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(54) Title: DOCUMENT RESOLUTION-ADAPTATION METHOD AND APPARATUS

(57) Abstract

A method and device for adapting the scanning-resolution used by a first document-scanning device (12) acting as an input device to a scanning-resolution used by a second such device acting as an output device (16) so that the signals generated by the first device (12) can be processed by the second device (16). User-selectable input and output scanning-resolutions determine an output/input resolution ratio which specifies replication of scan-lines received from the input device and transmittal and skipping of selected ones of these scan-lines to the output device. Replication and skipping of scan-lines take place concurrently so that only a single scan-line need be accessed and stored during the adaptation resolution process. The method and apparatus of the present invention permit connection of an input scanning device (12) to an output scanning device (16) without restriction as to the scanning-resolutions used internally within the devices.
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DOCUMENT RESOLUTION-ADAPTATION METHOD AND APPARATUS

FIELD OF THE INVENTION

This invention relates to transmission of documents by line-scanning techniques and, in particular, to method and apparatus for adapting the resolution used within one document-scanning device to that of another such device so that the output of the first device can be processed by the second device.

BACKGROUND OF THE INVENTION

In the transmission of documents, it is oftentimes necessary to adapt the resolution used within one type of line-scanning device, used as an "input" device such as a 480 lines-per-inch (l.p.i.) Teletex, to that used within another such device, used as an "output" device, such as a 300 l.p.i. facsimile terminal, so that the output representing a document generated by the Teletex may be transmitted via the facsimile terminal to another such terminal remote from the first. As another example, it may be necessary to adapt a bit-mapped resolution to a different resolution used by a cathode ray tube (crt) display.

Generally, it is desirable to be able to obtain any given output to input resolution ratio.

Present resolution-adaptation techniques do not
permit such generalized output-to-input resolution adaption. This is because they process a document represented by a fixed number of scan-lines having a given input resolution, by, for each scan-line, either making a duplicate copy of a line or skipping the scan-line, depending on whether the output resolution is higher, or lower, respectively, than the input resolution. This technique proves useful only for a limited number of output-to-input resolution ratios. For example, by skipping every third line an output resolution of 300 l.p.i. can be obtained from an input resolution of 450 l.p.i., or by duplicating every third scan-line of the document twice an input resolution of 300 l.p.i. can be adapted to an output resolution of 400 l.p.i. However, adaption of the resolutions of the Teletex to the facsimile terminal, described above, cannot be obtained by present techniques, because a resolution of 480 l.p.i. cannot be obtained from a resolution of 300 l.p.i. simply by skipping every pth line nor can 300 l.p.i. be obtained from 480 l.p.i. by simply duplicating every qth line, regardless of the value of p or q.

In addition, some present adaption techniques require that each scan-line from the input device be stored as an intermediate sequence, even though only certain of these scan-lines result in scan-lines in the output. This imposes a line
storage requirement that is larger than necessary.

SUMMARY OF THE INVENTION

The resolution adaption method according to the present invention permits adaption of any input resolution to any output resolution, thereby permitting use of any "input" document-scanning device with any "output" document-scanning device. Furthermore, replication and skipping of scan-lines takes place simultaneously so that an intermediate sequence of scan-lines need not be stored, thereby imposing only a minimal storage requirement.

The user specifies, without restriction, an input resolution and an output resolution which defines an output/input resolution ratio \( x/y \). For instance, to adapt a 480 l.p.i. input resolution to a 300 l.p.i. output resolution, an output/input resolution ratio of 300/480 or 5/8 is defined.

The method calls for accessing the scan-line from the input device. This line is replicated \((x-1)\) times to obtain a resolution \( x \) times as great as the input resolution. The first such scan-line becomes the first scan line transmitted to the output device. The next \((y-1)\) lines of the replicated input scan-lines are skipped before another scan-line from the replicated input is transmitted to the output device. This process is repeated until all the scan-lines generated by the input document-scanning device for a particular
document have been replicated and the corresponding output scan-lines have been generated.

Continuing with the example, each input scan-line from the Teletex using a 480 l.p.i. resolution would be replicated four times, resulting in a total of five scan-lines for each input scan-line. Starting with the first such scan-line, the first, ninth, seventeenth, etc. scan-lines from this replicated input would be transmitted to the output device to represent the document using the 300 l.p.i. resolution of the facsimile device.

The method does not actually call for replicating the input scan-lines, but for storing an input scan-line on a buffer, and performing the replication and skipping functions by counters.

Apparatus is disclosed which embodies the resolution-adaptation method of the present invention using commonly-available components.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an illustration of an application of a resolution-adaptation device constructed according to the teachings of the present invention.

Fig. 2 diagramatically illustrates the operation of the resolution adaptation method of the present invention.

Fig. 3 is a flowchart of the resolution adaptation method of the present invention.

Fig. 4 is a functional block diagram of a
resolution adaptation device constructed according to
the teachings of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The resolution adaptation method according to
the present invention provides a way of
interconnecting two document scanning
devices using different resolutions. The method is
able to adapt any scanning resolution used
internally within a device acting as the "input" to
any scanning resolution used within a second
device acting as the "output", for example, it can
provide an interface between two different
facsimile resolutions, a facsimile and a teletex, a
bit-map and any cathode ray tube (crt) resolution,
or two different crt resolutions.

As an illustrative embodiment, reference
should be had to Fig. 1. A document 10 is shown
therein being optically scanned line-by-line by a
document scanning device 12 using a resolution
of 480 lines per inch (l.p.i.). The resulting
electrical signals containing scanning information
derived from the document 10 are conveyed to a
resolution adaptation device 14 operating according
to the teachings of the instant invention. The
device 14 translates the 480 l.p.i. resolution of
the "input" device 12 into a 300 l.p.i. resolution
used by an "output" device 16, here a facsimile
terminal which generates signals suitable for
transmission of the document 10 over telephone
Referring to Fig. 2 of the drawings, the resolution adaptation method of the present invention is diagramatically illustrated by way of an example. Adaption of the document scanning device 12 having a resolution of 480 lines per inch (l.p.i.) ("input resolution" of 480 l.p.i.) to the facsimile terminal 16 with a 300 l.p.i. resolution ("output resolution" of 300 l.p.i.) is shown. The output/input resolution ratio is accordingly 300/480 = 5/8, resulting in a dividend x=5 and a divisor y=8.

As shown in the lefthand column of Fig. 2, a first, line "1", from the document scanning device 12 is accessed, this "input" line is replicated (x-1)=4 times to obtain the first five intermediate lines shown as five "1"'s in the middle column of Fig. 2. A second input line "2" is replicated (x-1)=4 times to obtain the second five intermediate lines shown as five "2"'s in the middle column of Fig. 2. Since the number of intermediate lines generated, ten, exceeds the value of the divisor y=8, the first line of the first ten generated is used to form the first line "1" of the "output", as shown in the righthand column of Fig. 2.

The next (y-1)=7 lines are skipped, as shown in the middle column of Fig. 2 and the ninth intermediate line generated, i.e., the second line
"2" from the document-scanning device 12 is used to form the second line of the output, as shown in the righthand column of Fig. 2.

Lines "3" and "4" are replicated \((x-1)=4\) times to obtain the next ten intermediate lines shown as five "3"'s followed by five "4"'s in the middle column of Fig. 2. The \((y-1)=7\) intermediate lines following the "2" used to form the second output line are skipped and the second "4" generated as an intermediate line is used to form the third line of the output. Accordingly, the fourth line from the document scanning device becomes the third facsimile line.

The procedure illustrated in Fig. 2 is repeated until all input lines of the document 10 as generated by the document-scanning device 12 have been processed, and the resulting output lines generated by resolution adaption device 14 are conveyed to the facsimile terminal 16 for transmission via telephone lines 18 or until the number of lines generated by resolution adaption device 14 equals the document-size utilized by facsimile terminal 16.

A flowchart 100 is presented in Fig. 3 which details the resolution adaption method according to the present invention suitable for inclusion in a resolution adaption device 14 such as illustrated in Fig. 1. Immediately after the start of the algorithm, at block 102, initialization of a pair
of variables, copy counter (CC) and skip counter (SC) to zero, is performed in blocks 104 and 106, respectively. Copy counter (CC) represents the number of times the input line has been replicated.

Whenever CC equals zero as determined in decision diamond 108, a new input line is accessed from scanning device 12 and written into a line buffer as indicated in block 110. Block 110 calls for processing to cease if a special end-of-page character, indicating that all input lines of document 10 have been processed, is received by the line buffer. If CC is not equal to zero, the input line is to be used again for replication and the contents of the line buffer is accordingly not changed. In either event following exit from either block 108 or block 110, the copy counter (CC) is incremented in block 112 to reflect the replication of the input line one time.

Following incrementation of CC at block 112, the current contents of CC are tested in block 114 against the value x, being the numerator of the output/input resolution ratio described above. If CC is equal to x, the current input line has been replicated the requisite number (x-1) times and CC is accordingly reset to zero in the block 116 leading from the "YES" exit from decision diamond 114.

A decision diamond 118 is entered from block 116 or from the "NO" exit from diamond 114 in which
the contents of SC is tested against zero. Whenever the results of this test are true, a block 120 leading from the "YES" exit from diamond 118 is entered which calls for the contents of the line buffer to be transmitted to the output device, such as the facsimile terminal 16. Block 120 calls for processing to cease upon reception of an overflow signal, indicating that the number of lines used within the facsimile terminal—or other destination device—has been equalled.

After transmitting the line to the output device, or if SC were not zero and the "NO" exit from diamond 118 was taken, a block 122 is entered which increments the skip counter (SC) by one. Following incrementation of the SC, a decision diamond 124 is entered which compares the contents of SC against the value \( y \), being the denominator of the output/input resolution ratio described above. If SC is equal to \( y \), the current input line has been skipped the requisite number \((y-1)\) times and SC is accordingly reset to zero in the block 126 leading from the "YES" exit from decision diamond 124.

Following resetting of SC, or if SC were not equal to \( y \) and the "NO" exit from diamond 124 was taken, flow passes back to decision diamond 108 for the processing of the remaining input lines.

The resolution adaptation method of the instant invention as illustrated in the flowchart 100 of
Fig. 3 performs the requisite \((x-1)\) "expansions" and the requisite \((y-1)\) "compressions" without requiring storage of the complete intermediate sequence of lines illustrated in the middle column of Fig. 2. The method imposes only the minimal memory requirement that resolution adaption device 14 contain a line buffer. The resulting resolution adaption performed by device 14 operates rapidly in that the "expansion" and "compression" proceed simultaneously.

Illustrative of a resolution adaption device 14 employing the method according to the teachings of the instant invention, reference should be had to Fig. 4. Resolution adaption device 14 is shown within the dashed border and comprises six major elements: an input memory access controller 210, an output access controller 220, an input memory address controller 230, a line skip controller 240, a line copy controller 250 and a control logic element 260. Document 10 line-scan bitmap information from the "input" device 12 having a given "input resolution" is stored in a memory 200 which is connected to the input memory access controller 210 via a bus 202. The resolution adaption device 14 will access the information stored in memory 200, transmit and copy it to an "output" device 270 by skipping and generating document 10 scan-lines thereby producing a bit-map of the document 10 having a given "output
resolution". The output device 270 may be another memory, a printer, a CRT, a facsimile device, or any similar device capable of storing or processing bit-map information having the given "output resolution". The output device 270 is connected to the input memory access controller 210 via a bus 222 connecting the output access controller 220 to the output device; the output access controller 220, in turn, being connected via a bus 212 to the input memory access controller 210.

As shown in Fig. 4, control logic element 260 is connected to the input memory access controller 210 and the output access controller 220 via signal lines 214 and 224, respectively, so that the accessing and copying operations can proceed as will be described below in accordance with the resolution adaption method of the present invention.

While for purposes of explanation, all scan-lines of document 10 are to be stored in the memory 200 shown in Fig. 4, the method and device of the instant invention does not require such storage, and the scan-lines could equally well be received directly from input device 12 on a line-by-line basis and stored in a buffer imposing only a single scan-line storage requirement.

As will be described, the resolution adaption device 14 contains four registers which must have their contents initialized before the "input
resolution" of document 10 is to be translated to the "output resolution". A scan-line length (LINE LENGTH) register 232 portion of input memory address controller 230 must be loaded with the number of contiguous memory locations required to store an input scan line within memory 200. An arithmetic-logic unit (ALU) 234 portion of input memory address controller 230 receives the contents of the LINE LENGTH register 232 at a first input.

A second input of the ALU 234 receives the contents of an input memory address (INPUT ADDRESS) register 236. The INPUT ADDRESS register 236 is the second register which must be initialized before resolution adaption begins; namely, the address within memory 200 at which the first document 10 input scan line begins.

Under control of logic element 260, signals are conducted via a signal line 238 to ALU 234 which causes the ALU 234 to add the contents of LINE LENGTH register 232 to the current contents of INPUT ADDRESS register 236 following each access of memory 200 of an input scan line and for the subsequent storage of this sum into INPUT ADDRESS register 236 so that the starting address of the next input scan line within memory 200 is stored within input address register 236. The contents of the INPUT ADDRESS register 236 is conducted to the input memory access controller 210, and upon reception of a suitable signal
generated by control logic element 260 and conducted to input memory access controller 210 via signal line 214, the next input scan line from memory 200 can be copied into the output access controller 220, as will be described hereinafter.

A third register which must be initialized is a DIVISOR register 242 portion of the line skip controller 240 which must be set to contain the divisor value "y" of the output/input resolution ratio, described in connection with Fig. 2, above.

The fourth register which must be initialized before the resolution adaptation process begins is a DIVIDEND register 252 portion of the line copy controller 250 which must be set to the dividend value "x" of the output/input resolution ratio.

Returning to the line skip controller 240, the contents of a resettable skip register (SKIP REG) 244 portion, which initially contains a zero value, is conducted to an input of an ALU 246 portion of the line skip controller 240 and to an input of a COMPARATOR 248 portion of the line skip controller 240. The COMPARATOR 248 also receives at a second input the contents of the DIVISOR register 242, "y". The ALU 246 receives at a second input a signal corresponding to the numerical value one and under control of logic element 260, signals are conducted via a signal line 249 to ALU 246 which causes the ALU 246 to add one to the contents of the SKIP REG 244. The resulting incremented value
is conducted from the output of the ALU 246 to the SKIP REG 244 for storage therein.

The newly updated value within the SKIP REG 244 is compared within COMPARATOR 248 against the contents "y" of DIVISOR register 242. When these values become equal, a signal is generated by comparator 248 which is conducted to resettable SKIP REG 244 which causes the value therein to be reset to zero. This signal is also conducted to control logic element 260 which, in response, subsequently generates signals on lines 214 and 224 causing the input memory access controller 210 to use the line starting address received from the input memory address register 236 to access the current scan line from the memory 200 and to transfer this scan line via busses 202 and 212 to the output access controller 230. The latter controller 230, in turn, in response to the signal generated on signal line 224 control logic 260, transmits the current scan line to the output device 270 via bus 222. The line skip controller 240 accordingly implements that portion of the resolution adaption method of the present invention contained in the flowchart 100 of Fig. 3 corresponding to blocks 118, 120, 122, 124 and 126.

In a similar manner, the line copy controller 250 portion of Fig. 4 implements that portion of the resolution adaption method of the present invention contained in the flowchart 100
corresponding to blocks 108, 110, 112, 114 and 116. As mentioned above, line copy controller 250 includes a DIVIDEND register 252 portion which contains the dividend value "x" of the output/input resolution ratio. The contents of a resettable copy register (COPY REG) 254 portion, which initially contains a zero value, is conducted to an input of an ALU 256 portion of the line copy controller 250 and to an input of a COMPARATOR 258 portion of the line copy controller 250. The COMPARATOR 258 also receives at a second input the contents of the DIVIDEND register 252, "x". The ALU 256 receives at a second input a signal corresponding to the numerical value one and under control element 260, signals are conducted via a signal line 259 to ALU 256 which causes the ALU 256 to add one to the contents of the COPY REG 254. The resulting incremented value is conducted from the output of the ALU 256 to the COPY REG 254 for storage therein.

The newly updated value within the COPY REG 254 is compared within COMPARATOR 258 against the contents "x" of DIVIDEND register 252. When these values become equal, a signal is generated by COMPARATOR 258 which is conducted to resettable COPY REG 254 which causes the contents therein to be reset to zero. This signal is also conducted to control logic element 260 which, in response, generates signals on lines 214 and 224 causing the
input memory access controller 210 to load the line starting address received from the input memory address register 236, to access the current scanline from the memory 200 and to transfer this scan line via busses 202 and 212 to the output access controller 220. The latter controller 230, in turn, in response to the signal generated on signal line 224 by control logic 260, transmits the current scan line to the output device 270 via bus 222.

The line copy controller 250 accordingly implements that portion of the resolution adaption method of the present invention contained in the flowchart 100 of Fig. 3 corresponding to blocks 108, 110, 112, 114 and 116.

The control logic 260 element of resolution adaption device 14 incorporates a programmable logic array (PLA) of a type well known to those skilled in the art. In conjunction with conventional signal-generation circuitry internal to control logic 260, and the PLA, control logic 260 sends pulses alternately to ALU 246 and to ALU 256 via signal lines 249 and 259, respectively, which cause the sequential processing of the lines of a document 10 as called for in blocks 112 and 122 as described above in connection with flowchart 100 of Fig. 3

In order to implement the blocks 110 and 120 of the flowchart 100 of Fig. 3, a signal is
generated by control logic 260 element on signal
line 238 which is received by ALU 234 causing the
ALU 234 to add the contents of LINE LENGTH register
232 to the current contents of INPUT ADDRESS
register 236 each time the signal generated by
comparator 258 causing the COPY REG 254 to be reset
to zero is also received by the control logic 260.
In this manner, the decision diamond 108 of
flowchart 100 is implemented and accessing of the
next scan line called for in block 110 is
implemented by the resolution adaption device 14
by control logic 260, in response to the receipt of
the signal generated by COMPARATOR 258, generates
on signal line 214 a signal which is received by
the input memory access controller 210 which causes
the next input scan line to be copied from memory
200 into the output access controller 220, as
described above.

Similarly, block 120 of flowchart 100 is
implemented when a signal is generated by control
logic 260 element on signal line 224 which is
received by output access controller 220 each time
the signal generated by comparator 248 causing the
SKIP REG 244 to be reset to zero is also received
by the control logic 260. In this manner, the
decision diamond 118 of flowchart 100 is
implemented and transmitting the current line
called for in block 120 is implemented by control
logic 260 which, in response to the receipt of the
signal generated by COMPARATOR 248, generates an
signal line 224 a signal which is received by the
output access controller 220 which causes the
current scan line to be transmitted to the output
device 270 via bus 222.

In addition to the connections explicitly shown
in Fig. 4, the control logic 260 element of
resolution adaption device 14, is connected to the
document scanning device 12 and the facsimile
terminal 16, or similar device, to facilitate
transmission of input and output scan lines, as
will be appreciated by those skilled in the art.

In order to implement the "START" block 102 of
flowchart 100, control logic 260 element initially
generates signals on line 214 which causes the
input memory access controller 210 to use the line
starting address received from the INPUT ADDRESS
register 236 to access one scan line from the
memory 200 and to transfer this scan line via
busses 202 and 212 to the output access controller
230. Control logic 260 then generates signals in
line 224 which causes the output access controller
230 to transmit this first scan line to the output
device 270 via bus 222. In addition, control logic
260 initializes the SKIP REG 244 and the COPY REG
254 to zero, as called for in blocks 106 and 104,
respectively, of flowchart 100.

The processing of scan-lines from document 10
continues within resolution adaption device 14
according to the method of the present invention as illustrated in flowchart 100 until either a special end-of-page character, generated by the document scanning device 12, or an overflow signal, generated by the facsimile terminal 16, is received by the control logic 260 element of the device 14, which then reinitializes the SKIP REG 244 and the COPY REG 254 to zero, as called for in blocks 106 and 104, respectively, of flowchart 100.

I CLAIM:

1. A method of adapting two-dimensional information represented as a first plurality of scan-lines along a first dimension having a first resolution scale along a second dimension so that said information is represented as a second plurality of scan-lines along said first dimension having a second resolution scale along said second dimension comprising the steps of:

a) representing said information as a third plurality of scan-lines along said first dimension wherein each said scan-line within said first plurality of scan-lines is replicated adjacent to along said second dimension in direct proportion to said second resolution scale; and

b) representing said information as said second plurality of scan-lines, being ones in number directly proportional
to said first resolution scale, and
selected in a predetermined manner
from said scan-lines within said third plurality.

2. The resolution adaption method of claim 1
wherein the fractional ratio of said second
resolution scale to said first resolution scale,
expressed in lowest terms, is \( \frac{x}{y} \), wherein step
(a) further calls for each scan-line of said first
plurality of scan-lines to be replicated \((x-1)\)
times in said third plurality of scan-lines and,
wherein step (b) further calls for selection
of the first, \((y+1)st\), \((2y+1)st\), \ldots, scan-lines
within said third plurality of scan-lines.

3. A method of adapting two-dimensional
information represented as a first plurality of
horizontal scan-lines arranged in a first-to-last
vertical order and having a first vertical
resolution scale so that said two-dimensional
information is represented as a plurality of
horizontal scan-lines arranged in a first-to-last
vertical order and having a second vertical
resolution scale, comprising the steps of:

c) calculating the fractional ratio of
said second vertical resolution scale
to said first vertical resolution
scale and reducing said fraction to
lowest terms by removing the greatest
common factor of both the dividend and
the divisor thereof;

d) initializing a copy counter and a skip
    counter to zero and setting an input
    pointer to said first one of said
    first plurality of horizontal
    scan-lines ("current scan-line");

e) comparing the value of said copy
    counter with zero, and moving said
    input pointer to the next one of
    said first plurality of horizontal
    scan-lines;

f) incrementing said copy counter by one;

g) comparing the value of said copy
    counter with the dividend of said
    reduced fractional resolution ratio
    and resetting said copy counter to
    zero when said comparison indicates
    equality;

h) comparing the value of said skip
    counter with zero, and including in
    said second plurality of
    horizontal scan-lines said current
    scan-line from said first plurality of
    horizontal scan-lines when said
    comparison indicates equality;

i) incrementing said skip counter by one;

j) comparing the value of said skip
    counter with the divisor of said
    reduced fractional resolution ratio
and resetting said skip counter to zero when said comparison indicates equality;

k) returning to step (e).

4. Apparatus for transmitting two-dimensional information including source means for generating electrical signals representing a first plurality of scan-lines along a first dimension having a first resolution scale along a second dimension, destination means responsive to electrical signals representing a second plurality of scan-lines along said first dimension having a second resolution scale along said second dimension for generating electrical signals representative of said two-dimensional information, and resolution-adaption means selectably operable in one of a plurality of input resolution modes and in one of a plurality of output resolution modes, responsive to said electrical signals representing said information as said plurality of scan-lines having said first resolution scale, being said selected input resolution, for generating electrical signals representing said information as said second plurality of scan-lines having said second resolution scale, being said selected output resolution, said resolution-adaption means comprising:

control logic means for generating control and timing signals;
input means responsive to said electrical signals generated by said source means connected to said control logic means for sequentially selecting and for retrieving ones of said scan-lines from said first plurality of scan-lines in response to signals from said control logic means;

output means connected to said control logic means, to said input means, and to said destination means for generating electrical signals conducted to said destination means representative of one of said scan-lines from said first plurality of scan-lines;

skip counter means connected to said control logic means responsive to said selectable input resolution for storing, incrementing, and setting to zero a skip-count and for generating a signal conducted to said control logic means when said skip-count is equal to a value proportional to said second resolution scale, thereby causing said skip-count to be reset to zero and causing said control logic means to generate a control signal to be received by said input means to select the next
scan-line in said sequence; and
copy counter means connected to said
control logic means responsive to said
selectable output resolution for
storing, incrementing and setting to zero
a copy-count and for generating a signal
conducted to said control logic means
when said copy-count is equal to a value
proportional to said first resolution
scale, said proportionality factor being
as for said skip-counter means, thereby
causing said copy-count to be reset to
zero and causing said control logic means
to generate control signals to be
received by said input means and by said
output means causing said input means
to access said currently-selected
scan-line and causing said output means
to generate signals conducted to said
destination means representative of one
of said scan-lines from said first
plurality of scan-lines.

5. Transmission apparatus according to claim
4 wherein said proportionality factor in said skip
counter means and in said copy counter means if
said resolution-adaption means is the fractional
ratio of said second resolution scale, being said
selected output resolution, to said first
resolution scale being said selected input
resolution.

6. Transmission apparatus according to claim 5 wherein said fractional ratio, expressed in lowest terms, is \( x/y \), wherein said skip counter means includes a user-accessible divisor register means for storing said value \( y \), resettable skip-count register means for storing and setting to zero said skip-count, comparator means connected to said divisor register means and to an output terminal of said skip-count register means for comparing for equality the contents of said skip-count register means and said divisor register means and for generating an equality signal upon detection of said equality, said equality signal conducted to a reset terminal of said skip-count and to said control logic register means and incrementor means responsive to a timing signal generated by said control logic means having an input terminal connected to said output terminal of said skip-count register means and having an output terminal connected to an input terminal of said skip-count register, for generating a signal causing the contents of said skip-count register means to be increased by one upon reception of a clock signal from said control logic means unless said comparator means generates said equality signal thereby causing the contents of said skip-count register means to be reset to zero, and wherein said copy counter means includes a
user-accessible dividend register means for storing said value \( x \), a resettable copy-count register means for storing and setting to zero said copy-count, comparator means connected to said dividend register means and to an output terminal of said copy-count register means for comparing for equality the contents of said copy-count register means and said dividend register means and for generating an equality signal upon detection of said equality, said equality signal conducted to a reset terminal of said copy-count register means and to said control logic means and incremener means responsive to a timing signal generated by said control logic means, said incremener means having an input terminal connected to said output terminal of said copy-count register means and having an output terminal connected to an input terminal of said copy-count register, for generating a signal causing the contents of said copy count register means to be increased by one upon reception of a clock signal from said control logic means unless said comparator means generates said equality signal thereby causing the contents of said copy count register means to be reset to zero.
FIG. 2
START 102

CC ← 0 104

SC ← 0 106

108

CC = 0?

ACCESS NEXT LINE TO BUFFER; STOP IF END-OF-PAGE 110

INCREMENT CC 112

CC = X?

YES

CC ← 0 114

NO

SC = 0?

YES

TRANSMIT LINE IN BUFFER; STOP IF OVERFLOW 120

NO

INCREMENT SC 122

SC = Y?

YES

INC

NO

SC ← 0 126

FIG. 3
## INTERNATIONAL SEARCH REPORT

**International Application No:** PCT/US86/00408

### I. CLASSIFICATION OF SUBJECT MATTER

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

- **INT. CL.** H04N 1/00, 1/04, 1/32, 1/40
- **U.S. CL.** 358/256, 257, 280, 287

### II. FIELDS SEARCHED

<table>
<thead>
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<th>Classification System</th>
<th>Classification Symbols</th>
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<tr>
<td>U.S.</td>
<td>358/140, 256, 257, 280, 287, 903</td>
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<td></td>
<td>382/47, 54</td>
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</tbody>
</table>

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

### III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
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</thead>
<tbody>
<tr>
<td>A,P</td>
<td>US, A, 4,533,958, 06 August 1985, Herget.</td>
<td>1-6</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 4,000,371, 28 December 1976, Ogawa.</td>
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</tr>
<tr>
<td>A</td>
<td>US, A, 3,914,538, 21 October 1975, Perreault et al.</td>
<td>1-6</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 3,751,582, 07 August 1973, Wernikoff et al.</td>
<td>1-6</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:
  - **A** document defining the general state of the art which is not considered to be of particular relevance
  - **E** earlier document but published on or after the international filing date
  - **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - **O** document referring to an oral disclosure, use, exhibition or other means
  - **P** document published prior to the international filing date but later than the priority date claimed

**“T”** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**“X”** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

**“Y”** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

**“&”** document member of the same patent family

### IV. CERTIFICATION

- **Date of the Actual Completion of the International Search:** 06 May 1986
- **Date of Mailing of this International Search Report:** 12 May 1986
- **International Searching Authority:** ISA/US
- **Signature of Authorized Officer:** Edward Coles