Dual Deflection Type CRT Display Equipment

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1. Introduction

Computer drived CRT displays are important means of man-machine communications, particularly for Command and Control Systems(CCS). In general, a display system for CCS is required to have a combined display function of figures and characters, and a rear-window type CRT[1][2] have been put to practical use by this time. However it could not been employed when the discrepancy in positionning may cause serious results or the background maps are required to move momentarily because of the difficulty of coordination and coincidence of the electron beam and optical systems on the CRT. We have developed the dual deflection type CRT display system compatible with an usual line generator or a digitally swept radar raw video display[3] and having a digital character generator applied multi-strokes method.[4][5] Since greater parts of complex strokes are displayed by the high speed static deflection system through this generator, load for I/O control program and CPU of a control computer should be reduced.

2. Outline of equipments

This display system may be divided into three major physical parts; a control computer(NEAC-3100), a CRT display unit, and a control and storage unit for digitally coded characters.(See Fig.1 and Fig.2).

By making use of a digital character generator, Japanese characters and graphic maps were displayed

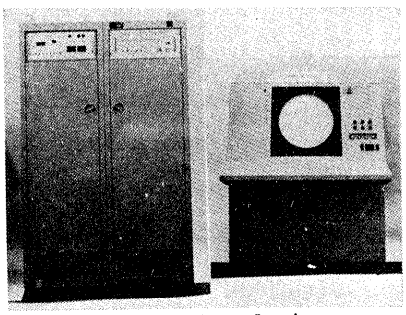

Fig.1 Display device used dual deflection type CRT.

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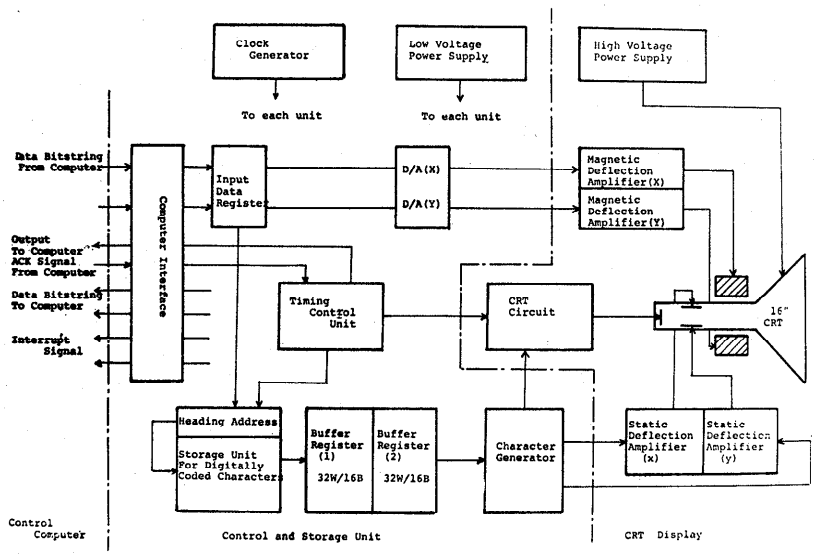


Fig. 2 Block diagram of tne dual deflection type CRT display

statically and dynamically with a simple display format. The following points were specially taken into care for this purpose.

1) Display elements are randomly positioned on a quantized XY field of 1023 by 1023 points using an electro-magnetic deflection system.

2) The characters or maps formed on a quantized xy field of 15 by 15 points are displayed by a high speed static deflection system. Where, one point length of xy coordinates equals to two points length of XY coordinates. Each origin of both coordinates are in the center, and two's compliment stands for a minus direction.

3) The display controller is coupled through DMA channel of the control computer whose main memory is partly shared by a display refresh memory.[6]

4) A high speed wire memory(8K words, 16 bits/word) is used as the storage unit for digitally coded characters. Contents of the memory are able to rewrite by a punched tape.

3. Hardware features

1) As shown in Fig.3(a), a display format consists of two words and ID bits are used to control transfer of the display words.

2) In order to increase a character display speed, an advanced control method is introduced to the buffer register BR-1 and BR-2 whose capacity is 32 words x 16 bits/word respectively(See Fig.2).

3) The characters storing in the storage unit are classified into four categories of 0 to 10, 11 to 14, 15 to 20, and 21~32 according to the number of strokes in a character. In order to save a transfer time, four data entries are provided for BR-1 and one of them is selected by identification bits for these categories.

4) As shown in Fig.2 and Fig.3 (b), (c), the storage unit for digitally coded characters is divided into two sections of a heading address storage section (location 0 to 1777) and a digitally coded character storage section (location 2000 to 17777), (i.e., an indirect addressing method is employed).

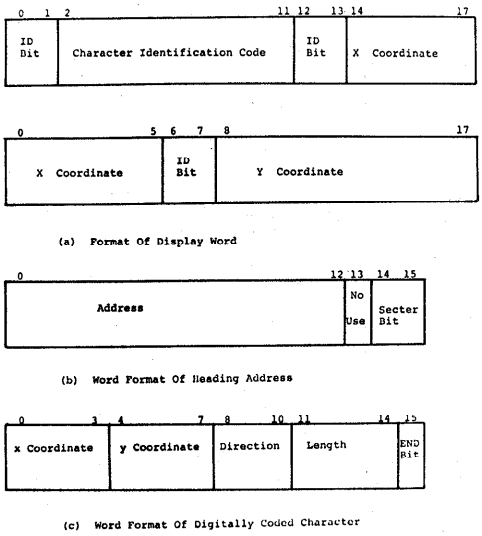


Fig. 3 Words formats

5) The standard flame refresh rate is 40 Hz and the flame time is automatically extended to the excess display time.

4. Software features

1) A static display program is consisted of a process and a display program, the former executes setting up of initial values and calculations required for display, the latter contains the refresh file.

2) A dynamic display has less complicated control program consisting of about 150 steps with the assembler and executes switching of the refresh files, processing for inturruptions, and updating.

5. Experimental results

5.1 Static display Fig.4 shows that Chinese character "英" of 500 are being displayed on the CRT screen. As shown in Fig.5, ability for combined display function of maps and characters was validated.

In Fig.5, the map is shown with short vectors of 251 and the characters displayed are 158. From Fig.6 we can see the following facts per one display flame time (25 m sec.); (a) the total display time for 158 characters is 9.4 m sec., (b) the display time for the map formed with 251 vectors is 12.4 m sec., and (c) the rest time for blanks is 3.2 msec.

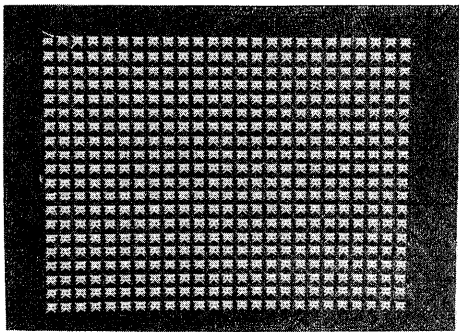


Fig.4 Example of static display

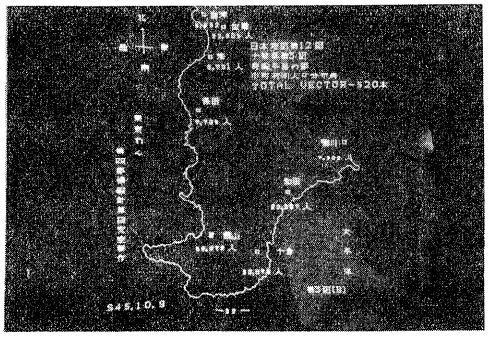
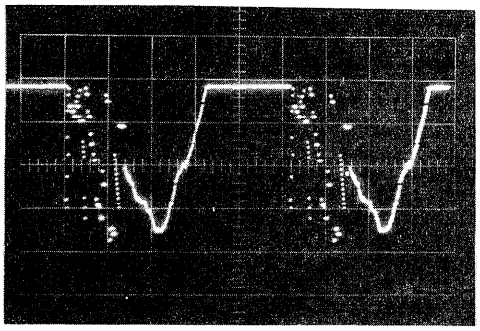
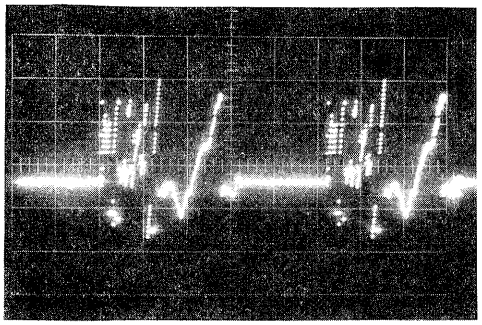


Fig.5 Example of combined display with map & characters



(a) X axis 5 msec/Div.



(b) Y axis 5 msec/Div.

Fig.6 Imput wave forms for the electro-magnetic deflection amplifiers for displaying the picture shown in Fig.5.

5.2 Dynamic display We have carried out experimental works for dynamic display functions, i.e., movement and rotation of displayed figures, and or movement of displayed characters and maps. One of the examples is shown in a consequtive photograph of Fig.7. Where a small □ symbol is being used as a dot.

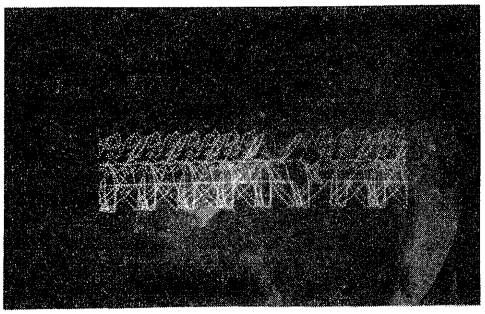


Fig.7 Example of dynamic display

6. Discussions

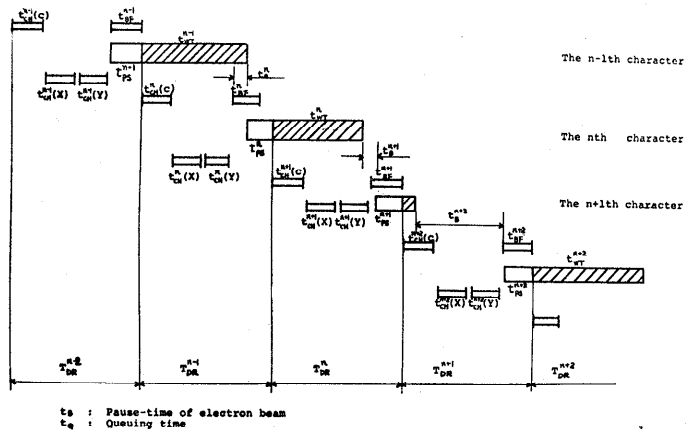


Fig.8 Time chart for display operation

An effective display time per one character and an availability rate of CRT electron beam per one character can be expressed in the following equations from the display time chart illustrated in Fig.8;

$$T_{DR}^{n} = \mathrm{Max}[\, T_1 , T_2 \,] , \quad T_1 = t_{CH}^{n+1} + t_{BF}^{n+1} , \quad T_2 = t_{WT}^{n} + t_{PS}^{n+1} \qquad \text{--- (1)}$$

$$Z^{n} = (t_{WT}^{n} / T_{DR}^{n}) \times 100 \quad (\%) \qquad \text{---------- (2)}$$

where, T_{DR}^{n} : The nth effective display time per one character.

t_{CH}^{n+1} : Transfer time of the (n+1)th display word(36 bits) from the computer.

t_{BF}^{n+1} : The decoded time of the (n+1)th character identification code and the storage time of an applicable, digitally coded character data in BR-1.

t_{WT}^{n} : The time that the total point length of the nth character is actually drawing. As a stroke is drawing at 2MHz, it requires 0.5 μ sec to draw one point length of the sub-deflection system(correspond to two points length of the main deflection system) and suspends for 0.5 μ sec between each stroke.

t_{PS}^{n+1} : The time required positionning of XY coordinates for the (n+1)th character. It is about 12 μ sec and is invariable at every point of the coordinates.

Z^n : Availability rate of CRT electron beam per one character. Fig.8 illustrates the state of a characters string is being sequencially transfered and displayed. An availability rate of CRT electron beam Z may be considered as a rate of unblanking(hatching portion in Fig.8) in an effective display time. Our experiment indicates that t_B becomes approximately zero for the characters when number of strokes excesses ten strokes. This means that the advanced control is working effectively. When the number of strokes in a character is less than nine strokes, t_B increases as the drawing time of the character decreases. From Fig.4 we can see that the display time of one hundred characters was about 5.2 m sec per one display flame, and an effective display time per one character is approximately 52 μ sec then the averaged display time per one stroke is 5.2 μ sec. The total number of strokes in the character "英" correspond to 68 points length giving t_{WT}^n of 39 μ sec, from Eq.(2) Z^n becomes 75 %. Since the effective display time per one vector of the map shown in Fig.5 is 49.5 μ sec, about five hundreds vectors might be displayed in one flame time of 25 m sec, the total displayable vectors can be increased up to 1500 by making use of a control computer which can transfer 36 bits per word at high speed since the transfer time can be decreased down to several μ sec.

7. Conclusion

We have attained the high speed display of Japanese characters, the combined display with maps and characters, and the dynamic display for these display elements. The equipment described above might be applied to a consol for CCS or a terminal equipment for MIS(Management Information Systems). Further detailed experimental studies are now going on and will be reported elsewhere.

References

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