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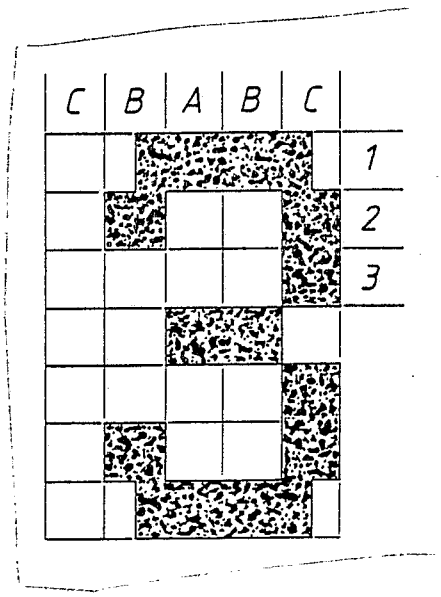

(57) Abstract

Character enhancement is achieved by a rounding technique in which the length of one or more of the dots in a character formed from a matrix of dots as defined is increased or not in accordance with its position relative to other dots in the character. The decision to extend is taken by reference to logical equations which take into consideration the position of a dot within a given character.

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IMPROVEMENTS IN OR RELATING TO CHARACTER ENHANCEMENT SYSTEMS

The present invention relates to character enhancement systems for characters in which the character shape is formed from a matrix of switchable elements. Such characters are often called dot matrix characters and will be referred to hereinafter.

Characters displayed on a visual display unit are formed from a matrix of dots and to render them more legible rounding schemes are employed. Such rounding schemes involve additional processing and storage of data to produce the added dots necessary to improve the legibility of each character. The storage of the basic bits necessary to display the character is increased, in known systems by the added bits required for rounding each character.

It is an object of the present invention to provide a character rounding system in which the storage requirements are considerably reduced over known rounding systems but still providing characters with enhanced legibility.

The present invention therefore provides a character display system in which characters are displayed as a matrix of dots including means for determining for each dot displayed whether or not that particular dot should be extended to produce a larger dot.

As defined above a dot for the purposes of the present invention may be an actual dot or any other switchable element.

In a preferred embodiment the extension of the dot is by half a dot width. The extension is preferably towards the edge of the character of which the dot forms a part.

Preferably the decision to extend a particular dot is made on the basis of a set of logical equations which interpret the presence or absence of dots adjacent to the particular dot and provide an instruction to extend the dot in a particular direction if the logical equations are satisfied.

The invention also provides a method of rounding a character for use with visual display systems in which each character comprises a matrix of dots as defined, in which for each particular dot to be displayed a logical decision is taken to extended the length of that particular dot dependent on the presence of the dots adjacent that particular dot.

The present invention also provides apparatus for use in character rounding for visual display or other systems in which each character comprises a matrix of dots as hereinbefore defined including logical decision means for deciding, in respect of a particular dot of a

character, to extend that dot, the logical decision means including means for determining the presence of the dots adjacent to the particular dot and means for deciding on the result of such determination whether the particular dot is to be extended.

Embodiments of the present invention will now be described, by way of example with reference to the accompanying drawings in which

Figure 1 shows a typical character with no enhancement,

Figure 2 shows the character of figure 1 with a known enhancement used in interlaced visual display systems,

Figure 3 shows the character of figure 1 with enhancement according to the method and apparatus of present invention,

Figure 4 shows a block schematic diagram of apparatus for implementing the character enhancement method on a master display system with five columns per character.

Figure 5 shows a comparison between a selection of basic 5 x 7 characters with no rounding enhancement and the same characters with rounding enhancement according to the present invention.

With reference now to Figure 1 it can be seen that

the character displayed is extremely crude and that in Figure 2 it can be enhanced by a known rounding technique. Such an enhancement however requires additional storage capacity in any system for each character.

With reference to figure 3 the character of figure 1 is enhanced in accordance with the present invention by rounding according to a set of logical equations or algorithms.

The invention allows a 50% reduction in storage requirements for character generation on a dot matrix, as expressed in dots per bit of stored information, by using a set of logical equations to determine whether or not, a given displayed dot should be extended towards the edge of the character by half a dot. The term dot matrix is defined for the purposes of the present invention as being any matrix of switchable elements eg. dots lines etc which by virtue of having different patterns of such elements ON or OFF describe typographical characters.

Character generators with enhancement (rounding), have as shown in Figure 2 predominantly been used in connection with Teletext and Viewdata display systems to date. However, the present invention, has applications in computer terminal displays, computer printer design, word processor systems and wherever typographical

information is stored and presented on a line-by-line basis.

The rounding scheme of Figure 2 which is widely used in Teletext, Viewdata and associated displays of figure 2 is applicable only to interlaced displays. The invention differs from this scheme in the following ways:

i) Three stored lines (rather than two) are processed to form one displayed line.

ii) The processing differs across the matrix.

iii) The form of the equations are different.

iv) The invention has applicability to both interlaced and non-interlaced displays.

A preferred alogrithm for character rounding is as follows:

If the character is composed of a matrix of five or more columns of dots, and three or more rows, then the function of the algorithm is demonstrated by considering any one row of dots in relation to the rows immediately above and below. Labelling the row under consideration at any given moment in time as "2", and the rows above and below as "1" and "3" respectively, and the outermost column of dots involved in the algorithm as "C", next column in as "B", and the innermost column or columns as "A", part of the character display can be represented as

shown:

C1 B1 A1 A1 B1 C1 or C1 B1 A1 B1 C1

C2 B2 A2 A2 B2 C2 or C2 B2 A2 B2 C2

C3 B3 A3 A3 B3 C3 or C3 B3 A3 B3 C3

The algorithms are:

i) "C" dots do not extend:

ii) "B2" dots extend outwards from the centre line of the character into the position of the "C2" dot according to the following logical equation:

$$B2 \text{ extension} = B2.((C1.\overline{B1}) (+) (C3.\overline{B3}))$$

i.e. B2 extends outwards if a) dot C1 is present and B1 is not; or

b) dot C3 is present and B3 is not;

but not if a) and b) are both true.

iii) "A2" dots extend outwards from the centre line of the character, into the position of the "B2" dot according to the following logical equation:

$$A2 \text{ extension}=A2.((B1.\overline{A1}) + (B3.\overline{A3})$$

i.e. A2 extends outwards if a) dot B1 is present and A1 is not; or

b) dot B3 is present and A3 is not.

If there is a single centre column of "A" dots, they extend out in both directions.

If there are more than six active columns in the character, inner "A" dots behave as described for "A2" dots, but the dots in the column immediately outside take the place of the "B" dots for the purposes of input to the logical equation.

When the top or bottom row is being considered, there is no data for the row above (or below). In this case the missing dots may be considered to be either all on or all off.

The mechanism for extending the displayed dots by half a dot, will depend on the display system to which the algorithm is being applied.

The invention can be applied in either a horizontal or a vertical sense to the character matrix as viewed, as appropriate to the mechanism for displaying the characters.

A schematic block diagram for the implementation of the above algorithm for a character having five columns as in figure 3 is shown in figure 4.

The effect of the rounding method on a set of typical characters is shown by comparison in figure 5 in which the upper set of characters are not rounded and the lower set are rounded according to the present invention to enhance their legibility on a visual display or in printed form.

CLAIMS

1. A character display system in which characters are displayed as a matrix of dots as hereinbefore defined including means for determining for each dot displayed whether or not that particular dot should be extended to produce a larger dot.

2. A character display system as claimed in claim 1 in which the extension of a dot is by half a dot width.

3. A character display system as claimed in claim 1 or claim 2 in which the extension of a dot is in a direction towards the edge of the character of which the dot forms a part.

4. A character display system as claimed in any one of claims 1 to 3 in which the decision to extend a particular dot is made on the basis of a set of logical equations which interpret the presence or absence of dots adjacent to the particular dot and provide an instruction to extend the dot in a particular direction if the equations are satisfied.

5. A method of rounding a character for use with visual display or other systems in which each character comprises a matrix of dots as hereinbefore defined in which for each particular dot to be displayed a logical decision is taken to extend the length of that particular dot dependant on the presence of dots adjacent to that particular dot.

6. Apparatus for use in character rounding for visual display or other systems in which each character comprises a matrix of dots as hereinbefore defined including logical decision means for deciding in respect of a particular dot of the character to extend that particular dot, the logical decision means including means for determining the presence of dots adjacent to the particular dot and including means for deciding on the result of such determination whether the particular dot is to be extended.

1/2

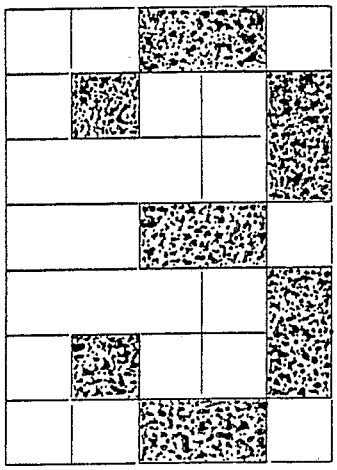

FIG.1.

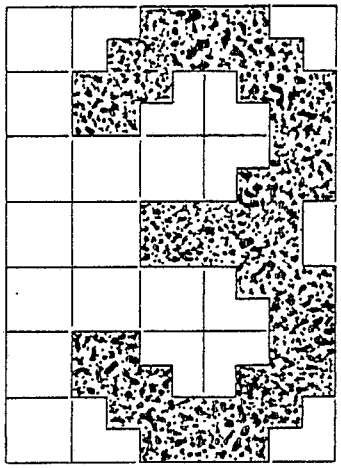

FIG.2.

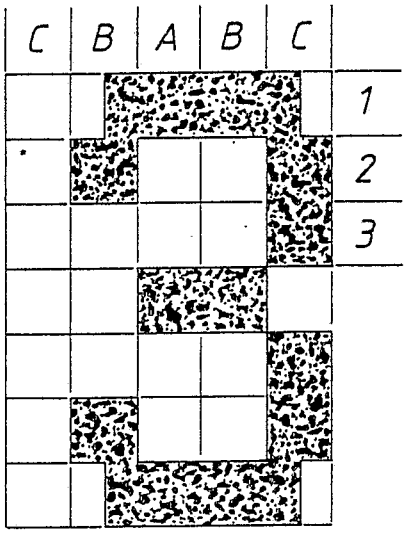

FIG.3.

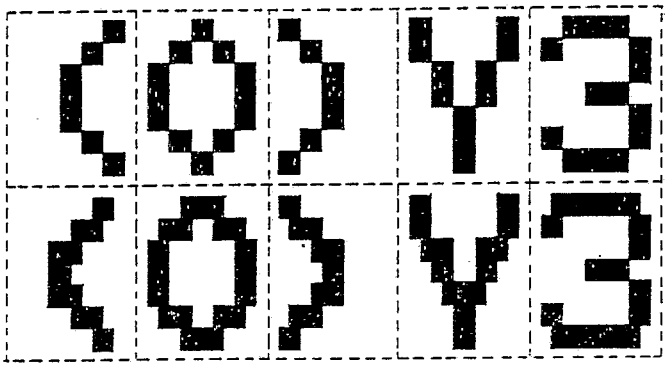

FIG.5.

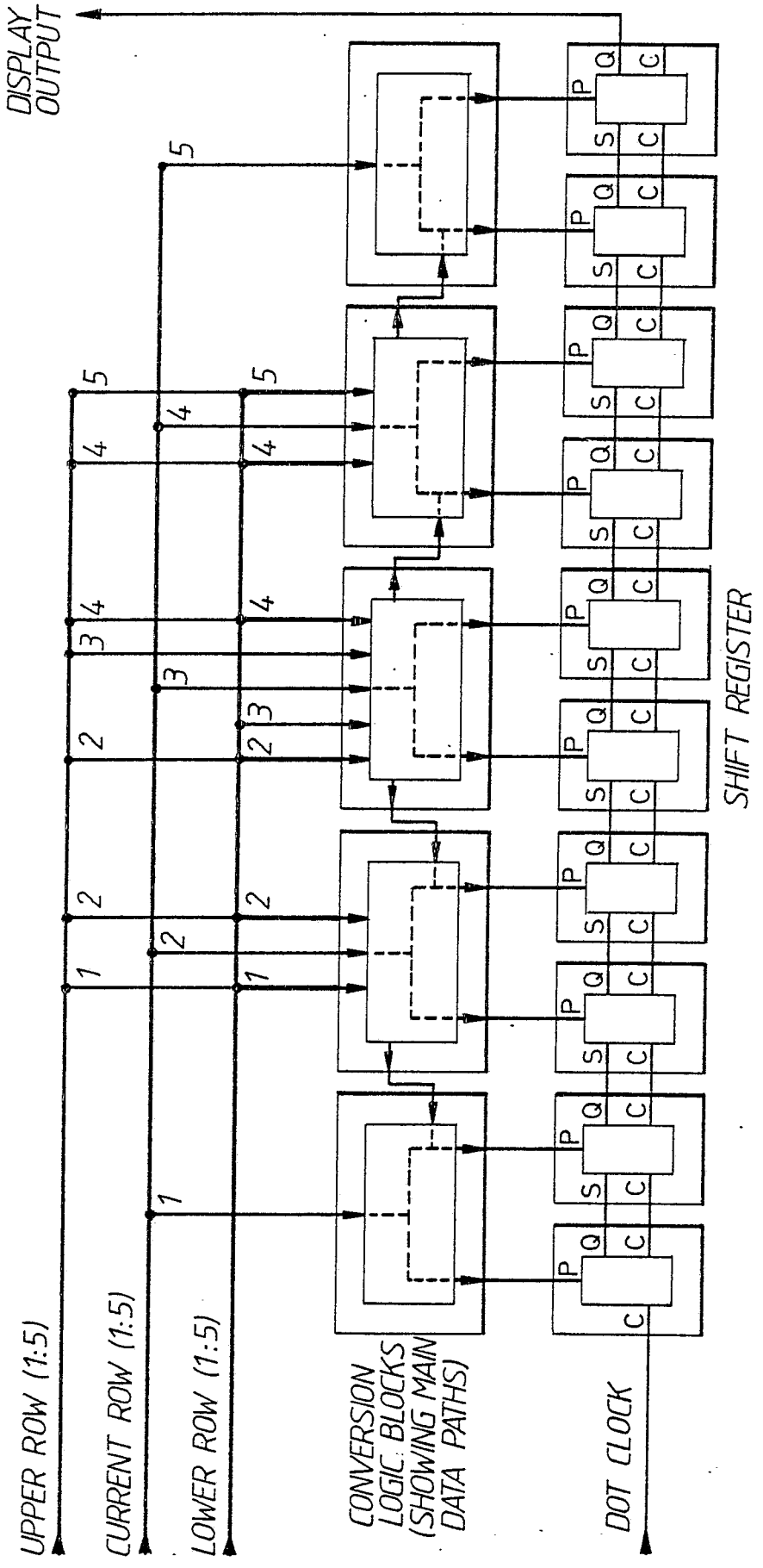
DISPLAY OUTPUT
SHIFT REGISTER
UPPER ROW (1:5)
CURRENT ROW (1:5)
LOWER ROW (1:5)
CONVERSION LOGIC BLOCKS (SHOWING MAIN DATA PATHS)
DOT CLOCK
P
Q
S
C

FIG.4.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00020

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: G 09 G 1/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	G 09 G 1/14

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	GB, A, 2055027 (TEXAS INSTRUMENTS) 18 February 1981 see figures 1-5; page 1, lines 56-111; page 2, line 33 - page 3, line 92 --	1,2,4-6
X	US, A, 3878536 (J.E. GILLIAM) 15 April 1975 see figures 1-4; abstract; column 1, line 67 - column 3, line 45	1,2,4-6

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14th April 1988	27 MAY 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8800020 SA 20241

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 02/05/88
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2055027	18-02-81	US-A- 4345243	17-08-82
US-A- 3878536	15-04-75	NL-A- 7210263	01-02-73
		FR-A- 2149133	23-03-73
		DE-A,B,C 2233757	08-02-73
		GB-A- 1343298	10-01-74
		CA-A- 954611	10-09-74
		AU-A- 4498672	31-01-74
		AT-B- 326194	25-11-75
		AU-B- 463796	07-08-75