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(54) AN ULTRASOUND IMAGING SYSTEM, AND A PROCESSING DEVICE USED INSIDE SAID ULTRASOUND IMAGING SYSTEM

ULTRASCHALLBILDGEBUNGSSYSTEM SOWIE VERARBEITUNGSVORRICHTUNG ZUR VERWENDUNG IN DIESEM ULTRASCHALLBILDGEBUNGSSYSTEM

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(73) Proprietor: **SuperSonic Imagine**
13857 Aix-en-Provence Cedex 3 (FR)

(72) Inventors:
- **MAURICE, François**
  83300 Draguignan (FR)
- **FELIX, Nicolas**
  13090 Aix-en-Provence (FR)

(74) Representative: **Cabinet Plasseraud**
66, rue de la Chaussée d'Antin
75440 Paris Cedex 09 (FR)

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Description

FIELD OF THE INVENTION

[0001] The present invention concerns an ultrasound imaging system.

BACKGROUND OF THE INVENTION

[0002] It is known an ultrasound imaging system comprising:

- an ultrasound probe comprising a plurality of transducers for emitting and receiving an ultrasound wave inside a medium, a received ultrasound wave being sensed by said transducers and being converted into input data by at least one analog to digital converter, and
- a computer receiving said input data through a data channel and processing these input data to provide an image representing a portion of said medium.

[0003] According to a first known embodiment, illustrated on the **figure 1,** a digital acquisition board (DAB), that is an interface board, is located between the ultrasound probe and the computer. Such interface board comprises a programmable logic device (PLD), usually a FPGA circuit, or a digital signal processor (DSP) for processing a beamforming process on at least a predetermined and limited number of signals. The beamformed data are then transmitted to the computer via a data channel.

[0004] In that case, the interface board comprises a predetermined and limited number of input signals, and the PLD or DSP has a limited computational power. If the number of transducers is increased, a new interface board must be designed, which is very expensive.

[0005] According to a second known embodiment, illustrated in the **figure 2,** the digital acquisition board (DAB) or interface board is located between the ultrasound probe and the computer. The interface board sends all the sensed signal samples (input data) to the computer by multiplexing them into a data channel.

[0006] Depending on the number of transducers, the data channels existing inside a standard computer are usually not able to absorb the input data rate from the transducers. Even though the data channels are efficient, the microprocessor of the computer is then unable to operate the beamforming process upon such a huge quantity of input data.

[0007] Document US2009/0054770 discloses an ultrasound imaging system, having an interface unit between the probe and the back-end imaging device. The interface unit performs the transmit control and the signal acquisition, as well as, buffering of the acquired signals. However, it does not perform any kind of image processing on these signals. Document US5795297 describes a modular ultrasound imaging system, which however does not buffer the acquired ultrasound signals and thus can not be used without major modifications, in case the number of the transducers is increased.

OBJECTS AND SUMMARY OF THE INVENTION

[0008] One object of the present invention is to provide an ultrasound imaging system so that the above limitations are removed.

[0009] To this effect, the ultrasound imaging system comprises a processing device located between the probe and the computer, and said processing device comprises:

- a first channel for receiving the input data corresponding to the received ultrasound wave,
- a second channel for transmitting output data to the computer,
- at least a processing unit comprising a memory or connected to a memory, said memory being adapted to store the input data and the output data, and said processing unit being adapted to operate an imaging method based upon said input data and to provide the output data, and said memory and processing unit forming a sub-assembly,
- a switch unit connected to the first channel, to the second channel and to said sub-assembly, said switch unit being adapted for routing the input data directly from the first channel to said memory and for routing the output data from said memory to the second channel.

[0010] Thanks to these features, the ultrasound imaging device is able to manage a first channel high rate from the probe to the memory, and is able to manage a second channel low rate from the memory to the computer. Such ultrasound imaging device architecture is therefore not dependent to the number of transducers, and it is easily scalable.

[0011] The processing unit can be chosen in a list of processing unit having a channel compatible with said switch unit. The processing unit can be a standard commercial processing unit, and is not expensive.

[0012] The computer does not need to be a powerful computer. A laptop computer may be used. The ultrasound imaging system is therefore more compact and less expensive.

[0013] In various embodiments of the ultrasound imaging device, one and/or other of the following features may optionally be incorporated.

[0014] According to another aspect of the invention:

- the second channel is a bidirectional channel, and is further adapted for receiving a processing program and processing data from the computer,
- the memory is further adapted for storing the processing program and the processing data , and
- the switch is further adapted for routing the process-

ing program and the processing data from the computer to the memory through said second channel.

[0015] According to another aspect of the invention, the second channel is a PCI express bus.

[0016] According to another aspect of the invention, the sub-assembly is connected to the switch unit via a PCI express bus.

[0017] According to another aspect of the invention, the switch unit is a PCI express switch.

[0018] According to another aspect of the invention, the sub-assembly is integrated inside a single electronic board.

[0019] According to another aspect of the invention, the processing unit and the memory are integrated inside a single electronic circuit.

[0020] According to another aspect of the invention, the processing unit is a graphic processing unit.

[0021] According to another aspect of the invention, the ultrasound imaging system comprises:

- a plurality of processing devices, and
- a system switch for routing the output data from each second channel of each processing devices to a third channel connected to the computer.

[0022] According to another aspect of the invention, the input and second channels of each processing units are PCI express buses and the third channel is a PCI express bus.

[0023] Another object of the invention is to provide a processing device for use in an ultrasound imaging system, said ultrasound imaging system comprising:

- at least an ultrasound probe comprising a plurality of transducers for emitting and receiving an ultrasound wave inside a medium, a received ultrasound wave being sensed by said transducers and converted into input data by at least one analog to digital converter, and
- a computer adapted at least for controlling the ultrasound probe and for visualizing an image representing a portion of said medium,

wherein the processing device is located between the ultrasound probe and the computer, and comprises:

- a first channel for receiving the input data corresponding to the received ultrasound wave,
- a second channel for transmitting the output data to the computer,
- at least a processing unit comprising a memory or connected to a memory, said memory being adapted to store the input data and the output data, and said processing unit being adapted to operate an imaging method based upon said input data and to provide the output data, and said memory and processing unit forming a sub-assembly,
- a switch unit connected to the first channel, to the second channel and to said sub-assembly, said switch unit being adapted for routing the input data directly 35 from the first channel to said memory and for routing the output data from said memory to the second channel.

[0024] In preferred embodiments of the processing device, one and/or the other of the following features may optionally be incorporated.

[0025] According to another aspect of the invention:

- the second channel is a bidirectional channel, and is further adapted for receiving a processing program and processing data from the computer,
- the memory is further adapted for storing the processing program and the processing data , and
- the switch is further adapted for routing the processing program and the processing data from the computer to the memory through said second channel.

[0026] According to another aspect of the invention, the first channel is a PCI express bus.

[0027] According to another aspect of the invention, the second channel is a PCI express bus.

[0028] According to another aspect of the invention, the switch unit is a PCI express switch.

[0029] According to another aspect of the invention, the processing unit is a graphic processing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Other features and advantages of the invention will be apparent from the following detailed description of four of its embodiments given by way of non-limiting example, with reference to the accompanying drawings. In the drawings:

- Figure 1 is an ultrasound imaging system according to a first prior art embodiment wherein the beamforming process is carried out by an interface board;
- Figure 2 is an ultrasound imaging system according to a second prior art embodiment wherein beamforming process is carried out by the computer;
- Figure 3 is an ultrasound imaging system according to a first embodiment of the invention;
- Figure 4 is an ultrasound imaging system according to a second embodiment of the invention;
- Figure 5 is an ultrasound imaging system according to a third embodiment of the invention;
- Figure 6 is an ultrasound imaging system according to a fourth embodiment of the invention;
- Figure 7 is an ultrasound imaging system according to a fifth embodiment of the invention.

MORE DETAILLED DESCRIPTION

[0031] In the various figures, the same reference num-

bers indicate identical or similar elements.

[0032] Referring back to the prior art **figure 1,** such known ultrasound imaging system comprises:

- a probe 3 having a plurality of transducers 3a, for emitting and receiving an ultrasound wave inside a medium 2, and providing transducers signals 4,
- a digital analog board (DAB) 5 connected to said probe 3, receiving the transducers signals and providing data on a second channel 6, and
- a computer 20 receiving said data from the DAB 5.

[0033] The DAB 5 comprises an analog transmitter receiver multiplexer 5a connected to said transducers 3a, a plurality of amplifiers 5b to amplify the transducers signals into amplified signals, and analog to digital converters (ADC) 5c to convert the amplified signals into first digital values and providing said first digital values to a circuit 5d, said circuit 5d being a programmable logic device (PLD) 7b, for example a field-programmable gate array (FPGA) or a digital signal processor (DSP).

[0034] The circuit 5d implements a logic corresponding to a beamforming method and provides output data of beamformed data on the second channel 6 for the computer 20.

[0035] The implemented beamformed method is programmed inside the circuit 5d during the system start up from the computer 20 or from an on-board flash memory, and can hardly be changed after. The implemented beamformed method can process a predetermined number of transducers signals. Therefore, such ultrasound imaging system architecture is predetermined at manufacturing; it is not modular and not easily scalable. For example, any change in the number of transducers signals or any change in the imaging method, will incur the need to design a new board or at least to program a new circuit 5d. Additionally, the known circuits are not enough powerful if the number of transducers signals increases a lot, and for example for a number of transducers signals higher than two hundreds, the known circuits 5d are not able to process a beamforming method on these signals.

[0036] As usual, the computer 20 comprises:

- a keyboard 25 for inputting information or control command from a user, and
- a screen 26 for visualising beamformed image to said user.

[0037] The second channel 6 is a bidirectional channel. The computer 20 also provides second digital values to the DAB 5 for emitting an ultrasound wave inside the medium 2.

[0038] The circuit 5d sends said second digital values to a digital analog converter 5e to produce signals. These signals are amplified by an amplifier 5f, and multiplexed by the analog transmitter receiver multiplexer 5a. The amplified signals are therefore sent to the probe transducers 3a for generating an ultrasound wave inside the medium 2.

[0039] Referring to the prior art **figure 2,** such known ultrasound imaging system differs from the first one by its circuit 5d. The circuit 5d is here only a bidirectional multiplexer that provides the first digital values from the ADC 5c to the computer 20 via the second channel 6, and that provides the second digital values from the computer 20 via the second channel 6 to the DAC 5e.

[0040] The computer 20 comprises a bridge 21 that interconnects the computer inner data channels. The bridge 21 connects the second channel 6 from the DAB 5, a memory 22 and a microprocessor 23. The computer 20 executes a beamforming software stored inside an hard drive 24. The beamforming software implements a beamforming method that uses the first digital values from the transducers. For example, the beamforming software implements known beamforming method, wherein the first digital values from the plurality of transducers 3a are each delayed with a predetermined delay, and summed together to compute an image of a slice inside the medium 2.

[0041] Such ultrasound imaging system is modular and scalable.

[0042] However, all the first digital values are transferred to the computer 20 and all the data processing is done by the computer 20. If the number of transducers is huge, for example several hundreds, the data channels usually embedded inside a standard computer, such as a USB or PCI express, are not able to absorb directly the input data rate from these transducers. A plurality of data channels may be used in parallel to increase the allowable rate, but the microprocessor and optional coprocessor embedded inside the computer may then be unable to operate the beamforming process upon such huge quantity of input data.

[0043] Therefore, even if such ultrasound imaging system architecture is pleasant and completely modular, it can not be carried out for a huge number of transducers, and therefore can not be carried out for producing accurate 2D real time images or for 3D images.

[0044] **Figure 3** represents an ultrasound imaging system according to present invention that comprises a processing device 10 located between the probe 3 and the computer 20.

[0045] In this first embodiment, the system comprises a DAB 5 after the probe 3. The processing device 10 is therefore connected between the DAB 5 and the computer 20.

[0046] The processing device 10 comprises at least:

- a first channel 11 for receiving the input data corresponding to the received ultrasound wave,
- a second channel 12 for transmitting output data to the computer,
- at least a processing unit 15 comprising a memory 14 or connected to a memory 14, and
- a switch unit 13 for routing the input data directly

from the first channel to said memory and for routing the output data from said memory to the second channel.

[0047] The memory 14 is adapted to store the input and output data.

[0048] The processing unit 15 is adapted to process a beamforming method or any imaging method based upon said input data, so that to provide the output data.

[0049] The processing unit 15 may be a graphic processing unit (GPU).

[0050] The switch unit 13 is therefore able to manage different channel rates. The second channel rate can be low, and the computer can be a low cost computer. Thanks to such architecture comprising a switch unit, the ultrasound imaging system is scalable.

[0051] The first channel may be a PCI express bus, or a USB bus, or the like.

[0052] The second channel may be a PCI express bus, or a USB bus, or the like.

[0053] The memory 14 and the processing unit 15 form a sub-assembly. Such sub-assembly may be integrated inside a single electronic board.

[0054] The sub-assembly may be connected to the switch unit 13 via a PCI express bus or the like.

[0055] The sub-assembly may be a Mobile PCI-Express Module (MXM).

[0056] Thanks to these features, the processing device 10 may use standard commercial processing units that are low cost. The ultrasound imaging system of the invention is less expensive than the equivalent (having same number of transducers) and than the prior art systems.

[0057] The second channel 12 is advantageously a bidirectional channel. The computer 20 can therefore provide digital values to the DAC 5e for generating the emitted ultrasound wave inside the medium 2.

[0058] Advantageously, the second channel 12 is also adapted for providing at least a processing program and processing data from the computer 20 to the memory 14, said processing program being the program that implements a beamforming or an imaging method. The processing unit 15 is then able to operate this processing program stored in memory 14.

[0059] The processing program can be updated or changed, and the ultrasound imaging system is scalable and upgradable.

[0060] Thanks to the switch 13 and the second channel 12, the processing unit 15 is seen from the computer as an internal resource; as it is located inside the computer 20. In case of a plurality of processing units 15, they are all seen as inside the computer. The program implementing the imaging method is easily developed because the program developed for the second prior art is very similar, and need only minor changes to be adapted to the new ultrasound imaging system architecture.

[0061] **Figure 4** represents a second embodiment of the invention, wherein the DAB 5 located after the probe 3 is integrated inside the processing device 10 before the switch unit 13. The first channel 11 is inside the processing device 10 and connects the DAB 5 to the switch unit 13.

[0062] **Figure 5** represents a third embodiment of the invention comprising a plurality of processing devices $10_1 ... 10_N$. The system comprises a number N of processing devices. Each processing device 10_i, i representing an index value between 1 and N, is connected:

- at its input to a corresponding DAB 5_i via a corresponding first channel 11_i, and
- at its output to a system switch 18 via a second channel 12_i.

[0063] The system switch 18 gathers all the output data from all the processing devices $10_1 ... 10_N$ and sends these data to the computer 20 via a third channel 19 (system channel).

[0064] Thanks to such architecture, the ultrasound imaging system is scalable. The computing power of all the processing devices grows with the number of transducers. The computer 20 is independent to said transducers number, and can still be a laptop computer.

[0065] The processing devices 10_i may also be connected to each other via an optional connexion channel 16_i, in a linear architecture as represented on figure 5: A processing device i is connected to the next one via the connexion channel 16_i. The last processing device 10_N is connected to the first processing device 10_1 via the last connexion channel 16_N.

[0066] In this embodiment, the switch unit 13 of each processing device 10_i comprises a first additional channel for connecting the previous processing device and a second additional channel for connecting the next processing device 10_{i+1}.

[0067] Thanks to these features the processing units $15_1 ... 15_N$ of the system may communicate to each other, to operate a more complex imaging method based on a number of transducers higher than the number of transducers connected to one DAB 5.

[0068] **Figure 6** represents a fourth embodiment of an ultrasound imaging system wherein the processing device 10 comprises a plurality of sub-assemblies, each of one comprising a memory 14_j and a processing unit 15_j, j being an index comprised between 1 and M, M being a number of sub-assemblies. Each assembly is connected to the switch unit 13 via a connexion channel.

[0069] The connexion channel may be a PCI Express bus or the like.

[0070] **Figure 7** represents a fifth embodiment of an ultrasound imaging system, wherein the probe 3 comprises the DAC and ADC 3b. The probe is therefore a digital probe outputting directly digital values. The probe 3 is then directly connected to the switch unit 13 of the processing device 10 via the first channel 11.

[0071] In this embodiment, the first channel 11 may be a USB 3.0 bus.

[0072] The features of this fifth embodiment may be used in all previous embodiments to provide a full digital architecture to the ultrasound imaging device.

[0073] The second channels in the previous embodiments are advantageously PCI express buses. Each of them may comprise a plurality of lane (between 1 and 32 lanes). The number of used lanes can be adapted to the needed rate for a predetermined ultrasound imaging system, and depending on the number of transducers, the imaging method used. Thanks to this feature the ultrasound imaging system is again more scalable.

[0074] Such new architecture of ultrasound imaging system makes it now possible to build a fast 3D ultrasound imaging system.

Claims

1. **An ultrasound imaging system** comprising:

   - at least an ultrasound probe (3) comprising a plurality of transducers (3a) for emitting and receiving an ultrasound wave inside a medium (2), a received ultrasound wave being sensed by said transducers and converted into input data by at least one analog to digital converter, and
   - a computer (20) adapted at least for controlling the ultrasound probe and for visualizing an image representing a portion of said medium,

   wherein the ultrasound imaging system comprises a processing device located between the probe and the computer, and said processing device comprises:

   - a first channel (11) for receiving the input data corresponding to the received ultrasound wave,
   - a second channel (12) for transmitting output data to the computer,
   - at least a processing unit (15) comprising a memory (14) or connected to a memory (14), said memory (14) being adapted to store the input data and the output data, and said processing unit (15) being adapted to operate an imaging method based upon said input data and to provide the output data, said memory and processing unit forming a sub-assembly and
   - a switch unit (13) connected to the first channel, to the second channel and to said sub-assembly, said switch unit being adapted for routing the input data directly from the first channel to said memory and for routing the output data from said memory to the second channel.

2. The ultrasound imaging system according to claim 1, wherein

   - the second channel is a bidirectional channel, and is further adapted for receiving a processing program and processing data from the computer,
   - the memory is further adapted for storing the processing program and the processing data , and
   - the switch is further adapted for routing the processing program and the processing data from the computer to the memory through said second channel.

3. The ultrasound imaging system according to claim 1 or claim 2, wherein the second channel (12) is a PCI express bus.

4. The ultrasound imaging system according to any one of the claims 1 to 3, wherein the sub-assembly is connected to the switch unit (13) via a PCI express bus.

5. The ultrasound imaging system according to any one of the claims 1 to 4, wherein the switch unit (13) is a PCI express switch.

6. The ultrasound imaging system according to any one of the claims 1 to 5, wherein the sub-assembly is integrated inside a single electronic board.

7. The ultrasound imaging system according to any one of the claims 1 to 6, wherein the processing unit (15) and the memory (14) are integrated inside a single electronic circuit.

8. The ultrasound imaging system according to any one of the claims 1 to 7, wherein the processing unit (15) is a graphic processing unit.

9. The ultrasound imaging system according to claim 1, comprising:

   - a plurality of processing devices (10_1 to 10_N), and
   - a system switch (18) for routing the output data from each second channel (12_1 to 12_N) of each processing devices (10_1 to 10_N)to a third channel (19) connected to the computer (20).

10. The ultrasound imaging system according to claim 9, wherein the input and second channels (11_1 to 11_N; 12_1 to 12_N) of each processing units (10_1 to 10_N)are PCI express buses and the third channel is a PCI express bus.

11. **A processing device (10)** for use in an ultrasound imaging system, said ultrasound imaging system comprising:

    - at least an ultrasound probe (3) comprising a

plurality of transducers (3a) for emitting and receiving an ultrasound wave inside a medium (2), a received ultrasound wave being sensed by said transducers (3a) and converted into input data by at least one analog to digital converter, and
- a computer (20) adapted at least for controlling the ultrasound probe and for visualizing an image representing a portion of said medium,

wherein the processing device (10) is adapted to be located between the ultrasound probe and the computer, and wherein the processing device comprises:

- a first channel (11) for receiving the input data corresponding to the received ultrasound wave,
- a second channel (12) for transmitting the output data to the computer,
- at least a processing unit (15) comprising a memory (14) or connected to a memory (14), said memory (14) being adapted to store the input data and the output data, and said processing unit (15) being adapted to operate an imaging method based upon said input data and to provide the output data, said memory and processing unit forming a sub-assembly and
- a switch unit (13) connected to the first channel, to the second channel and to said sub-assembly, said switch unit being adapted for routing the input data directly from the first channel to said memory and for routing the output data from said memory to the second channel.

12. The processing device according to claim 11

- the second channel is a bidirectional channel, and is further adapted for receiving a processing program and processing data from the computer,
- the memory is further adapted for storing the processing program and the processing data , and
- the switch is further adapted for routing the processing program and the processing data from the computer to the memory through said second channel.

13. The processing device according to claim 11 or claim 12, wherein the first channel (11) is a PCI express bus.

14. The processing device according to any one of the claims 11 to 13, wherein the second channel (12) is a PCI express bus.

15. The processing device according to any one of the claims 11 to 14, wherein the switch unit (13) is a PCI express switch.

16. The processing device according to any one of the claims 11 to 15, wherein the processing unit (15) is a graphic processing unit.

Patentansprüche

1. Ultraschallbildgebungssystem aufweisend:

- mindestens einen Ultraschallsensor (3) mit mehreren Wandlern (3a) zum Senden und Empfangen einer Ultraschallwelle im Innern eines Mediums (2), wobei eine empfangene Ultraschallwelle von den Wandlern detektiert und von mindestens einem Analog/DigitalUmsetzer in Eingabedaten umgesetzt wird,
- einen Computer (20), der konfiguriert ist, zumindest den Ultraschallsensor zu steuern und ein Bild, das einen Teil des Mediums repräsentiert, visuell darzustellen,

wobei das Ultraschallbildgebungssystem eine zwischen dem Sensor und dem Computer angeordnete Verarbeitungsvorrichtung aufweist, und die Verarbeitungsvorrichtung aufweist:

- einen ersten Kanal (11) zum Empfangen der Eingabedaten, die der empfangenen Ultraschallwelle entsprechen,
- einen zweiten Kanal (12) zum Senden von Ausgabedaten zu dem Computer,
- mindestens eine Verarbeitungseinheit (15), die einen Speicher (14) aufweist oder mit einem Speicher (14) verbunden ist, wobei der Speicher (14) konfiguriert ist, die Eingabedaten und die Ausgabedaten zu speichern, und die Verarbeitungseinheit (15) konfiguriert ist, ein Bildgebungsverfahren auf Basis der Eingabedaten zu betreiben und die Ausgabedaten bereitzustellen, wobei der Speicher und die Verarbeitungseinheit eine Unteranordnung bilden, und
- eine Schaltereinheit (13), die mit dem ersten Kanal, mit dem zweiten Kanal und mit der Unteranordnung verbunden ist, wobei die Schaltereinheit konfiguriert ist, die Eingabedaten direkt aus dem ersten Kanal zu dem Speicher zu leiten und die Ausgabedaten aus dem Speicher zu dem zweiten Kanal zu leiten.

2. Ultraschallbildgebungssystem nach Anspruch 1, wobei

- der zweite Kanal ein Zweirichtungskanal ist und ferner konfiguriert ist, ein Verarbeitungsprogramm und Verarbeitungsdaten aus dem Computer zu empfangen,
- der Speicher ferner konfiguriert ist, das Verarbeitungsprogramm und die Verarbeitungsdaten

zu speichern, und
- der Schalter ferner konfiguriert ist, das Verarbeitungsprogramm und die Verarbeitungsdaten aus dem Computer durch den zweiten Kanal zu dem Speicher zu leiten.

3. Ultraschallbildgebungssystem nach Anspruch 1 oder Anspruch 2, wobei der zweite Kanal (12) ein PCI-Expressbus ist.

4. Ultraschallbildgebungssystem nach einem der Ansprüche 1 bis 3, wobei die Unteranordnung über einen PCI-Expressbus mit der Schaltereinheit (13) verbunden ist.

5. Ultraschallbildgebungssystem nach einem der Ansprüche 1 bis 4, wobei die Schaltereinheit (13) ein PCI-Express-Schalter ist.

6. Ultraschallbildgebungssystem nach einem der Ansprüche 1 bis 5, wobei die Unteranordnung in einer einzigen elektronischen Platine integriert ist.

7. Ultraschallbildgebungssystem nach einem der Ansprüche 1 bis 6, wobei die Verarbeitungseinheit (15) und der Speicher (14) in einer einzigen elektronischen Schaltung integriert sind.

8. Ultraschallbildgebungssystem nach einem der Ansprüche 1 bis 7, wobei die Verarbeitungseinheit (15) eine graphische Verarbeitungseinheit ist.

9. Ultraschallbildgebungssystem nach Anspruch 1, aufweisend:

- mehrere Verarbeitungsvorrichtungen (10_1 bis 10_N) und
- einen Systemschalter (18) zum Leiten der Ausgabedaten aus jedem zweiten Kanal (12_1 bis 12_N) jeder Verarbeitungsvorrichtung (10_1 bis 10_N) zu einem mit dem Computer (20) verbundenen dritten Kanal (19).

10. Ultraschallbildgebungssystem nach Anspruch 9, wobei die Eingabe- und zweiten Kanäle (11_1 bis 11_N; 12_1 bis 12_N) jeder Verarbeitungseinheit (10_1 bis 10_N) PCI-Expressbusse sind und der dritte Kanal ein PCI-Expressbus ist.

11. Verarbeitungsvorrichtung (10) zur Verwendung in einem Ultraschallbildgebungssystem, wobei das Ultraschallbildgebungssystem aufweist:

- mindestens einen Ultraschallsensor (3) mit mehreren Wandlern (3a) zum Senden und Empfangen einer Ultraschallwelle im Innern eines Mediums (2), wobei eine empfangene Ultraschallwelle von den Wandlern (3a) detektiert und von mindestens einem Analog/DigitalUmsetzer in Eingabedaten umgesetzt wird, und
- einen Computer (20), der konfiguriert ist, zumindest den Ultraschallsensor zu steuern und ein Bild, das einen Teil des Mediums repräsentiert, visuell darzustellen,

wobei die Verarbeitungsvorrichtung (10) konfiguriert ist, zwischen dem Ultraschallsensor und dem Computer angeordnet zu werden, und die Verarbeitungsvorrichtung aufweist:

- einen ersten Kanal (11) zum Empfangen der Eingabedaten, die der empfangenen Ultraschallwelle entsprechen,
- einen zweiten Kanal (12) zum Senden der Ausgabedaten zu dem Computer,
- mindestens eine Verarbeitungseinheit (15), die einen Speicher (14) aufweist oder mit einem Speicher (14) verbunden ist, wobei der Speicher (14) konfiguriert ist, die Eingabedaten und die Ausgabedaten zu speichern, und die Verarbeitungseinheit (15) konfiguriert ist, ein Bildgebungsverfahren auf Basis der Eingabedaten zu betreiben und die Ausgabedaten bereitzustellen, wobei der Speicher und die Verarbeitungseinheit eine Unteranordnung bilden, und
- eine Schaltereinheit (13), die mit dem ersten Kanal, mit dem zweiten Kanal und mit der Unteranordnung verbunden ist, wobei die Schaltereinheit konfiguriert ist, die Eingabedaten direkt aus dem ersten Kanal zu dem Speicher zu leiten und die Ausgabedaten aus dem Speicher zu dem zweiten Kanal zu leiten.

12. Verarbeitungsvorrichtung nach Anspruch 11 oder 12, wobei

- der zweite Kanal ein Zweirichtungskanal ist und ferner konfiguriert ist, ein Verarbeitungsprogramm und Verarbeitungsdaten aus dem Computer zu empfangen,
- der Speicher ferner konfiguriert ist, das Verarbeitungsprogramm und die Verarbeitungsdaten zu speichern, und
- der Schalter ferner konfiguriert ist, das Verarbeitungsprogramm und die Verarbeitungsdaten aus dem Computer durch den zweiten Kanal zu dem Speicher zu leiten.

13. Verarbeitungsvorrichtung nach Anspruch 11 oder 12, wobei der erste Kanal (11) ein PCI-Expressbus ist.

14. Verarbeitungsvorrichtung nach einem der Ansprüche 11 bis 13, wobei der zweite Kanal (12) ein PCI-Expressbus ist.

15. Verarbeitungsvorrichtung nach einem der Ansprüche 11 bis 14, wobei die Schaltereinheit (13) ein PCI-Express-Schalter ist.

16. Verarbeitungsvorrichtung nach einem der Ansprüche 11 bis 15, wobei die Verarbeitungseinheit (15) eine graphische Verarbeitungseinheit ist.

Revendications

1. Système d'imagerie ultrasonore comprenant :

- au moins une sonde ultrasonore (3) comprenant une pluralité de transducteurs (3a) destinés à émettre et recevoir une onde ultrasonore à l'intérieur d'un milieu (2), une onde ultrasonore reçue étant détectée par lesdits transducteurs et convertie en données d'entrée par au moins un convertisseur analogique-numérique, et
- un ordinateur (20) adapté au moins pour la commande de la sonde ultrasonore et la visualisation d'une image représentant une portion dudit milieu,

dans lequel le système d'imagerie ultrasonore comprend un dispositif de traitement situé entre la sonde et l'ordinateur, et ledit dispositif de traitement comprend :

- un premier canal (11) destiné à recevoir les données d'entrée correspondant à l'onde ultrasonore reçue,
- un deuxième canal (12) destiné à transmettre des données de sortie à l'ordinateur,
- au moins une unité de traitement (15) comprenant une mémoire (14) ou connectée à une mémoire (14), ladite mémoire (14) étant adaptée pour stocker les données d'entrée et les données de sortie, et ladite unité de traitement (15) étant adaptée pour exploiter une méthode d'imagerie basée sur lesdites données d'entrée et fournir les données de sortie, ladite mémoire et l'unité de traitement formant un sous-ensemble et
- une unité de commutateur (13) connectée au premier canal, au deuxième canal et audit sous-ensemble, ladite unité de commutateur étant adaptée pour le routage des données d'entrée directement du premier canal à ladite mémoire et pour le routage des données de sortie de ladite mémoire au deuxième canal.

2. Système d'imagerie ultrasonore selon la revendication 1, dans lequel

- le deuxième canal est un canal bidirectionnel, et est en outre adapté pour la réception d'un programme de traitement et de données de traitement depuis l'ordinateur,
- la mémoire est en outre adaptée pour le stockage de programme de traitement et des données de traitement, et
- le commutateur est en outre adapté pour le routage du programme de traitement et des données de traitement de l'ordinateur à la mémoire par le biais dudit deuxième canal.

3. Système d'imagerie ultrasonore selon la revendication 1 ou la revendication 2, dans lequel le deuxième canal (12) est un bus PCI Express.

4. Système d'imagerie ultrasonore selon l'une quelconque des revendications 1 à 3, dans lequel le sous-ensemble est connecté à l'unité de commutateur (13) via un bus PCI Express.

5. Système d'imagerie ultrasonore selon l'une quelconque des revendications 1 à 4, dans lequel l'unité de commutateur (13) est un commutateur PCI Express.

6. Système d'imagerie ultrasonore selon l'une quelconque des revendications 1 à 5, dans lequel le sous-ensemble est intégré à l'intérieur d'une carte électronique unique.

7. Système d'imagerie ultrasonore selon l'une quelconque des revendications 1 à 6, dans lequel l'unité de traitement (15) et la mémoire (14) sont intégrées à l'intérieur d'un circuit électronique unique.

8. Système d'imagerie ultrasonore selon l'une quelconque des revendications 1 à 7, dans lequel l'unité de traitement (15) est une unité de traitement graphique.

9. Système d'imagerie ultrasonore selon la revendication 1, comprenant :

- une pluralité de dispositifs de traitement (10_1 à 10_N),
et
- un commutateur système (18) pour le routage des données de sortie issues de chaque deuxième canal (12_1 à 12_N) de chaque dispositif de traitement (10_1 à 10_N) vers un troisième canal (19) connecté à l'ordinateur (20).

10. Système d'imagerie ultrasonore selon la revendication 9, dans lequel le canal d'entrée et le deuxième canal (11_1 à 11_N; 12_1 à 12_N) de chaque unité de traitement (10_1 à 10_N) sont des bus PCI Express et le troisième canal est un bus PCI Express.

11. Dispositif de traitement (10) à utiliser dans un système d'imagerie ultrasonore, ledit système d'image-

rie ultrasonore comprenant :

- au moins une sonde ultrasonore (3) comprenant une pluralité de transducteurs (3a) destinés à émettre et recevoir une onde ultrasonore à l'intérieur d'un milieu (2), une onde ultrasonore reçue étant détectée par lesdits transducteurs (3a) et convertie en données d'entrée par au moins un convertisseur analogique-numérique, et
- un ordinateur (20) adapté au moins pour la commande de la sonde ultrasonore et la visualisation d'une image représentant une portion dudit milieu,

dans lequel le dispositif de traitement (10) est adapté pour être situé entre la sonde ultrasonore et l'ordinateur, et dans lequel le dispositif de traitement comprend :

- un premier canal (11) destiné à recevoir les données d'entrée correspondant à l'onde ultrasonore reçue,
- un deuxième canal (12) destiné à transmettre des données de sortie à l'ordinateur,
- au moins une unité de traitement (15) comprenant une mémoire (14) ou connectée à une mémoire (14), ladite mémoire (14) étant adaptée pour stocker les données d'entrée et les données de sortie, et ladite unité de traitement (15) étant adaptée pour exploiter une méthode d'imagerie basée sur lesdites données d'entrée et fournir les données de sortie, ladite mémoire et l'unité de traitement formant un sous-ensemble et
- une unité de commutateur (13) connectée au premier canal, au deuxième canal et audit sous-ensemble, ladite unité de commutateur étant adaptée pour le routage des données d'entrée directement du premier canal à ladite mémoire et pour le routage des données de sortie de ladite mémoire au deuxième canal.

12. Dispositif de traitement selon la revendication 11

- le deuxième canal est un canal bidirectionnel, et est en outre adapté pour la réception d'un programme de traitement et de données de traitement depuis l'ordinateur,
- la mémoire est en outre adaptée pour le stockage de programme de traitement et des données de traitement, et
- le commutateur est en outre adapté pour le routage du programme de traitement et des données de traitement de l'ordinateur à la mémoire par le biais dudit deuxième canal.

13. Dispositif de traitement selon la revendication 11 ou la revendication 12, dans lequel le premier canal (11) est un bus PCI Express.

14. Dispositif de traitement selon l'une quelconque des revendications 11 à 13, dans lequel le deuxième canal (12) est un bus PCI Express.

15. Dispositif de traitement selon l'une quelconque des revendications 11 à 14, dans lequel l'unité de commutateur (13) est un commutateur PCI Express.

16. Dispositif de traitement selon l'une quelconque des revendications 11 à 15, dans lequel l'unité de traitement (15) est une unité de traitement graphique.

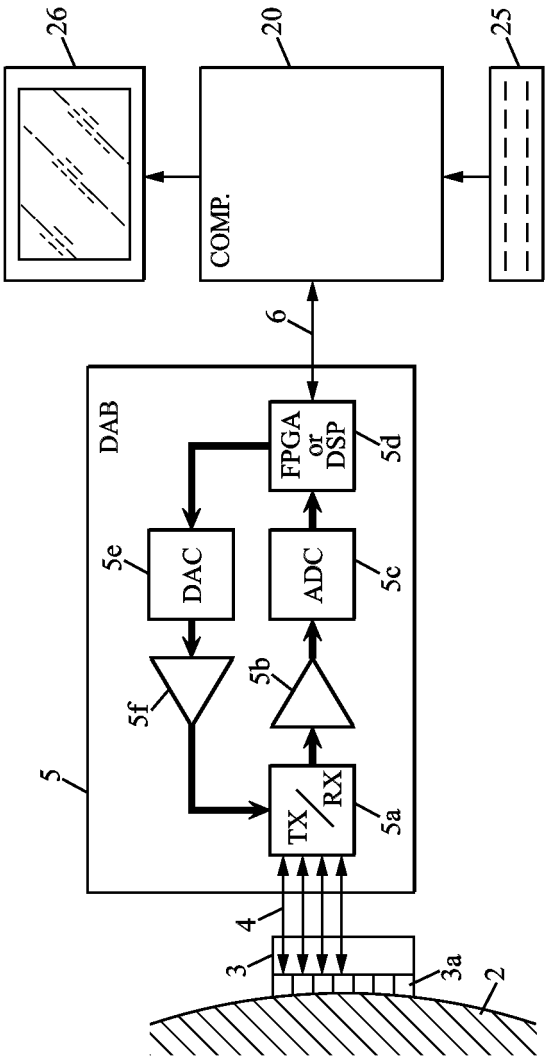

FIG. 1
(PRIOR ART)

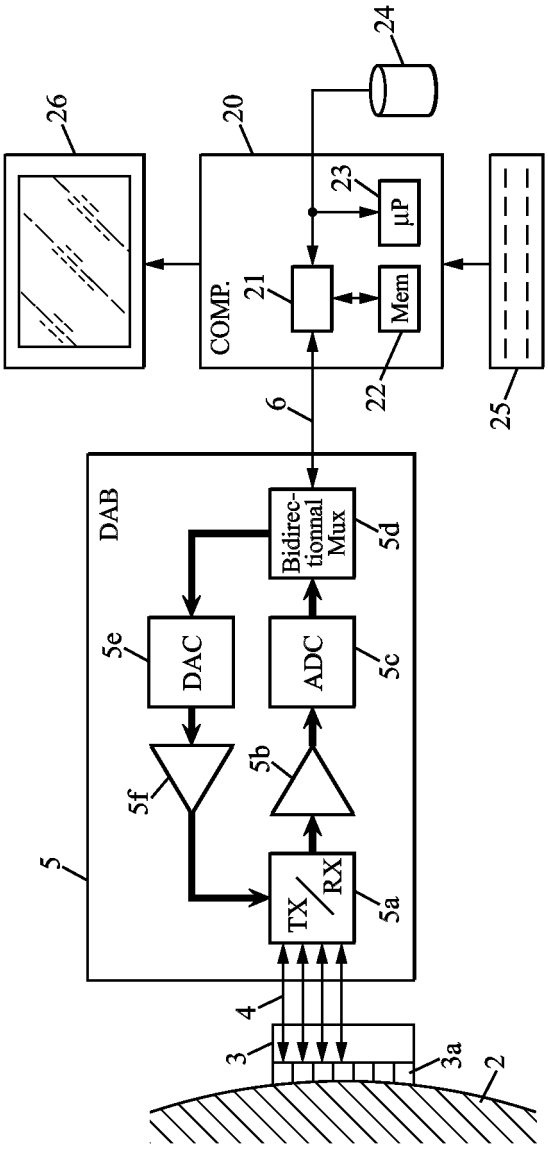

FIG. 2
(PRIOR ART)

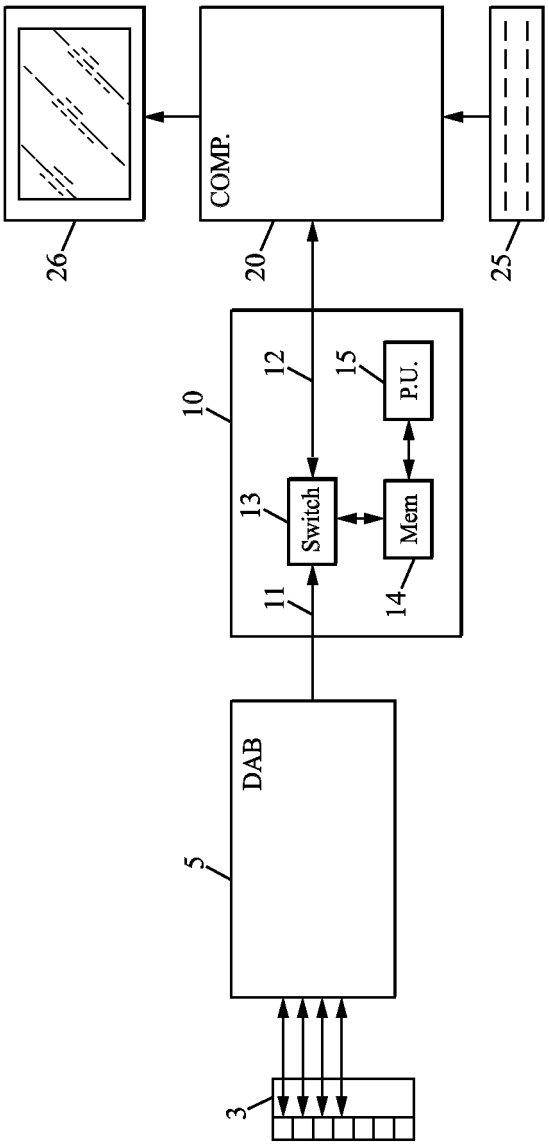

FIG. 3

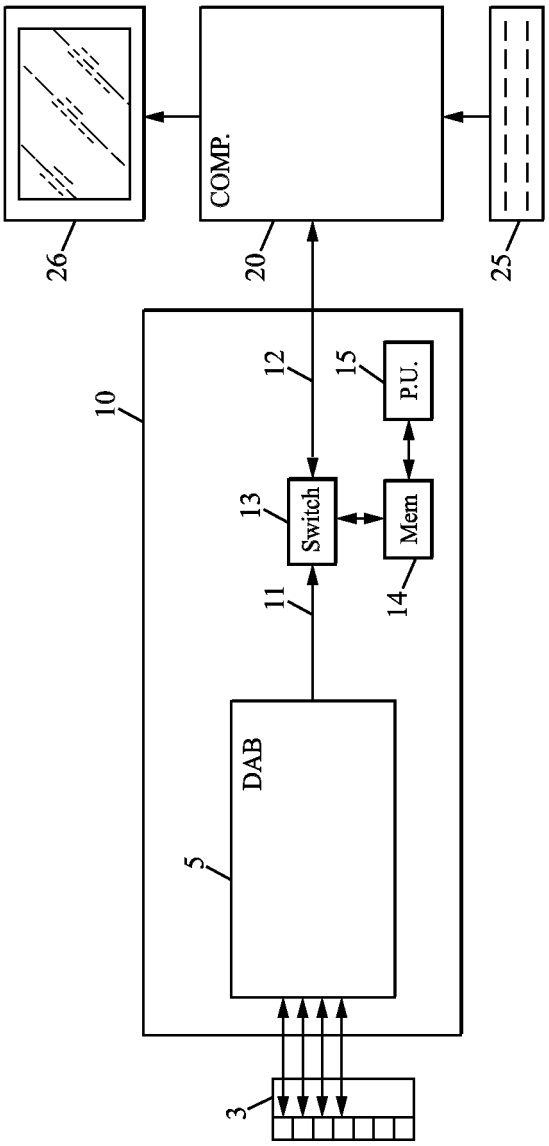

FIG. 4

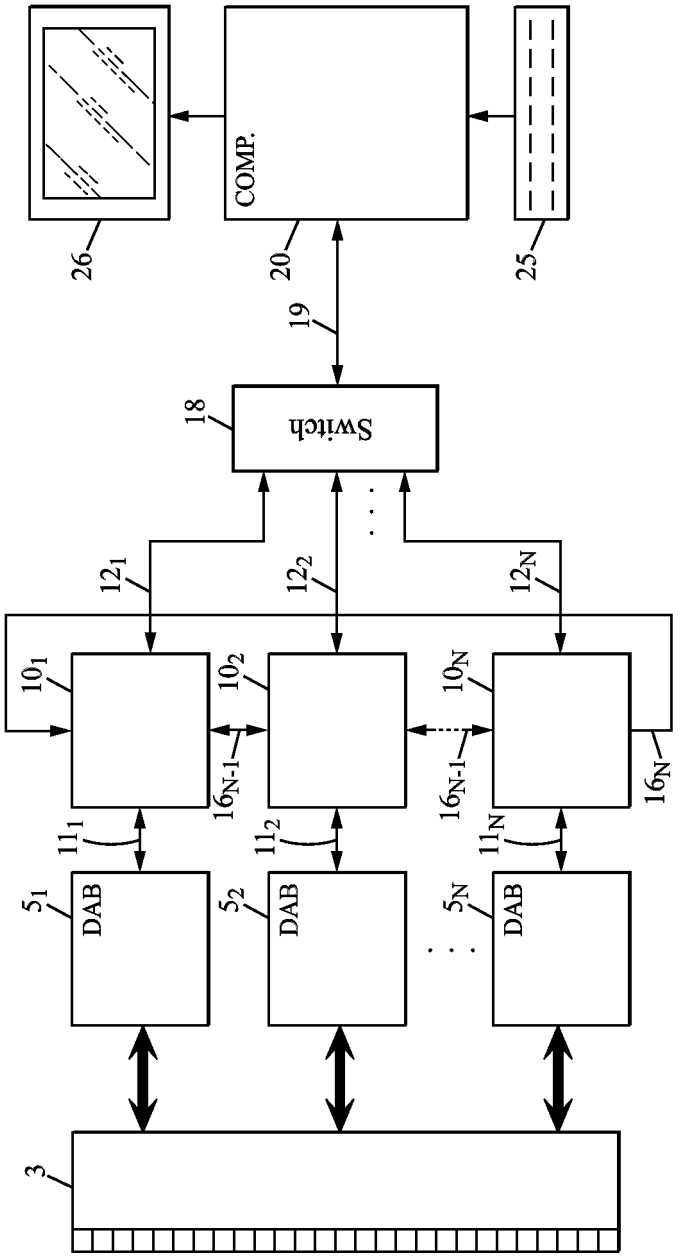
COMP.
26
20
25
19
18
Switch
12₁
12₂
12N
10₁
10₂
10N
16N-1
16N-1
16N
11₁
11₂
11N
5₁
5₂
5N
DAB
DAB
DAB
3

FIG. 5

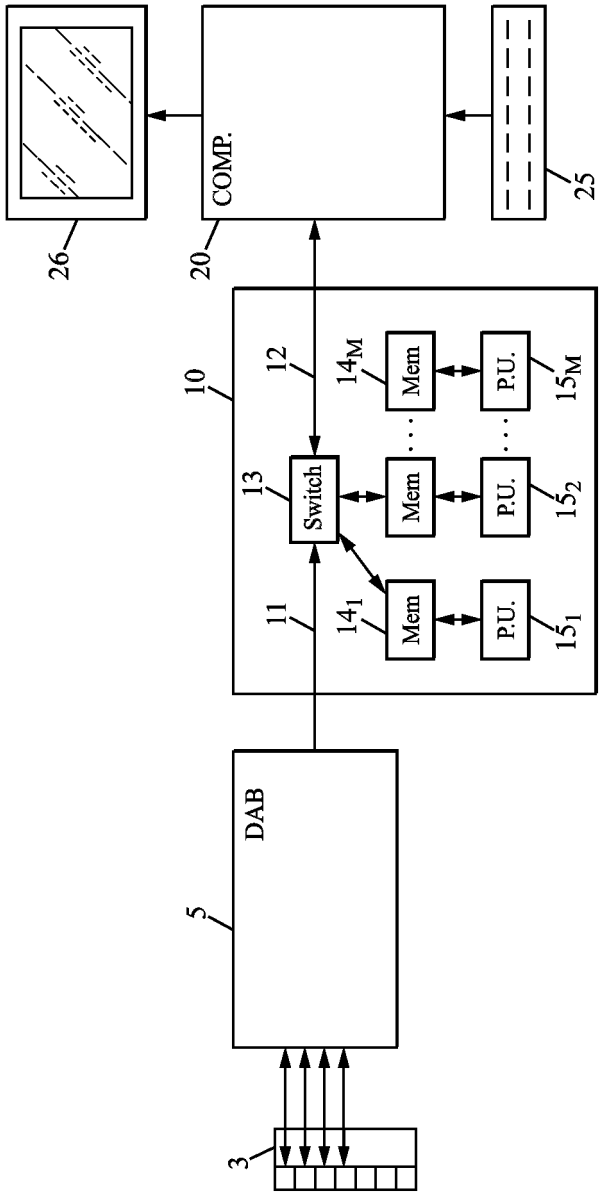
26
20
COMP.
25
10
12
14_M
Mem
P.U.
15_M
13
Switch
Mem
P.U.
15_2
11
14_1
Mem
P.U.
15_1
5
DAB
3

FIG. 6

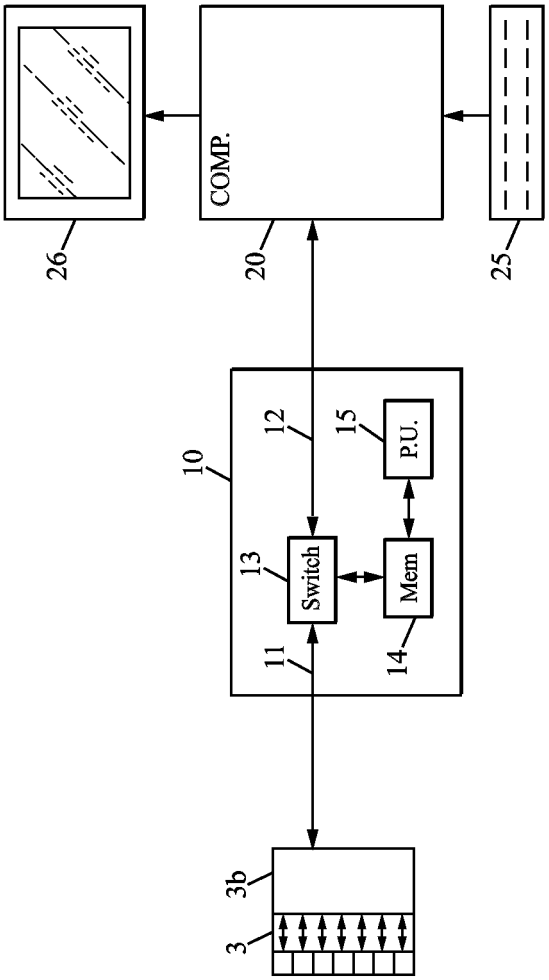

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20090054770 A **[0007]**
- US 5795297 A **[0007]**

专利名称(译)	超声成像系统，以及在超声成像系统内使用的处理设备		
公开(公告)号	EP2790584A1	公开(公告)日	2014-10-22
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[标]申请(专利权)人(译)	超声成像公司		
申请(专利权)人(译)	超音速IMAGINE		
当前申请(专利权)人(译)	超音速IMAGINE		
[标]发明人	MAURICE FRANCOIS FELIX NICOLAS		
发明人	MAURICE, FRANÇOIS FELIX, NICOLAS		
IPC分类号	A61B8/00		
CPC分类号	A61B8/4411 G01S7/034 G01S7/5208 G01S7/52082 G01S7/52017		
代理机构(译)	柜PLASSERAUD		
其他公开文献	EP2790584B1		
外部链接	Espacenet		

摘要(译)

超声成像系统包括超声探头（3）和计算机（20），用于控制超声探头和用于可视化图像。该系统包括位于探头和计算机之间的处理设备，该处理设备包括用于操作成像方法的处理单元（15）和用于路由输入和输出数据的开关单元（13）。