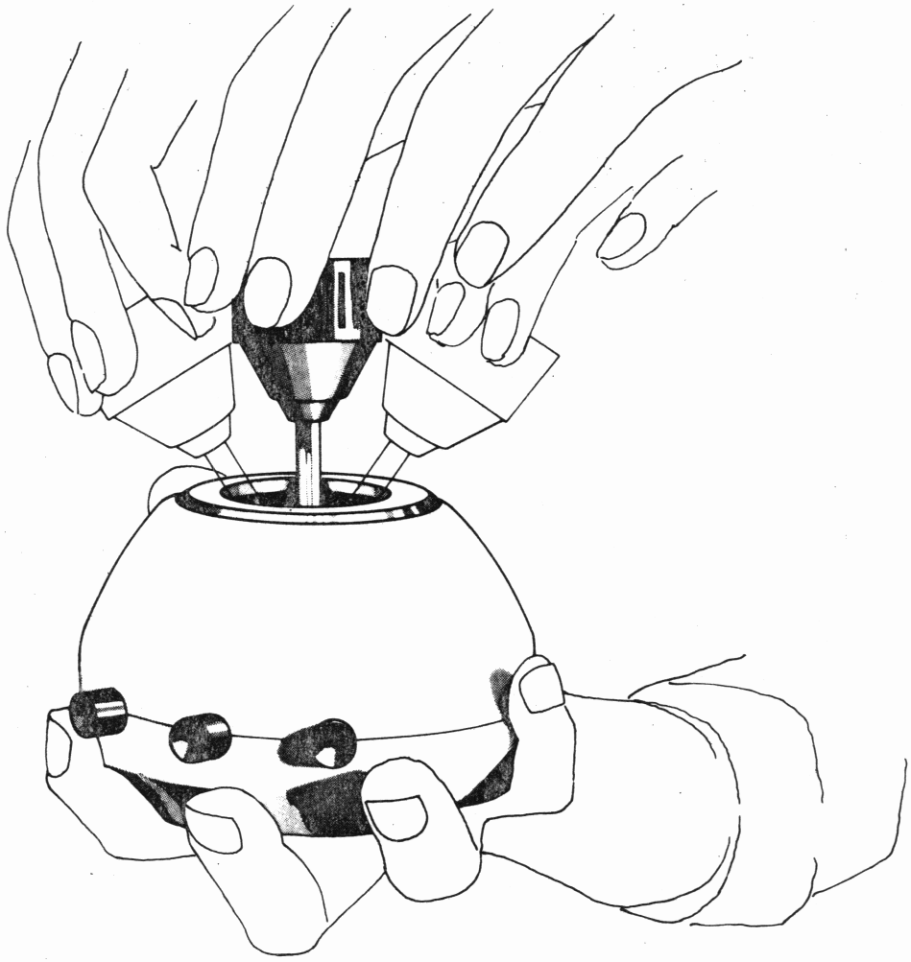


Figure 1

Figure 2



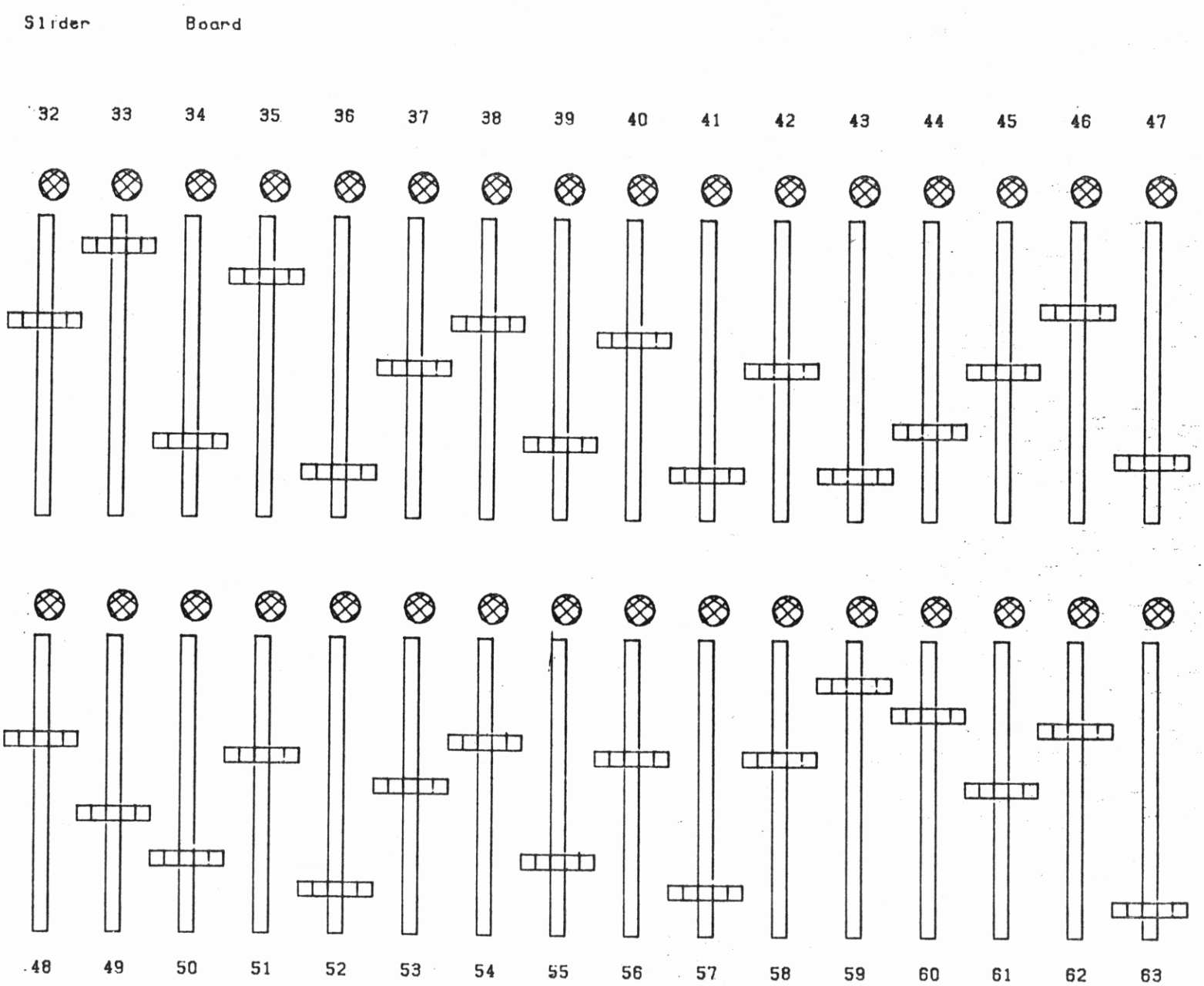

Slider
Board
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63

Figure 3