

Description

This invention relates to a television apparatus comprising means for de-compacting compacted text characters recovered from the memory.

It is generally desirable to minimize the amount of memory storage capacity required to store a given number of characters representing text. This is particularly important in applications using so-called "one chip" microcomputers in which a microprocessor and its associated memories and input-output devices are integrated to form a self-contained computer on a chip. Since memory storage space is limited in one-chip micro-computers, the storage efficiency is of greater importance than in microprocessor systems employing external memories which are easily expandable.

The efficiency of storage of text characters is a function of the number of unique characters to be stored, the code used to represent the characters and the memory organization. As an example, assume that text is encoded using the standard 7-bit ASCII (American Standard Code for Information Interchange) code format. This format is commonly used by input/output (I/O) devices such as keyboards, television display character generators, printers and the like. This 7-bit code (8-bits with parity or a control bit) can uniquely represent 128 individual characters. As used herein, "character" includes letters, punctuation, numbers, symbols, control codes and the like associated with textual material. If a memory is organized to provide 8-bits (one byte) of storage per address location and text is stored in the ASCII (7-bit) format, then the efficiency would be only 50%. This results because an 8-bit byte can uniquely represent 256 possible states whereas only 128 states are used in the 7-bit ASCII code format.

Code formats requiring fewer than 7-bits to represent text are known. For example, in the 5-bit Baudot code used in some teleprinter transmission systems characters are divided into two sets and sequentially transmitted "shift" characters are used to select the appropriate set for printing. The principle is much the same as that provided by the shift keys of an ordinary typewriter for reducing the number of keys required. Specifically, a transmission of letters is preceded by the letters shift code 11111 (binary) and a transmission of figures is preceded by a figures shift code 11011 (binary). The shift codes are stored in a printer for selecting letters or figures for printing.

The 5-bit Baudot code has the capability of transmitting 60 unique characters. This results because 5-bits define 32 unique states. Two codes are "dedicated", so to speak, to the shift up (LETTERS, 11111 in binary) and shift down (FIGURES, 11011 in binary) codes. This leaves 30

states (32-2) remaining to represent text for letters and (because of the shift) another 30 states to represent figures for a total of 60 characters.

Although only 5-bits are required to transmit 60 characters, the Baudot code is even less efficient than ASCII when stored in an 8-bit organized memory since three bits per byte are unused. The efficiency is at best only about 23% since only 60 of 256 possible states are used and the efficiency decreases with the number of shift codes that are included in the text.

In "Computer Design", V1.12, No. 4 April 1973, p.89, there is disclosed a method of computing for storage a generated sequence of characters in which some characters are from a first 5-bit character set and other characters are from a second 5-bit character set. The 5-bit characters are stored three to a word, with the 16th bit specifying which of the two sets is represented. Such method is intended for a multipurpose computer wherein data is stored in random access memory positions and is constantly being deleted and new data inserted. However, such method is not optimum for fixed storage of characters, as may be required for example in television receiver apparatus.

The present invention is directed to meeting the need for improving the efficiency of storage of text characters in memories organized in such a manner that the number of bits per character is different from the number of bits per byte of a memory storage location.

The present invention provides television receiver apparatus including means for generating and displaying characters, such means including a memory wherein each memory address location has a size which is an integral multiple of the size of selected characters for storing two of said characters, each character being taken from one or the other of two four-bit character sets or a unique four-bit shift indicating character; and means for decompacting the four-bit characters comprising means for reading said memory to provide a sequence of said characters with said unique shift indicating character separating characters from different sets; and means responsive to said shift indicating character for decoding all characters of one set in accordance with a first code table and decoding all characters of the other set in accordance with a second code table to provide a sequence of decoded output characters to character display means.

In the accompanying drawings:

FIGURE 1 is a block diagram of a television receiver including character decompacting apparatus embodying the invention.

FIGURE 2 is a table illustrating a character code used in the decompacting apparatus of FIGURE 1;

FIGURE 3 is a table illustrating compaction of a specific message displayed by the receiver of FIGURE 1;

FIGURES 4, 5 and 6 are flow charts illustrating operation of the decompaction apparatus in the receiver of FIGURE 1;

FIGURE 7 is a block diagram of a system for compacting ASCII text in a ROM in accordance with the invention;

FIGURE 8 is a flow chart illustrating operation of the system of FIGURE 7; and

FIGURES 9-13 are illustrative program listings of on-screen display messages to be stored in compacted form in a ROM memory of the receiver of FIGURE 1.

FIGURE 1 illustrates the principles of character compaction and decompaction in accordance with the invention as applied to a television receiver. The receiver (10) includes a tuner/demodulator unit 12 having an antenna input 14 for receiving television signal modulated on a radio frequency (RF) carrier and outputs supplying demodulated picture (S1) and sound (S2) signals to respective video (16) and audio (18) processing units. Unit 18 provides various sound processing functions (e.g., mono/stereo selection, tone control, muting, etc.) and provides processed sound signals (S3) to a stereo speaker unit 20. Video processing unit 16 provides various picture processing functions (e.g., saturation and hue control, contrast control, peaking, etc.) and supplies a processed video signal (S4) to a display unit 22.

Control signals (S5) for tuner 12, video processing unit 16 and audio processing unit 18 are provided by means of a micro-computer 30 coupled thereto via bus 32. As an aid to operation of the receiver, micro-computer 30 supplies various messages in ASCII code format (signals S6) via bus 34 to a character generator 36 which converts the ASCII coded messages to a raster scan format signal (S7) suitable for display on display unit 22. Character insertion unit 38 combines the output of generator 36 (S6) and the processed video signal of unit 16 (S4) to provide a display signal (S8) in which text characters (as hereinbefore defined) are overlayed with picture signals so as to inform the user of current receiver operating functions and to prompt the user in setting up (selecting) new receiver operating functions.

Micro-computer 30 is a self contained "computer on a chip" and includes a processor 40 coupled via data and address buses to internal read-only (ROM) and random access (RAM) memories 42 and 44, respectively. Processor 40 provides conventional functions of arithmetic and logic (ALU) processing, input and output (I/O) processing, pointer control and so forth. A micro-computer suitable for use as unit 30 in the type

6305YO manufactured, for example, by Hatachi. This part has internal ROM and RAM capacities of 8K and 256 bytes, respectively, organized on an 8-bit per byte basis with von Neumann architecture.

Overall control of receiver 10 is provided by a user operated remote control unit 50 which is coupled to an input port of processor 40 in micro computer 30 via a remote control receiver unit 52.

In operation, when a user presses one or more keys on remote control unit 50, processor 40 fetches an appropriate instruction from ROM 42 and sends signals via bus 32 to the tuner, video and/or audio processing units to implement the desired instruction. Concurrently, processor 40 also selects messages in compacted form from ROM 42, translates the messages to ASCII and sends the ASCII coded messages to character generator 36 for display on unit 22 as a prompt or confirmation to the user of the remote control.

FIGURES 9-13 illustrate both the need for character compacting in ROM 42 and certain aspects of the solution according to the invention. As shown, there are a total of 84 message "strings" (numbered OSD0 to OSD83, OSD stands for "on screen display"). Some messages may be shown singly (e.g., "enter channel number") more complex messages may be formed by combining shorter messages. FIGURE 9 lists general control messages (sharpness, color, tint, etc.). FIGURE 10 lists messages specific to time setting functions. FIGURE 11 lists picture reset messages (push to store, etc.). FIGURE 12 lists toggle function messages (e.g., on-off, mono-stereo, etc.). FIGURE 13 lists messages specific to parental control displays. In all, the 84 messages stored in ROM 42 total 827 characters.

The 827 characters of FIGS. 9-13, if stored in ROM 42 using ASCII coding, would require 827 memory locations. This amounts to about 10% of the total ROM memory space which is a substantial portion of the memory considering that the ROM 42 must also store instructions for executing the large number of functions indicated by the messages. The messages are stored in compacted form in ROM 42 so as to provide maximum memory space for instruction storage.

In this specific example of the invention the 827 message characters stored in ROM 42 are compacted to 612 memory locations (bytes). This provides a saving of over 200 bytes of ROM or a compaction to 75% of the message memory space which otherwise would be required using ASCII coding.

Considering now the details of text data compaction in accordance with the invention, it is seen in FIGS. 9-13 that all of the text "strings" can be formed using only 30 different characters. These 30 characters (which can be seen to exclude the

letters J, Q, X and Z) are divided into two sets of 15 characters each and stored as 4-bit codes in ROM 42. A single shift character (0000 in binary) is inserted between characters of different sets to facilitate set selection during de-compaction.

FIGURE 2 provides a listing of the code assignments for the 30 text characters and the single shift character (0000) in both binary and hexadecimal notation. As shown, each character, including the shift character (0000), comprises 4-bits. Thus, two characters of compacted code may be stored in a single (8-bit) byte of ROM 42. Of course, the shift character 0000 does require memory space and this has an effect on the storage efficiency. For the 827 characters of FIGS. 9-13 there are a total of 197 shift characters used to compact the code to 612 bytes. Even so, the savings of 26% of the memory space (827 reduced to 612 bytes) is substantial.

FIGURE 2A represents the ROM table, in which ROM.ADDR. indicates, in HEX, the lower 5 bits of the ROM addresses in which the ASCII character codes are stored for the two character sets "A" and "B". The lower four bits of the addresses (0-F Hex) identify all of the ROM 8-bit memory locations in which character set "A" and character set "B" are stored; the next most significant bit (bit 5) addresses the "A" character set when zero and the "B" character set when one.

FIGURE 3 provides a specific example of compaction of the on-screen display (OSD) message number 73 of the "Parental Control Displays" listing of FIGURE 13 as stored in ROM 42. The message is "ENTER # CHANNEL # NUMBER". The symbol # represents a "block" space. In FIGURE 2 there are two symbols for spaces between characters. The character * of set "B" is a "see through" space symbol which character generator 36 inserts between words without blocking the video signal being displayed. When the # character is used for a space the video is blocked by a black background.

In FIGURE 3 the portion of the message "ENTER # CHANNEL # NU" is comprised of characters which are all taken from the character set (A) of FIGURE 2. These 16 characters sequence require only 8 bytes of storage. The letters M and B are of character set "B". In accordance with the invention, at byte 9 the code for letter M is preceded by the shift character "O" (Hex) to identify M and B and being of a different character set "B". The identical shift character "O" is inserted in byte 10 after the code for "B" to signify that the remaining characters (ER) are of set "A". Byte 12 comprises a pair of shift characters "OO" (Hex) which signifies the end of the message (EOT stands for end of transmission).

To summarize, in FIGURE 3 the 20 character message ENTER # CHANNEL # NUMBER is encoded in 4-bit bytes and requires only 12 bytes of ROM storage including the two shift characters and the end of transmission character (OO, Hex).

The shift character "OOOO" will be seen to provide a "toggle" function, that is, the character does not actually identify either of the two character sets. What the shift character does is to signify a change in character sets. This is important in satisfying the requirement, in this case, that 30 text characters (as hereinbefore defined) be represented in a 4-bit code. Four bits can uniquely represent only 16 states. By using a single shift character (OOOO) this leaves 15 possible states for each one of two character sets which provides a total of 30 characters which can be represented. If the Baudot shift technique were to be used in a 4-bit format, the absolute maximum number of characters which could be represented is only 28 which is two short of what is required to represent 30 characters used in the 84 messages of FIGURES 9-13.

FIGURES 4, 5 and 6 are flow charts illustrating one way in which the compacted characters stored in ROM 42 may be decompacted by processor 40 of micro-computer 30. In FIG. 4 the first step comprises clearing (resetting to zero) a shift flag and an 'X', or index, register in the microprocessor. The 'X' register is assumed to be used in an index addressing mode whereby a memory address is identified from an address contained in the 'X' register plus an offset value. Clearing the shift flag is important because in the present invention the shift code signifies only that a change in character sets has occurred; it does not identify the set as in the Baudot code format. This provides a known starting point for decoding. Initially characters will be decoded as coming from set "A" of FIG. 2. Subsequent characters will be decoded in accordance with changes in the shift flag. An 8-bit double character code is loaded from a memory location which is offset from the beginning of the message string according to the value in the X register and a "pointer" pointing at the beginning of the message string as in the concept known as Index (8-bit offset) Addressing in the Hitachi 6305Y0 micro-computer.

The first test is for an EOT (end of transmission, 00000000 binary, 00 Hex, char =00 as shown). If the end of a character string (FIGS. 9-13) is found (code 00000000) then the message is complete and the program ends. If not, the upper (DCUP) 4-bit nibbles of the 8-bit character code are decoded to ASCII by the routine of FIGURE 5 and then the lower 4-bit nibbles are decoded to ASCII by the routine of FIGURE 6. This process repeats (loops) back to FIGURE 4 until all characters of a

message have been decoded to ASCII and the EOT code (OO Hex) has been detected. Specifically, as shown in FIG. 5, the first character of a message is represented by the first four bits of the 8-bit double code. These four bits are shifted into the lower four bits of the accumulator of processor 40 and represent the location of the ASCII code for that particular character. If the character is zero (hex), it is a shift character and the shift level bit (flag) is reversed. It is set to one if previously equal to zero or to zero if previously equal to one. This effectively toggles the shift bit. If the character is not zero, it represents, if the shift flag is zero, a character code of set "A" and is used to load the ASCII code of the set "A" character (from FIG. 2A) into the accumulator of processor 40. If the shift flag is one, a "shift" bit is added to the character code (ADD16) and the character of table "B" is loaded.

After the first four bits are decoded, the lower 4-bits of the code are reloaded in the accumulator as shown in FIGURE 6. This represents the second character of the "double-code". This character is decoded in the same manner as in FIGURE 5. This process repeats until all 4-bit "nibbles" of each 8-bit code word are examined and decoded using the table of FIGURE 2 and outputted to character generator 36 for display on display 22.

FIGURE 7 provides an example of apparatus suitable for encoding text characters as herein before described. The apparatus comprises a source 702 for providing ASCII characters to a computer 705 which is coupled to a ROM programming unit 706. In operation, ROM 42 is inserted in unit 706 and programmed by computer 704 as shown in the flow chart of FIGURE 8. The flow chart includes branches for determining if a character of a message is set "A" or set "B" of the tables of FIGURE 2 and inserts the shift character OOOO in the character sequence when a change of character sets occurs. The "offset" in Figure 8 is the difference between the starting address of the decoding table (Figure 2A), and the address of the entry in that table containing the character which matches the character being examined. This offset is examined to see which character set "A" or "B" it is pointing to, and if it points to character set "A" then the offset is used directly as the compacted code. If the offset points into character set "B" then 16 (Hex 10) is subtracted from the offset value and the result is used as the compacted code. A shift character is stored whenever the value of the offset switches from pointing to one character set to pointing to the other. There are numerous alternatives to the particular routine shown. What is important, for purposes of the present invention, is that character be identified as belonging to one of two sets and that a unique shift character be in-

serted in the character sequence when a change of character sets occurs.

The term "nibble" refers to an integer sub-multiple of a memory byte. As an example, if all characters are stored as 4-bit codes, there are two "nibbles" per byte of an 8-bit organized memory, 3 "nibbles" per byte of a 12-bit organized memory, 4 "nibbles" per byte of a 16-bit organized memory, and so forth.

Claims

1. Television apparatus including means (30,36,38) for generating and displaying characters, such means including a memory (42) wherein each memory address location has a size which is an integral multiple of the size of selected characters for storing two of said characters, each character being taken from one or the other of two four-bit character sets or a unique four-bit shift indicating character; and means (40) for decompacting the four-bit characters comprising:
 - means for reading said memory to provide a sequence of said characters with said unique shift indicating character separating characters from different sets; and
 - means responsive to said shift indicating character for decoding all characters of one set in accordance with a first code table and decoding all characters of the other set in accordance with a second code table to provide a sequence of decoded output characters to character display means (36,38,22).
2. Apparatus according to claim 1, wherein the first and second character sets of four bits per character are insufficient for providing all characters of the alphabet so that the letters J, Q, X and Z are excluded.

Patentansprüche

1. Fernsehgerät mit Mitteln (30, 36, 38) zur Erzeugung und Anzeige von Schriftzeichen, wobei die Mittel einen Speicher (42) enthalten, in dem jeder Speicher-Adressenplatz eine Größe hat, die gleich einem ganzzahligen Vielfachen der Größe von ausgewählten Schriftzeichen ist, um zwei dieser Schriftzeichen zu speichern, wobei jedes Schriftzeichen von der einen oder der anderen von zwei 4-Bit-Schriftzeichen-Gruppen oder einem eindeutigen, eine Umschaltung anzeigenden 4-Bit-Schriftzeichen genommen wird; und mit Mitteln (40) zum Dekomprimieren der 4-Bit-Schriftzeichen, umfassend: Mittel zum Lesen des Speichers, um eine

message have been decoded to ASCII and the EOT code (OO Hex) has been detected. Specifically, as shown in FIG. 5, the first character of a message is represented by the first four bits of the 8-bit double code. These four bits are shifted into the lower four bits of the accumulator of processor 40 and represent the location of the ASCII code for that particular character. If the character is zero (hex), it is a shift character and the shift level bit (flag) is reversed. It is set to one if previously equal to zero or to zero if previously equal to one. This effectively toggles the shift bit. If the character is not zero, it represents, if the shift flag is zero, a character code of set "A" and is used to load the ASCII code of the set "A" character (from FIG. 2A) into the accumulator of processor 40. If the shift flag is one, a "shift" bit is added to the character code (ADD16) and the character of table "B" is loaded.

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 - means for reading said memory to provide a sequence of said characters with said unique shift indicating character separating characters from different sets; and
 - means responsive to said shift indicating character for decoding all characters of one set in accordance with a first code table and decoding all characters of the other set in accordance with a second code table to provide a sequence of decoded output characters to character display means (36,38,22).
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Patentansprüche

1. Fernsehgerät mit Mitteln (30, 36, 38) zur Erzeugung und Anzeige von Schriftzeichen, wobei die Mittel einen Speicher (42) enthalten, in dem jeder Speicher-Adressenplatz eine Größe hat, die gleich einem ganzzahligen Vielfachen der Größe von ausgewählten Schriftzeichen ist, um zwei dieser Schriftzeichen zu speichern, wobei jedes Schriftzeichen von der einen oder der anderen von zwei 4-Bit-Schriftzeichen-Gruppen oder einem eindeutigen, eine Umschaltung anzeigenden 4-Bit-Schriftzeichen genommen wird; und mit Mitteln (40) zum Dekomprimieren der 4-Bit-Schriftzeichen, umfassend: Mittel zum Lesen des Speichers, um eine



Folge von Schriftzeichen vorzusehen, bei der das eindeutige, eine Umschaltung anzeigende Schriftzeichen Schriftzeichen aus verschiedenen Gruppen trennt; und

Mittel, die auf das die Umschaltung anzeigende Schriftzeichen ansprechen, um alle Schriftzeichen einer Gruppe gemäß einer ersten Code-Tabelle zu dekodieren und alle Schriftzeichen der anderen Gruppe gemäß einer zweiten Code-Tabelle zu dekodieren, um eine Folge von dekodierten Ausgangs-Schriftzeichen Schriftzeichen-Anzeigemitteln (36, 38, 22) zuzuführen.

2. Gerät nach Anspruch 1, bei dem die ersten und zweiten Schriftzeichen-Gruppen mit vier Bits pro Schriftzeichen nicht ausreichen, um alle Buchstaben des Alphabets vorzusehen, so daß die Buchstaben J, Q, X und Z ausgeschlossen sind.

Revendications

1. Dispositif de télévision comprenant un moyen (30, 36, 38) pour fournir et afficher des caractères, tel qu'un moyen comprenant une mémoire (42) dans lequel chaque position d'adresse de mémoire possède une dimension qui est un multiple entier de la dimension des caractères sélectionnés pour stocker deux desdits caractères, chaque caractère étant prélevé de l'un ou de l'autre des deux jeux de caractères de 4 binaires ou un caractère unique d'indication de changement de 4 binaires ;
 et un moyen (40) pour décompresser les caractères de 4 binaires comprenant :
 un moyen pour lire ladite mémoire pour fournir une séquence desdits caractères avec ledit caractère unique d'indication de changement séparant les caractères des différents jeux ; et
 un moyen sensible audit caractère d'indication de changement pour décoder tous les caractères d'un jeu en conformité avec une première table de code et décoder tous les caractères de l'autre jeu en conformité avec une seconde table de code pour fournir une séquence de caractères se sortie décodés au moyen d'affichage des caractères (36, 38, 22).
2. Dispositif selon la revendication 1, dans lequel les premier et second jeux de caractères de quatre binaires par caractère sont insuffisants pour fournir tous les caractères de l'alphabet de sorte que les lettres J, Q, X et Z sont exclues.

