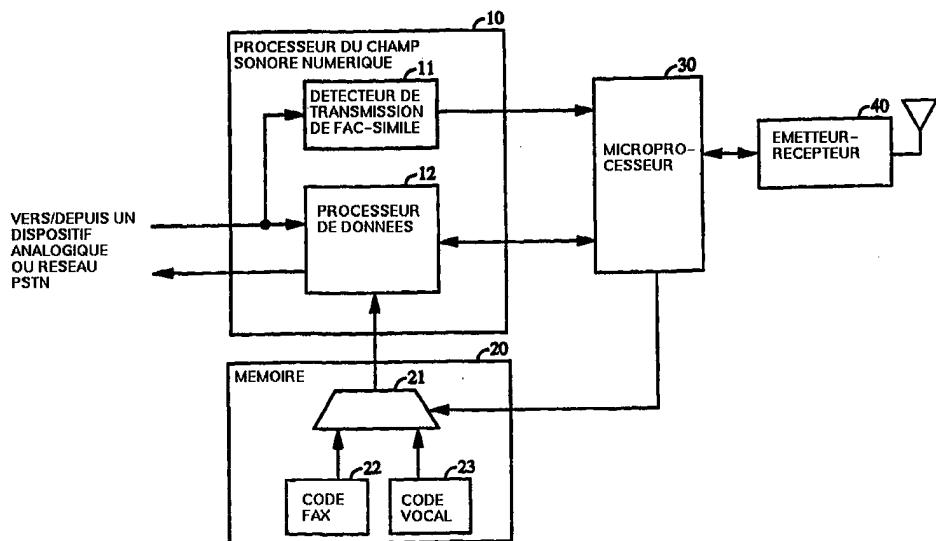




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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|--|--|----|--|
| (51) International Patent Classification ⁶ : H04N 1/327, H04Q 7/32, 7/22, H04M 1/72 | | A1 | (11) International Publication Number: WO 98/21879 (43) International Publication Date: 22 May 1998 (22.05.98) |
| (21) International Application Number: PCT/US97/20757 | | | (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). |
| (22) International Filing Date: 13 November 1997 (13.11.97) | | | |
| (30) Priority Data: 751,190 15 November 1996 (15.11.96) US | | | |
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(54) Title: METHOD AND APPARATUS FOR DETECTING A FACSIMILE TRANSMISSION



(57) Abstract

A novel and improved method and apparatus for providing an interface to a digital wireless telephone system compatible with standard analog wire line telephones and analog wire line fax machines are disclosed. During a telephone call, a fax detector (11) monitors the incoming data for fax signals. If a fax is detected, the data processor (12) switches from processing the data as if it were voice to processing it as fax. In addition, the remote station is sent a signal notifying it to process the data as fax rather than voice. The fax detector (11) operates by detecting the preamble of a V.21 message, present at the beginning of every fax call. Energy is measured in both frequencies of the BFSK signals. A decision is made by analyzing these energies and locating a specific pattern which repeats itself a sufficient number of times.

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METHOD AND APPARATUS FOR DETECTING FACSIMILE TRANSMISSION

BACKGROUND OF THE INVENTION

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I. Field of the Invention

The present invention relates to communications systems. More particularly, the present invention relates to a novel and improved method 10 for automatically detecting a facsimile (fax) transmission and providing the correct service option based on that detection.

II. Description of the Related Art

15 Information is exchanged more efficiently in digital wireless telephone systems than in analog wireless telephone systems. Increased efficiency allows a greater number of telephone calls or other communications to be conducted over digital wireless telephone systems using a given amount of radio frequency (RF) bandwidth. A prominent 20 example of an analog wireless telephone system is the AMPS cellular telephone system, employed extensively throughout the United States.

In some instances, the increased efficiency provided by digital wireless telephone systems is so substantial that digital wireless telephone service becomes economically competitive with the traditional analog wire line 25 telephone service. Analog wire line telephone service is the telephone service provided using the conventional wire based telephone system, often referred to as the public switched telephone network (PSTN). Analog wireline telephone systems typically process data in analog format directly, or in a digital representation of the analog data, referred to as pulse code 30 modulated (PCM) format. Analog wire line telephone service has traditionally been far less expensive than wireless telephone service.

To provide a complete replacement for traditional analog wire line telephone service, wireless digital telephone systems must be able to accommodate all the services and functions that are currently supported by 35 analog wire line telephone service. One such service is fax transmission.

Although, digital wireless telephone systems typically provide fax transmission service, the interface to the fax service is generally different than that of analog telephone systems. In particular, digital wireless telephone systems process the digital data directly, rather than in the form of 40 tones, as practiced for analog communication systems.

Because of the different interface methods, some analog telecommunication equipment cannot be used with the digital wireless telephone systems. In particular, fax machines that are designed to be used with an analog telephone system typically cannot be used with a digital 5 wireless telephone system. Therefore, a user converting from analog wire based telephone service to digital wireless telephone service must consider the additional cost of providing equipment suited to the digital wireless service when comparing the costs to the benefits in converting to a digital wireless telephone service.

10 Therefore, to reduce the cost of converting from a wire based telephone service to a digital wireless telephone service, it is desirable to provide an interface to a digital wireless telephone system that operates with analog based wire line telecommunication equipment. In particular, it would be desirable to provide an interface to a digital wireless telephone 15 system that operates with standard telephones and fax machines.

SUMMARY OF THE INVENTION

The present invention is a novel and improved method and 20 apparatus for providing an interface to a digital wireless telephone system compatible with standard analog wire line telephones and analog wire line fax machines. During a telephone call, a fax detector monitors the incoming data for fax signals. If a fax is detected, the data processor switches from 25 processing the data as voice data to processing it as fax data. In addition, the remote station is sent a signal notifying it to process the data as fax rather than voice.

The fax detector operates by detecting a known pattern that is present 30 at the beginning of every fax call. During the initiation of a fax call, certain parameters are negotiated between the transmitting and the receiving fax machines. These parameters are transmitted as BFSK signals consisting of a preamble followed by the parameter data. The preamble is the known 35 pattern which can be detected. Energy is measured in both frequencies of the BFSK signals. A decision is made by analyzing these energies and locating a specific pattern which repeats itself a sufficient number of times.

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BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below, when

taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is a block diagram of the digital wireless telecommunications system when configured in accordance with one embodiment of the present invention;

FIG. 2 is a block diagram of one embodiment of the fax detector; and

FIG. 3 is a flow chart illustrating the operation of the decision making element of the fax detector when configured in accordance with one embodiment of the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 depicts elements that are common to both the subscriber and base stations. Thus, the present invention is equally applicable when the subscriber initiates a call to the base station, or the base station initiates a call to the subscriber. For the elements considered in FIG. 1, it is only necessary to know whether the call is being initiated or received, and not whether the device is a base station or a subscriber station. In the exemplary embodiment, fax detection occurs in the station that received the call.

First, consider the call initiation. Memory 20 contains code for processing fax 22 and code for processing voice 23. In the exemplary embodiment, the voice code 23 performs a variable rate code excited linear prediction (CELP) algorithm, as described in detail in U.S. Patent No. 5,414,796 entitled "Variable Rate Vocoder" which is assigned to the assignee of the present invention and incorporated by reference herein. Memory 20 may be a random access memory (RAM) or read only memory (ROM) or other memory devices as are known in the art. In the exemplary embodiment, the default data processing code is set for voice. Hence, voice code 23 is loaded via memory multiplexor (mux) 21 into data processor 12, and microprocessor 30 signals to the remote station via transceiver 40 that the following call data should be processed as voice. Data samples from the local input device are processed by digital signal processor (DSP) 10. Those samples are processed by data processor 12 and also provided to fax detector 11. Results of data processor 12 are sent to microprocessor 30 where they are transmitted to the remote station via transceiver 40. The data is processed as a voice call, until such time as fax detector 11 determines that the incoming data is that of a fax. Upon detection of facsimile data, fax detector 11 provides a signal indicating the detection to microprocessor 30. Following

receipt of the fax detection signal from fax detector 11, microprocessor 30 signals to the remote station (not shown) via transceiver 40 that the following call data should be processed as fax, and no longer as voice. In addition, microprocessor 30 provides a signal to DSP 10 and memory 20 5 which causes the fax code 22 to be provided through mux 21 to data processor 12. Data processor 12, now loaded with fax code, also processes data received from the remote station via transceiver 40 and microprocessor 30. Results of that processing are sent to the local output device which, in the exemplary embodiment, is a speaker for voice data and a connected fax 10 machine for fax data (not shown).

In the exemplary embodiment, voice code 23 or fax code 22 is selectively loaded into DSP 10. In an alternative embodiment, both fax code 22 and voice code 23 may reside concurrently in DSP 10. Another alternative embodiment may include parallel processors, one for voice, the 15 other for fax, where the output of one processor is selected based on the type of call being processed. These and other alternatives obvious to those skilled in the art employ the principles defined in this invention.

Now consider a received call. Microprocessor 30 receives instructions indicating how to process the call data from the remote station via 20 transceiver 40. Microprocessor 30 provides a signal to DSP 10 and memory 20. In response to the signal from microprocessor 30, data processor 12 is loaded with fax code 22 or voice code 23 via memory mux 21.

In the exemplary embodiment, the subscriber station local samples come from and go to an external (to the subscriber station) analog device, 25 such as a fax machine or fax modem connected through an interface circuit, which converts the analog signal into digital samples and vice versa. The base station local device is the Public Switched Telephone Network (PSTN).

Fax calls must conform to behavior as specified in "ITU-T Recommendation T.30: Procedures For Document Facsimile Transmission 30 in the General Switched Telephone Network" incorporated herein by reference. In the exemplary embodiment, parameter negotiation at the beginning of a fax call is accomplished as specified by "CCITT Recommendation V.21 : 300 BPS Duplex Modem Standardized For Use in the General Switched Telephone Network (GSTN)" incorporated herein by 35 reference.

At the start of a fax call, messages are exchanged between the fax machines according to V.21. These V.21 messages communicate parameters, such as capabilities of the fax machines and rates supported. The V.21 messages are BFSK modulated signals where 1650 Hz represents binary 1 and

1850 Hz represents binary 0. Each message consists of a preamble followed by the information specific to that message. The preamble is made up of a sequence of the pattern 0x7e repeated for 1 second within a 15% tolerance. Fax detector 11 determines a call is fax by detecting this preamble. Although 5 the exemplary embodiment detects V.21 signals in order to detect fax, this invention can also be used to detect other signals including non-fax V.21 signals and, with slight modification, non-V.21 signals as well. However, the simplicity of the detector and its reliability derives from intimate knowledge of fax protocols and the nature in which V.21 signals are used in 10 fax calls. The spectral characteristics of the V.21 message exhibit a pattern that is repetitive and stationary over a sufficient amount of time so as to be detected by fax detector 11. Also, the pattern is sufficiently unique that false detects are highly unlikely. The V.21 message is repeated for a duration of up to 30 seconds. This allows for data processor 12 to be replaced with fax 15 code 22 in time to process the information in the V.21 message once fax detector 11 determines a fax call is beginning.

FIG. 2 shows the block diagram of fax detector 11. Input samples are filtered by notch filter 50 at 1650 Hz, squared by squaring means 51, and summed up by accumulator 52 to produce the energy at 1650 Hz (ene1650). 20 In like fashion, input samples are filtered by notch filter 60 at 1850 Hz, squared by squaring means 61, and summed up by accumulator 62 to produce the energy at 1850 Hz (ene1850). In the preferred embodiment, the sampling rate is 8 KHz and the energy measurements are sums of 20 samples. Comparator 70 compares ene1650 with ene1850 and produces two 25 outputs: one signifying whether ene1650 is less than a fraction of ene1850, and one signifying whether ene1850 is less than a fraction of ene1650. In the preferred embodiment, the fraction used in both comparisons is 0.25. The outputs of comparator 70 go into decision box 80, where a detection decision is made based on the present and some of the past comparison values.

30 Decision box 80 looks for 6, 7, or 8 consecutive frames where the 1650 Hz energy measurements are less than one quarter of their corresponding 1850 Hz energy measurements, followed by 3 or 4 frames where that condition is not true and wherein at least one of those 3 or 4 frames has the energy at 1850 Hz less than one quarter of the corresponding 1650 Hz energy 35 measurement. Only if this sequence is consecutively repeated 8 times will decision box 80 declare that V.21 signals, and hence fax signals, are detected. Values associated with comparison thresholds, number of consecutive energy measurements, sampling rates, samples per energy calculation, etc.

can all be readily modified by someone skilled in the art to accomplish the same result.

The flow chart in FIG. 3 depicts the decision making process as utilized by the preferred embodiment of decision box 80. Start in 81, labeled 5 "START AGAIN". There, initialize variables A, \bar{A} , B, and Rep to zero and proceed to 82. In 82, if $\text{ene1650} < 0.25 * \text{ene1850}$ (defined as condition A) is true, proceed to 83. Otherwise, return to 81, "START AGAIN". In 83, increment A by one, get the next sample, and proceed to 84. In 84, if condition A is true, loop back to 83. Otherwise, proceed to 85. In 85, if 10 $6 \leq A \leq 8$, proceed to 87. Otherwise, proceed to 86 and then back to 81, "START AGAIN". In 87, increment \bar{A} by one and proceed to 88. In 88, if $\text{ene1850} < 0.25 * \text{ene1650}$ (defined as condition B), proceed to 89. Otherwise, jump ahead to 90. In 89, increment B by one and proceed to 90. In 90, get the 15 next sample and proceed to 91. In 91, if condition A is false, proceed to 92. In 92, if $\bar{A} < 4$, loop back to 87. Otherwise, proceed to 93 then return to 81, "START AGAIN".

In 91, if condition A is true, proceed to 94. In 94, if $\bar{A} = 3$ or 4 and B > 0, proceed to 95. Otherwise, proceed to 97 then return to 81, "START AGAIN".

20 In 95, if Rep = 8, proceed to 96 and signal that a fax is detected. Otherwise, proceed to 98. In 98, increment rep by one, reset A, \bar{A} , and B to zero, and loop back to 83.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. 25 The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent 30 with the principles and novel features disclosed herein.

WE CLAIM:

CLAIMS

1. An apparatus for transmitting voice and fax data, comprising:
 - 2 processor means for receiving a signal containing speech data or fax data and for processing said signal in accordance with a control signal;
 - 4 and
 - 6 detector means for receiving said signal, determining when said signal consists of fax data and for providing said control signal in accordance with said determination.
2. The apparatus of claim 1 further comprising transceiver means for transmitting a fax mode signal when said detector means determines that said signal consists of fax data.
3. The apparatus of claim 1 further comprising memory means for storing a fax processing code and a voice processing code and wherein processor means processes said signal in accordance with said fax processing code or said voice processing code in accordance with said control signal.
4. The apparatus of claim 1 wherein said detector means determines when said signal consists of fax data based upon V.21 preamble message protocol.
5. The apparatus of claim 4 wherein detector means comprises:
 - 2 first subband energy calculator means for receiving said signal and calculating first subband energy values;
 - 4 second subband energy calculator means for receiving said signal and calculating second subband energy values; and
 - 6 decision means for receiving said first subband energy values and said second subband energy values and determining, based upon statistics of said first subband energy values and said second subband energy values, whether said signal is a fax signal.
6. Apparatus for processing incoming data, including:
 - 2 a) a detector which receives an input signal and detects the presence of a format in the received input signal; and
 - 4 b) a data processor, coupled to the detector, which responds to the presence of the format by the detector by processing the received input signal

6 in accordance with a first process, and otherwise processing the received
input signal in accordance with a second process.

7. The apparatus of Claim 6, wherein the detector detects the
2 format by detecting a preamble having a sequence of the pattern 0x7e in the
received signal.

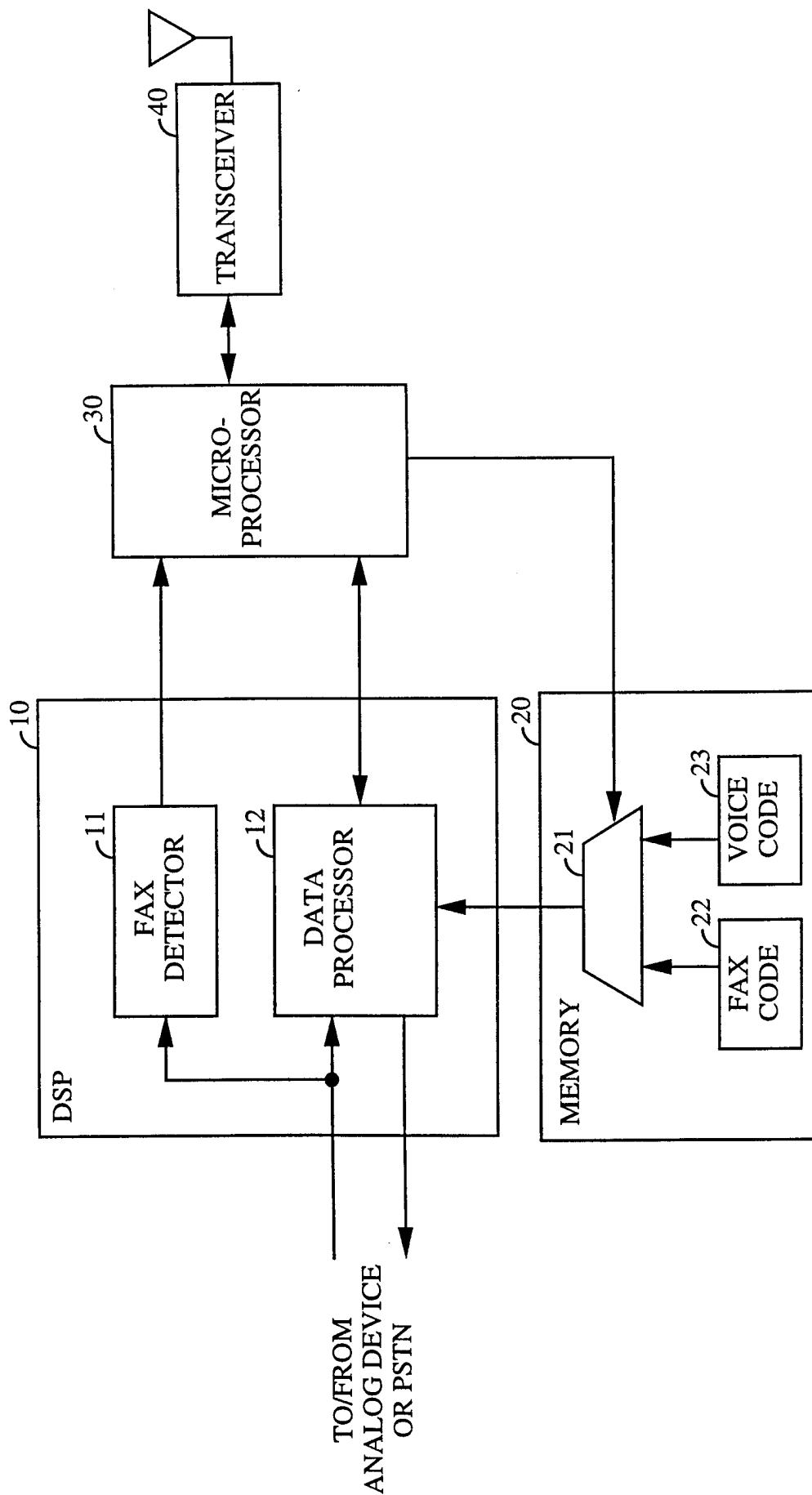


FIG. 1

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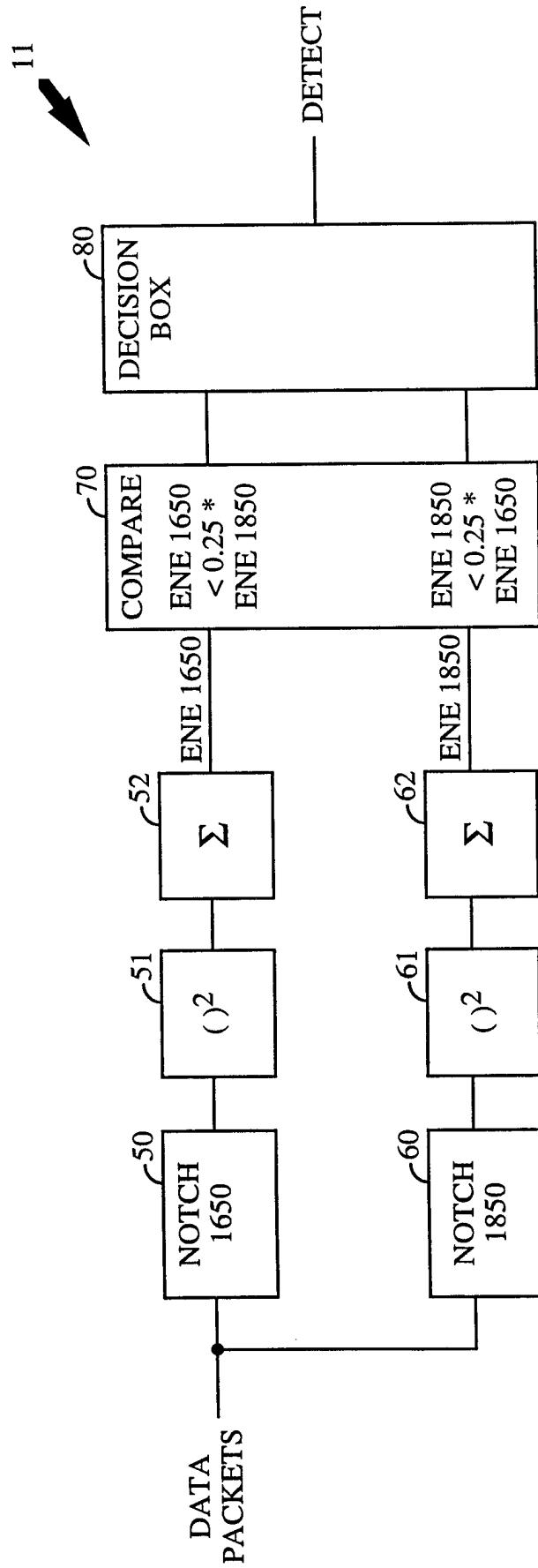


FIG. 2

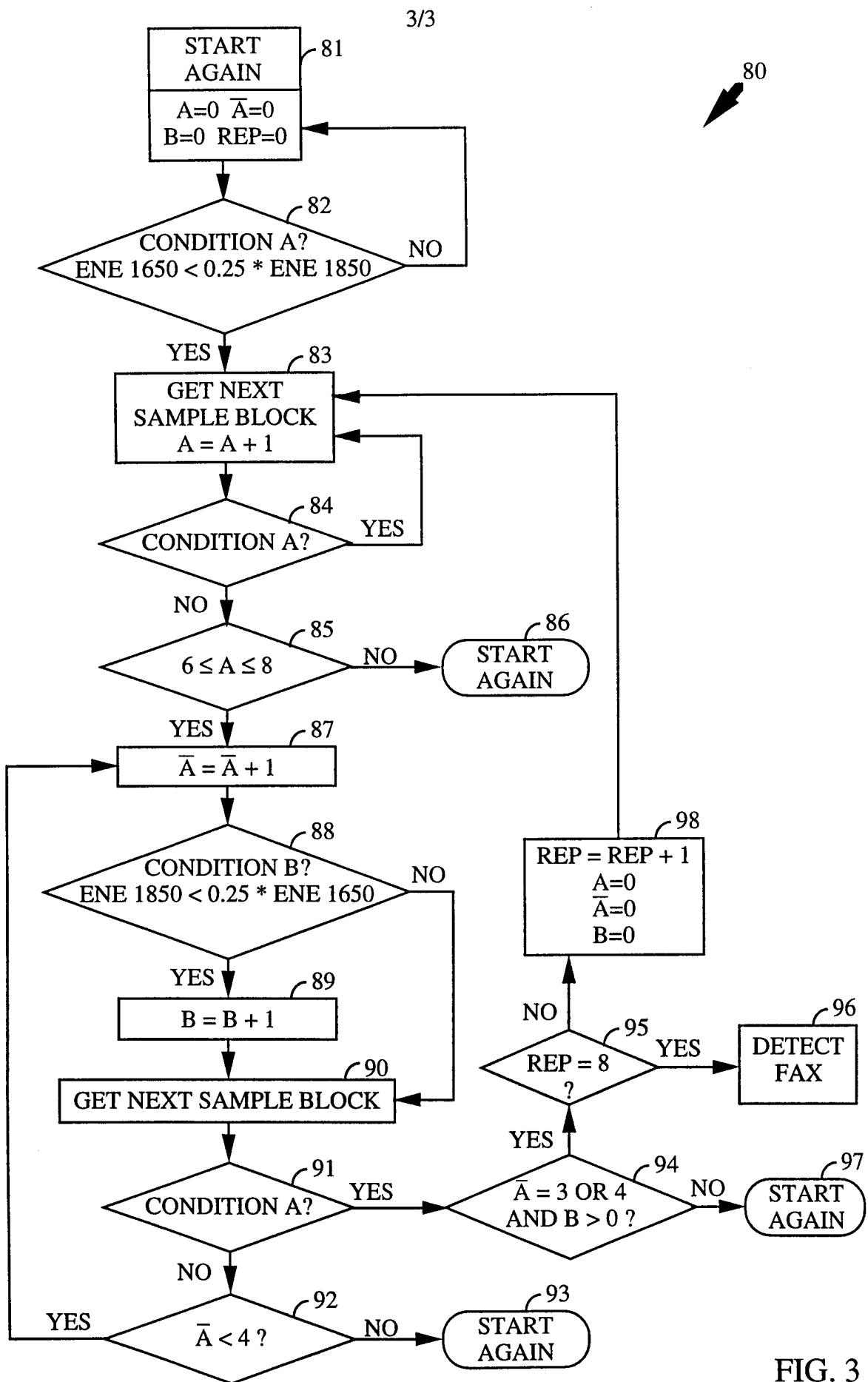


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 97/20757

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04N1/327 H04Q7/32 H04Q7/22 H04M1/72

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N H04Q H04M

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category [°] | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------------------|---|-----------------------|
| A | US 5 022 071 A (MOZER FORREST S ET AL) 4 June 1991 see abstract --- | 1,6 |
| A | GB 2 169 174 A (CANON KK) 2 July 1986 see abstract --- | 2 |
| A | US 5 448 378 A (MATSUMOTO SEI) 5 September 1995 see column 8, line 37 - line 41 ----- | 4 |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

18 March 1998

Date of mailing of the international search report

26/03/1998

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