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(54) TRANSMISSION OF ALPHANUMERIC DATA BY TELEVISION

(71) We, BRITISH BROADCASTING CORPORATION, a British body corporate of Broadcasting House, London, W1A 1AA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to television systems and receivers and concerns systems which enable alphanumeric information, such as captions and pages of information to be transmitted simultaneously with a video signal while allowing the picture represented by the videol signal to be displayed with or without the alphanumeric information.

It is well known to superimpose captions such as sub-titles on a picture by including the information relating thereto in the video signal itself. The caption is then unavoidably displayed with the picture. There are however situations in which it is desirable to have caption information available for display only if so desired.

For example, this possibility would enable deaf viewers (of which there are many) to have added to their pictures sub-titles which would not appear on the screens of non-deaf viewers. Furthermore information totally unrelated to the pitcures could be transmitted with the video signal for reception only by selected viewers who could display such information with or without the picture or store the information for later display. Such information could be stock exchange reports for example. Another possibility is to superimpose information relating to the source, the routing and destination of a video signal for display only on monitor screens viewed by producers, programme controllers and such personnel, or for effecting automatic executive action relating to the signal routing and monitoring. This would greatly facilitate the work of such persons in controlling the switching of cameras, etc., especially in complex outside broadcast situations.

Various proposals have been made for adding information to a television signal. In some, extra video waveforms are placed on lines in the television vertical interval. It has also been proposed to use these lines to carry digital codes. The object of the present invention is to provide an improved system which combines the advantages of using digital codes with the ability to effect display operating with a conventional television raster. The use of digital codes leads to great flexibility; all of the possibilities envisaged above are readily catered for and the embodiments described below will demonstrate how the system can handle either the simple addition of single line sub-titles to pictures or the transmission of individually selectable complete pages of information.

According to the present invention in one aspect, there is provided a television system comprising a source of a video signal, means operative synchronously with the video signal to superimpose or otherwise add thereto, without interfering with the picture signal included therein, a digitally coded data signal representing alphanumeric information, and a receiver adapted to receive the video signal and display a corresponding picture, the receiver including a first circuit adapted to extract the digitally coded data signal from the received video signal, means for storing the digitally coded signal, and a decoding circuit operative synchronously with the line time base of the receiver to convert the stored digitally coded data signal into a corresponding repetitive vision signal representing the alphanumeric information.

According to the invention in another aspect, there is provided a television receiver for use in a television system wherein a digitally coded data signal representing alphanumeric information is superimposed on or otherwise added to a video signal in synchronous relation thereto, without interfering with the picture signal included therein, the receiver being adapted to receive the video signal and display a corresponding picture, and including a first circuit adapted to extract the digitally coded signal from the received video signal, means for storing the digitally coded signal, and a decoding circuit operative synchronously with the line time base of the receiver to convert the stored digitally coded data signal into a corresponding repetitive vision signal representing the alphanumeric information.

It will be understood that the receiver may be a broadcast receiver, a closed circuit receiver, or other form of visual readout means separate from the television display. The receiver need not have its scanning time bases locked to the incoming signal; they may be controlled by a local source. The decoding circuit is in any event synchronised with the line time base at the receiver.

The alphanumeric vision signal and the main vision signal carried by the video signal may be combined in various known ways to produce different types of display of the alphanumeric information, e.g. simple superimpositions, white symbols in a black strip or box, black symbols in a white strip or box, black edged white symbols or white edged black symbols. Markers may be included in the transmitted signal to create a strip or box in the receiver. For simplicity, however, the vision signal preferably switches between black level, representing the ground for the symbols, and a whiter than white level representing the symbols themselves. The signal can then simply be added to the main vision signal to produce very bright symbols which will contrast adequately with the picture. A coded control signal can be made to switch a colour synthesiser at the receiver for controlling the hue of the displayed symbols.

The storing means for the transmitted alphanumeric information may be provided at the receiving terminal on a large scale, for example 25,000 characters equivalent to say 32 printed pages, by magnetic or other means, to provide data on a wide range of subjects each of which can be independently selected by individual viewers provided with suitable equipment additional to or built into the domestic television receiver. By this means the general utility of the television service may be expanded and specialised interests catered for.

The digitally coded data signal which provides for updating the multiple page store may be organised in various different ways, of which examples are given below.

If the information transmission rate is made sufficiently high, access to several pages of information may be provided very economically using only a store for the one page under scrutiny at the receiver, a small delay before reading a newly selected page while this is being read into the store then being accepted; the higher the information rate the smaller the delay will be.

The alphanumeric vision signal as derived from the digital code may be displayed alone, a switch on the receiver being provided for cutting out the main vision signal carried by the video signal. Alternatively, the two vision signals may be combined in various known ways to produce different types of display of the alphanumeric information, e.g. simple superimpositions, white symbols in a black strip or box, black symbols in a white strip or box, black edged white symbols or white edged black symbols. Markers may be included in the transmitted signal to assist the creation of this box or strip within the receiver. A coded control signal can be made to switch a colour synthesiser at the receiver for varying the hue of the displayed symbols.

The video signal, including the data signal, can be recored to enable later use of the signal or at least the data signal portion. The data signal alone can be recorded by a low bandwidth device, such as a magnetic tape recorder, for later utilisation. Thus, the recorded data signal can be fed, when required, into the storing means of the receiver. The receiver can alternatively include storage for storing the vision signal, in the form of bits representing dot matrix characters, enabling the data to be utilised at a later time.

The coded data signal may be added to the transmitted signal in various ways without interfering with the picture signal included therein. For example, the data signal may be modulated upon the sub-carrier in the sound channel or upon a separate sub-carrier in the neighbourhood of the sound carrier frequency. Thus, if sound is carried (in U.K. standards) on a 6 MHz sub-carrier, the data signal can be carried on a 6.3 MHz sub-carrier. If the data rate is kept low, the required bandwidth is small enough for there to be no problem with interference. The data signal may be superimposed on the horizontal intervals of a plurality of lines of the video signal.

Alternatively, and preferably, the coded data signal can be added as pulses to one or more lines of the video signal which carry no ordinary picture information, i.e., the lines provided during the vertical interval to allow the field time base to stabilize before the first picture line of the new field. For some applications this information could be carried by a number of lines, if necessary, occupying the entire picture period. Furthermore, this signal could be recorded at video for later utilization.

An embodiment of the invention utilizing this mode of transmitting the data signal will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a block diagram of the transmitting terminal,

Figures 2 and 3 show block diagrams of corresponding receiving terminals,

Figure 4 is a block diagram of a second transmitting terminal, and,

Figure 5 is a block diagram of a receiving terminal for use therewith.

The illustrated embodiment is intended to provide 32 pages of data with 768 characters per page, arranged in 24 32-character rows, pages being selectable at will by the viewer whose receiver is appropriately equipped. The data can be fed into the system from a number of asynchronous sources 51 (Fig. 1) which may be geographically separate. The data is then ordered and stored, by computer techniques which are well known, under the control of an executive program in a data ordering and storage unit 52.

Unit 52 receives timing signals which permit it to put out synchronous data to be added to the video signal during the television vertical interval (field blanking interval) as NRZ pulses on two of the unused lines which precede the picture information, in a manner similar to that described below with reference to Fig. 4. The said two lines can be lines 13 and 14 of even fields and lines 326 and 327 of odd fields in a 625 line system.

Assuming that the alphanumeric characters are represented by an 8-bit data code, there may be capacity for 32 characters in the said two lines of a single field. Various data organisations may be considered by way of example, the bits of a character being sequential in both cases. The first organisation will be called page-interlaced, each page having 768 characters in 24 rows of 32 characters, and has the first character of pages 1 to 32 in the first field, the second character of pages 1 to 32 in the second field, and so on. Each page thus has an invariant position in the time cycle of a field and a complete data cycle requires 768 fields, i.e. 15.4 sec. at 50 fields per second. Field 1 of the cycle (or the preceding field 0) has a special framing character inserted therein, whose purpose is explained below.

The second organisation is page-sequential; the 768 characters of the first page are transmitted in the first 24 fields, again preceded by a framing character, the characters of the next page are transmitted in the next 24 fields, and so on.

A third and preferred organisation is similar to the first but the page-interlacing is by row rather than by character. Fields 1 to 32 contain row 1 of pages to 32 respectively, fields 33 to 64 contain row 2 of pages 1 to 32 respectively, and so on.

Given any such fixed data organisation, the data can be de-multiplexed purely by timing operations synchronized relative to the framing character. However, it may be preferred to add to the character codes address codes which identify, to take the example of the third organisation, the page and row being transmitted in any given field. If such address codes are employed demultiplexing no longer relies upon timing operations and the framing character is not essential. Furthermore, flexibility of data organisation becomes permissible and the system can be adaptive, unused pages or unused lines in a page being omitted from the data format, thereby shortening the time taken for a complete data cycle. Thus, fields pertaining to absent digitally coded data signals and/or to absent rows of characters can be omitted from the data cycle.

Fig. 2 illustrates a receiving terminal in which the binary data is first separated by a circuit 53 which times the data pulses out of the said two lines, for example in the manner described in relation to Fig. 5. These pulses are used to update a multiple page store 54. This store holds approximately 200,000 bits on a magnetic disc, representing the total of the data available to the viewer at any time, the actual number of bits required being $23 \times 768 \times 8$. The page selector 55 under manual control applies data from the required page to a read only memory dot matrix character generator 56. The character generator uses timing signals to address the R.O.M. and produces an output signal of alphanumeric information based on a 7×5 dot matrix in vision signal form to provide the input to the display, again as described in more detail below, (although other matrix formats could be used).

The disc store 54 can have 32 concentric tracks, one per page and a single read-write transducers. Only the page being displayed can therefore be updated. If the first page-interlaced organisation is employed, the page selector 55 performs two functions; it moves the transducer to the selected track and shifts a timing gate (8-bits wide) at the input to the store into coincidence with the time position in the frame which corresponds to that page. In order to enter the characters into the correct positions on the track, the system waits until the framing character appears. The next character passing through the timing gate is then written into the first character position of the selected track, and so on, one character per field. The rotation of the disc is kept synchronous with the appearances of the framing character.

If the page-sequential organisation is employed the disc is again synchronized to the framing character, so that each revolution corresponds exactly to a group of 24 fields representing one page. The page selector again selects the correct track by positioning the transducer in alignment therewith and sets a field counter to 24(N−1) where N is the selected page number. When the framing character appears, the counter is counted down by 1 for each field and, when it reaches 0, the characters appearing in the next 24 frames are written into the store.

If the third organisation is employed the page selector moves the transducer to the selected track and sets a mod-32 field counter to one less than the page number N. The counter is counted down cyclically by 1 for each field and, each time it reaches 0, the row of 32 characters in the corresponding field is written into the store.

Fig. 3 illustrates an embodiment of the receiving terminal in which page selection is accomplished before storage; in this embodiment a single page store 59 of 6,144 bits only is required and this is most economically achived in integrated circuit technology. The page selector 58 simply selects the timing gate position for reading into the store if the page-interlaced organisation is used or sets the field counter as just described if either of the other organisations is used.

Details of the timing and logic circuits have not been given since they employ conventional techniques of data processing equipment, e.g. as in the second embodiment. Obviously there are almost limitless possibilities for detailed design. Other data organisations may be used and, in order to keep the number of bits added to any one line to an acceptable value it may be desirable in the embodiments described to expand the time scale by a factor of two and use four lines for 32 characters and carry only 16 characters per field. Instead of using serial stores as described, addressed random access stores may be employed, in which case each character or row of characters has added thereto address code bits defining the page and/or the position within the page thereof, depending on the data organisation employed.

In this case the page selector sets up the required page code and the timing signals set up a sequence of character or row address codes. The incoming address codes are compared with the set-up codes and, as matches occur, the associated character codes are entered into storage.

In the preferred arrangement, utilizing the aforesaid third organisation, the said two lines in the vertical intervals are used as follows. The first part of the first line includes a fairly long address code specifying the page and row being transmitted plus several bits which serve to establish the timing of the data extraction in the receiver, to provide for parity checks and possibly to provide other redundant, error checking facilities. The remainder of the first line and the whole of the second line are used for the 32 8-bit codes representing the characters of a row.

The embodiment illustrated in Figs. 4 and 5 utilises the aforesaid first organisation and is intended to display a line of 32 characters, e.g. for sub-titling pictures only for deaf viewers whose receivers are appropriately equipped. The data can be fed into the system using a paper tap reader (as in the illustrated embodiment), magnetic tape, or a manual keyboard with buffer store and editing facilities. Each line of characters is punched in a standard ISO-7 code on 8-hole paper tape, preceded by STX (start of text) and followed by ETX (end of text). The eighth, parity bit is ignored in this description and in fact it is assumed that only 6 bits are employed, this being all that is necessary for upper case symbols only. However, 7 bit working can clearly be employed to give full upper and lower case capability.

The tape is read by a tape reader 10 (Fig. 4), one character per field, during the 13th line of each even field, (the 326th line of each odd field) this line preceding the vision-carrying lines of the video signal. To this end a line sync pulse counter-decoder 11 counts sync pulses provided on an input 12 and produces on an output pulse marking the 13th line, being of approximately line period duration. The counter-decoder 11 opens an AND gate 13 during the 13th line and allows the sync pulse also applied to the AND gate 13 but delayed very slightly by a delay circuit 14, to pass to an AND gate 15. This gate is opened when it is desired to change the line of characters by setting a bistable flip-flop 16. This is effected by a pulse on an input 17 which may be provided from a push button or by a cueing signal from a video recorder, for example. The flip-flop is reset when a detector 18 detects the ETX character.

In this way, each time the flip-flop 16 is set, the next block of up to 32 characters, preceded by STX and followed by ETX, is pulsed out of the tape reader in bit-parallel format, one character per field.

The characters enter a register 19 which is a 6-bit shift register with parallel entry. The characters are immediately shifted out of register in bit-serial format, and through an AND gate 20 opened by the counter-decoder 11, to an output line 21. The pulses are fed to the video circuits of the transmitter (not shown) to be superimposed on the vision signal portion of the 13th line. To ensure that the six bits appear at accurately defined portions in the line, a bit clock source 22 running at a higher frequency than line frequency feeds a bit counter 23. Selected states of the counter are decoded by a decoder 24 so as to generate, in each line, six accurately positioned bit marker pulses. These are used as the shift pulses which shift the bits serially out of the register 19.

To ensure accurate maintenance of the bit marker pulse positions, the counter 23 is reset at the beginning of each line by the sync pulse passed by the gate 13.

At the receiving end (Fig. 5), the characters are extracted from the viedo signal on a line 30 by applying six bit marker pulses to a six bit shift register 31 with parallel output. These marker pulses are generated by a bit clock 32, counter 33 and decoder 34, corresponding to items 22, 23 and 24 in Figure 4. To ensure that the marker pulses are only presented to the register 31 during line 13 a line counter 35 and line decoder 36 open an AND gate 37 during the 13th line only.

The characters have to be transferred, one per field, into the correct poistions in six 32-bit shift registers 38 (of which only two are shown) which constitute recirculating stores holding 32 characters in bit-parallel, character serial format. The registers are recirculated synchronously with the line period, via normally open AND gates 39, by pulses from a divider 40 which divides down the bit clock to provide 32 pulses each line period.

When characters are being received they are timed into the correct positions in the registers 38 during the 14th line by pulses provided by a comparator 41. These pusles pass through an AND gate 42 which is enabled only during the 14th line by the decoder 36 and only when a bistable flip-flop 43 is set. The flip-flop is set when a circuit 44 detects STX and reset when this circuit detects ETX. The detection of STX also causes a field counter 45 to be reset. This counter now counts 1, 2, 3, etc. in successive fields and provides one input to the comparator 41. The other input is provided by the bit counter 33 and the comparator 41 produces an output pulse each time that the bit counter counts up to the number in the field counter 45. The comparator output pulses therefore appear at progressively later positions in the line in successive fields, these positions being timed to coincide with the times at which the successive characters respectively are re-entered in the registers 38.

The pulses from the comparator 41 passed by the gate 42 enable AND gates 46 connected between the parallel outputs of the register 31 and the inputs to the registers 38. Simultaneously, the recirculation gates 39 are closed via an inverter 47. By this means, the 32 characters in the registers 38 are replaced by the incoming characters at the rate of one per field.

Each character appearing at the output of the registers 38 is converted into a video waveform over say 8 adjacent line scans near the bottom of the picture, assuming that the displayed characters occupy a matrix of picture elements 7 lines high and 5 elements wide in a character space of 8 lines high and 6 elements wide. This conversion is performed by apparatus which is known in itself and is therefore only briefly described.

The six bits from the register 38 are presented to one set of inputs of a ROM (read only memory) 48 which has other inputs from the line counter 35. The ROM is essentially a complex decoder which converts each character into six bits in each of eight adjacent lines. The "1" bits represent the elements of the 7×5 matrix which make the character in question. Each set of five bits is buffered in a 5-bit shift register 49 with parallel entry and serial readout. The bits are pulsed out by a clock 49A to provide a two-level video signal on line 50. This signal is available to be recorded, to be displayed by itself or to be added to the incoming video signal for display of the characters on the picture.

The aforesaid eight adjacent lines are actually four from each of two interlaced fields. This complication is readily taken care of by programming the ROM 48 to decode on the correct line numbers. Character height can be conveniently increased in multiples of eight lines.

With the arrangement described the displayed characters can be seen to change one by one (during 32 consecutive fields) when a fresh line of characters is transmitted from the punched tape. If this is considered objectionable it may be arranged to blank the signal on line 50 while the flip-flop 43 is set.

The bit formats employed can be changed in various ways. For example, although the described format may be preserved in the registers 38, the arrangements of Figure 4 and that part of Figure 5 preceding these registers may be altered in such a way that, in each of six consecutive fields, the 32 bits for one register 38 are transmitted in series. It will then be essential to blank the output on line 50 during such transmission.

WHAT WE CLAIM IS:—

1. A television system comprising a source of a video signal, means operative synchronously with the video signal to superimpose or otherwise add thereto, without interfering with the picture signal included therein, a digitally coded data signal representing

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