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(54) DIGITAL CONTROL METHOD FOR MEASURING BLOOD PRESSURE

DIGITALES STEUERVERFAHREN ZUR BLUTDRUCKMESSUNG

PROCÉDÉ DE RÉGULATION NUMÉRIQUE POUR MESURE DE TENSION ARTÉRIELLE

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Description

[0001] The present application is a non-provisional of U.S. provisional patent application serial no. 61/256,081 filed October 29, 2009 and from U.S. provisional patent application serial no. 61/256,110 filed October 29, 2009.

BACKGROUND

1. Field

[0002] The invention relates generally to a method of measuring blood pressure, and more particularly to a method of reducing the effects of noise in the light signal of a PPG blood pressure measuring system.

2. Description of Related Art

[0003] Pulse contour analysis (PCA) is the process of calculating parameters from a blood pressure pulse, especially from the contour of the pulse wave. PCA begins with measuring blood pressure (BP).

[0004] Blood pressure may be measured in a number of ways. As one example, a standard non-invasive sphygmomanometer (NBP) may be placed on the upper arm or wrist. The NBP applies pressure to the arteries, causing them to constrict and limit blood flow. As the pressure is released, blood flow is restored in the artery, and the systolic and diastolic blood pressures may be measured. NBP measures BP intermittently and not continuously, so it cannot be used for PCA.

[0005] Another device for measuring blood pressure is a finger cuff having an infrared light source and a light detector for measuring a photo-plethysmographic (PPG) signal that is known also from pulsoximetry. This PPG-signal is fed into a control system, which produces a counter pressure in the finger cuff. The counter pressure equals intra-arterial pressure when the PPG-signal is kept constant. Thus, the counter pressure, which is indirectly equivalent to intra-arterial pressure, is measured. This method is known as "Vascular Unloading Technique" and the continuous pressure signal can be used for PCA.

[0006] Invasive devices may also be used to measure blood pressure, such as an intra-arterial catheter, for example. Intra-arterial transducers have relatively high frequency transmission (up to 200Hz) and can therefore be used for PCA.

[0007] Some example parameters that may be calculated from the contour of the pulse wave include stroke volume (SV), cardiac output (CO), stroke volume variation (SVV), pulse pressure variation (PPV), and total peripheral resistance (TPR). In addition, PCA can be used for other measurements which give insight to the human vascular properties, for example arterial stiffness. Thus, it is desirable that the measured blood pressure signals be as accurate as possible.

[0008] Invasive devices have the disadvantage of being overly disturbing and painful to the patient, whereas signals from non-invasive devices have problems with the fidelity or accuracy of the signal.

[0009] WO 2004/086963 A2 shows a device and a method for continuous blood pressure measurement comprising a pressure cuff to be applied to a body part containing an artery. The cuff including a PPG system comprises a light source and a light detector and is inflatable by a pressure system comprising a pump, at least one valve or valve system and a pressure sensor. A controller is configured for controlling the pressure in the cuff using the valve system.

[0010] WO 2007/134062 A2 discloses a light-to frequency converter including a switch connected in series with a reverse-biased photodiode. A node in the current path through the switch and the photodiode is connected to the input of a Schmidt trigger, whose output controls the switch.

SUMMARY

[0011] A system and method of digital control for a blood pressure measurement system is disclosed. In one embodiment, a device for continuous blood pressure measurement is disclosed. The device includes a pressure cuff adapted to be placed over an artery in a human finger, the cuff including a PPG system having at least one light source and at least one light detector, a pressure system comprising at least one pump, at least one valve or valve system, and at least one pressure sensor; and a controller for controlling pressure in the cuff by altering the valve or valve system, wherein the one or more light detectors are associated with at least one light-to-frequency conversion (LFC) device

[0012] In another embodiment, a method for continuously measuring blood pressure is disclosed. The method includes placing a photo-plethysmographic (PPG) system over an artery or vein in a human finger, the PPG system producing a PPG signal based on volume of the artery or vein, the PPG system including at least one light source and at least one light detector, utilizing a computing device to alter a pressure inside the cuff by altering a valve or valve system that is connected to a pump and pressure sensor, wherein, based on the measured blood volume of the artery or vein, a frequency signal is produced by a light-to-frequency conversion (LFC) device, and wherein the computing device holds the frequency signal substantially constant by altering the cuff pressure.

[0013] In yet another embodiment, a sensor for continuously measuring blood pressure is disclosed. The sensor includes a pressure cuff adapted to be placed over an artery in a human finger, a PPG system inside the cuff having at least one light source and at least one light detector, at least one computing device for receiving and submitting electrical digital signals and power supply signals, one or more air connectors for applying pressure to the cuff, wherein the at least one light detector is configured as a light-to-frequency conversion (LFC) device and, based on measured light, produces a frequency signal to the at least one computing device to the control unit of the sensor.

BRIEF DESCRIPTION OF THE FIGURES

[0014] An exemplary embodiment of the present invention is described herein with reference to the drawings, in which:

Figure 1 illustrates a Vascular Unloading Technique (VUT) control system using a photo-plesthysmographic (PPG) system controlling the cuff pressure for measuring blood pressure, in accordance with an embodiment;
Figure 2 illustrates a PPG system including light-to-digital conversion and ambient light control, in accordance with an embodiment;
Figure 3 describes digital control of a VUT system, in accordance with an embodiment;
Figure 4 is a block diagram of a VUT control system, including intermittent NBP height correction and connection to a patent monitor, in accordance with an embodiment;
Figure 5 illustrates an example sensor for measuring blood pressure using a double cuff for measuring blood pressure in one of two fingers alternatively, in accordance with an embodiment; and
Figure 6 is a block diagram illustrating an example computing device, in accordance with an embodiment.

DETAILED DESCRIPTION

[0015] A system and method for enhanced digital control of a continuous non-invasive arterial pressure (CNAP) measurement system is described. The CNAP measurement output signals may then be used to more accurately calculate a variety of parameters for a patient, such as stroke volume (SV), cardiac output (CO), total peripheral resistance (TPR), and arterial stiffness, for example. Such a calculation process may be referred to as Pulse Contour Analysis (PCA).

[0016] Figure 1 shows a typical "Vascular Unloading Technique" (VUT) system 100 and its control principle, such as that described in copending U.S. Patent Application 2011/0105918 A1, titled "Apparatus and Method for Enhancing and Analyzing Signals from a Continuous Non-Invasive Blood Pressure Device," and filed on an even date herewith. The VUT system 100 includes a "photo-plethysmographic" (PPG) system comprising a finger cuff 102 having one or more light sources 104 and one or more light detectors 106. The PPG-signal is fed into a control system 114 that produces a pressure in the cuff 102.

[0017] In operation, a human finger 108 is placed in the finger cuff 102. The finger cuff 102 measures blood volume in a artery 110 of the finger 108. During systole, when blood volume increases in the finger 108, a controller 114 increases the pressure of the finger cuff 102, $p_{cuff}(t)$, until the excess blood volume is squeezed out by pressure of the cuff. On the other hand during diastole, the blood volume in the finger is decreased, and therefore the controller 114 decreases $p_{cuff}(t)$ so the overall blood volume in the artery remains constant. As blood volume and thus v(t) is held constant over time, the pressure difference between cuff pressure $p_{cuff}(t)$ and intra-arterial pressure, $p_{art}(t)$, is zero. Thus, $p_{art}(t)$ is equal to cuff pressure $p_{cuff}(t)$, which can be measured by means of a manometer (pressure measuring instrument), for example. Thus, intra-arterial pressure $p_{art}(t)$ itself is measured indirectly, and a PPG-signal v(t), which reflects the arterial blood volume changes in the measuring area (e.g. the finger) is obtained. As the PPG-signal is kept constant, the counter pressure eliminates the arterial blood volume changes and the diameter of the artery is constant too. So, arterial influx is guaranteed during measurement, whereas return in the vein 112 from the fingertip is slightly reduced.

[0018] A PPG system may measure artery volume by emitting light radiation into the artery 110 from one or more light sources 104 and detecting the emitted light that is shone through the finger at one or more light detectors 106. A measurement of the intensity of reflected light relative to the intensity emitted light is indicative of the volume v(t) of the measured artery 110. Any type of light source can be used, including LEDs, laser diodes, or another type of lamp.

[0019] For accurate readings, the light source emitter/detector (which may include one or more photodiodes producing photocurrent) is usually as close to the artery as possible. Other electronic components necessary for the measurement, such as signal processing components and/or the power source, are located remotely from the emitter and detector. Typically, these components are electrically connected to the emitter/detector via one or more conductors (wires)'.

[0020] In some methods, the emitter/detector includes at least one photodiode that produces a photocurrent as a result of detecting the light. This photocurrent is fed back into the pressure loop, as described above, to cause an adjustment in the pressure of the cuff, if necessary. Signals of this sort are usually on the order of nano-Amperes. And as such, these signals are especially susceptible to interference (i.e., noise) resulting from neighboring electronic components, such as resistors, high impedance amplifiers, common mode rejection ratio (CMRR) interference, and other interference resulting from conductors. Typically, the photocurrent signals are protected from noise by using electromagnetic shields. However, this shielding technique is not always effective, and, at times, can add cost to the system.

[0021] Disclosed herein are different methods. In at least one embodiment of the disclosed methods, the detected light radiation is not converted to a photocurrent; rather, the light energy is converted to an alternating (AC) signal where the frequency of the AC-signal contains the light-information. This frequency (referred to as f(t)) is essentially modulated by the light radiation (referred to as I(t)).

[0022] In at least one embodiment, this light-to-frequency conversion is carried out by a device referred to as a light-to-frequency converter. Such a device may carry out what is referred to as a light-to-frequency conversion (LFC). In at least one embodiment, a TSL245 from Texas Instruments can be used for at least such a purpose. The LFC may produce a relatively high frequency when the intensity of light is relatively high. The LFC may produce a relatively low frequency when the intensity of light is relatively low.

[0023] An example equation for modeling the LFC is given by Equation 1, where H() is the transfer function of the LFC.

$$f(t) = H(I(t)) \qquad (1)$$

[0024] The AC-signal (f(t)) from the LFC is thereafter transmitted from the sensor to an electrical control unit, which includes at least a timer unit. The AC-signal is provided to the timer unit as an input. The AC-signal begins a timer kept by the timer unit on a "zero-passing" or an "edge" in one direction (e.g. passing from negative voltage to positive voltage or vice versa). The timer stops when the AC-signal passes zero again or has an edge in the other direction. In this manner, the timer counts and thus, measures, the duration of a half duty cycle. This can be modeled by Equation 2.

$$T/2 = 1/f(t) = 1/H(I(t)) \qquad (2)$$

[0025] When the timer stops, the timer unit retains the value of the timer. This timer value is equivalent to the time of the half duty cycle of the LFC-frequency and is inversely proportional to the intensity of light radiation measured by the emitter/detector. When the AC-signal crosses zero, the signal has a high transient (modeling in a best case, a rectangular signal). For at least this reason, the signal is relatively immune to noise.

[0026] Further, control systems that take advantage of the present methods can avoid using expensive electronic components, such as instrumentation amplifiers with good CMRR, as well as electromagnetic shields. In at least one embodiment of the present methods, the light signal appears as the timer value and may be used as digital data for any further process.

[0027] Fig. 2 illustrates an example light control system 200. In at least one embodiment, the light control system produces the digital PPG-signal and eliminates ambient light. The limb 108 (e.g. a finger) is illuminated with light radiation from a light source (e.g. LED 104). The emitted light radiation is transmitted through the limb or reflected at the bone and an LFC device 202 detects the reflected light. Both, LED 104 and LFC device 202 are positioned near the limb 108 and housed inside a cuff 102.

[0028] In some embodiments, the LFC device 202 produces (as an output) a square wave signal. This signal contains light information and may be connected to any number of other electrical components or computing devices, such as a microcontroller μC 204. A light-to-digital conversion unit may at least take the form of a microcontroller implemented timer in order to produce a digital time series signal for further processing. An ambient light control unit 208 may control the pulsation of LED 104. During the the "off' portion of the LED pulse (referred to as a "blanking interval") ambient light detection can take place.

[0029] One advantage of the present systems and methods is shown in Fig. 3. A computing device 204 (e.g., a digital signal processor (DSP)) is receiving signals from the LFC device 202 and from a pressure gauge 306 producing a signal ($p_{cuft}(t)$). Further, the computing device 204 may be submitting at least one control signal to one or more light sources (LED 1 to LED x) and possibly to a valve or a valve system 302. The LED's and valve or valve system 302 may be controlled by duty cycle modulated signals output from the computing device 204 (e.g., pulse width modulated (PWM) signals).

[0030] According to VUT methods, the PPG-signal is desired to remain constant. As the PPG-signal (reflected light radiation) is encoded with the LFC-frequency (f(t)), this frequency is similarly desired to remain constant due to the counter pressure p_{cuff}.

[0031] The computing device 204 (or at least a DSP portion of a computing device) is programmed to carry out one or more digital control loops, which supply the PWM signals to the valve or valve system 302 in order to keep the LFC-frequency, and thus, the duty cycle, constant. This constant value can be obtained utilizing VUT feedback loops.

[0032] Fig. 4 illustrates an embodiment of the digital VUT-system. This illustrated system uses a double valve system and two or more control loops. Those skilled in the art will realize that the digital VUT system can operate without the double valve system, possibly with a single control loop. Fig. 4 illustrates the overall principle of at least one embodiment.

[0033] The inner loops control the counter pressure inside the finger cuffs using separate inlet and outlet valves for fast reactivity to blood pressure (BP) changes. The inlet valve and the outlet valve each have a control loop and a combined control loop in order to produce a more accurate pressure signal. As can be seen in Fig. 4, a pressure signal from an electronic gauge is fed back to the pressure control unit and compared with the setpoint pressure value calculated from the digital control loop system. If the actual pressure value is lower than desired setpoint pressure value, the increase unit opens the inlet valve to the pump and reservoir site, while the outlet valve is closed. This increases pressure in the device. If the actual value is higher than desired setpoint pressure value, the inlet valve is closed and the release unit opens the outlet valve. This decreases pressure in the device. These loops act quickly by using, for example, piezoelectric valves, which may have a response (e.g., opening/closing) time less than 10msec. With this fast reacting pressure system, physiologic BP changes can be tracked (followed) with adequate response time. Additionally, there may be no need for precise linearity of the valve system. This allows for easier reproduction and calibration of the system, which results in a less expensive system.

[0034] One of the two valves is closed at any time and therefore the pump does not unnecessarily blow air to the outside. Further, there may be no need for a constant filling pressure in the reservoir. Simple and less reliable pumps may be used intermittently and therefore, power consumption and costs may be significantly reduced. These improvements have an impact on the form factor - an important issue especially for devices used in practice settings, such as patient transport, post anesthesia care units (PACUs) and intensive care units (ICUs).

[0035] As illustrated by Fig. 4 and Fig. 2, the PPG-system may regulate the effects of surrounding (or ambient) light by an ambient light control method. Thus, a PPG-signal with reduced noise may be encoded into the LFC-frequency that is kept constant by the counter pressure inside the cuff. One or more LEDs and an LFC device of that system can be integrated directly into the cuff.

[0036] For regulating pressure according to the VUT methods, a digital control loop system may be used. This system can comprise two or more interlocking control loops. The control loops, as well as all other elements surrounded by the dashed-line in Fig. 4, can be implemented as software on a computing device or DSP. This digitization may simplify associated electrical and mechanical hardware.

[0037] In addition, any of the following elements can be integrated with any of the described embodiments: standard NBPs for calibration to upper arm BP-values, height correction systems to correct differences in hydrostatic pressures between finger (sensor level) and heart level, excitation voltages from at least one external monitor device in order to scale the BP-signal to the at least one monitor device, and a display for showing the BP-signal.

[0038] The physician is used to blood pressure values that are obtained at heart level. As the finger could be on a different hydrostatic level, the difference between finger and heart level could be corrected with a water filled tube between these two sites. Thus, a height correcting system may be incorporated with at least one embodiment of the described systems and methods in order to eliminate hydrostatic difference of the finger sensor and heart level. Such a height correcting system may consist of a fluid-filled tube, where the density of the fluid corresponds to the density of blood. One end of the tube is placed at heart level, whereas the other end is placed on the finger cuff. A free-floating membrane, which prevents the fluid from escaping, could be attached at the heart end of the tube. A pressure sensor at the finger end connected directly to the fluid measures the hydrostatic pressure difference. The pressure sensor of this height correcting system can be constructed so that a frequency or digital signal at the sensor site is produced and submitted to the overall control system.

[0039] The described systems and methods may also produce a scaled version of the BP signal ($p_{cuff}(t)$), while the control system may transform $p_{cuft}(t)$, the single BP values from the calibration device, the input of the height correction, and an excitation voltage coming from a standard patient monitor.

[0040] Fig. 5 illustrates a typical finger sensor 500 embodied as double finger cuff. The sensor switches the measuring finger from time to time in order to avoid pressure marks when having measuring time greater than 1 hour. Each finger sensor consists of a light source (as previously described) in a position 502 (e.g. an LED), light detector configured as a LFC (as previously described) in position 504, and cuff 506. Electrical and air supplies are fed into the sensor over a general connector 508.

[0041] Fig. 6 is a block diagram illustrating an example computing device 600 that may be associated with the system and method of the present application and may take the place of at least one computing device already described. The computing device 600 may perform at least one method step of the present application.

[0042] In a very basic configuration 601, computing device 600 typically includes one or more processors 610 and system memory 620. A memory bus 630 can be used for communicating between the processor 610 and the system memory 620.

[0043] Depending on the desired configuration, processor 610 can be of any type including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. Processor 610 can include one more levels of caching, such as a level one cache 611 and a level two cache 612, a processor core 613, and registers 614. The processor core 613 can include an arithmetic logic unit (ALU), a floating point unit (FPU), a digital signal processing core (DSP Core), or any combination thereof. A memory controller 615 can also be used with the processor 610, or in some implementations the memory controller 615 can be an internal part of the processor 610.

[0044] Depending on the desired configuration, the system memory 620 can be of any type including but not limited to volatile memory (such as RAM), nonvolatile memory (such as ROM, flash memory, etc.) or any combination thereof. System memory 620 typically includes an operating system 621, one or more applications 622, and program data 624. For example, an application 622 may be designed to receive certain inputs from the PPG system and base decisions off of those inputs. For instance, the application may be designed to receive inputs from the PPG system, the NBP, and potentially other systems. As an output, the application 622 may carry out any of the methods described herein above and provide a higher fidelity BP signal.

[0045] Computing device 600 can have additional features or functionality, and additional interfaces to facilitate communications between the basic configuration 601. For example, a bus/interface controller 640 can be used to facilitate communications between the basic configuration 601 and one or more data storage devices 650 via a storage interface bus 641. The data storage devices 650 can be removable storage devices 651, non-removable storage devices 652, or a combination thereof. Examples of removable storage and non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDD), optical disk drives such as compact disk (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSD), and tape drives to name a few. Example computer storage media can include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

[0046] System memory 620, removable storage 651 and non-removable storage 652 are all examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by computing device 600. Any such computer storage media can be part of device 600.

[0047] Computing device 600 can also include an interface bus 642 for facilitating communication from various interface devices to the basic configuration 601 via the bus/interface controller 640. Example output interfaces 660 include a graphics processing unit 661 and an audio processing unit 662, which can be configured to communicate to various external devices such as a display or speakers via one or more A/V ports 663. Example peripheral interfaces 660 include a serial interface controller 671 or a parallel interface controller 672, which can be configured to communicate with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports 673. An example communication interface 680 includes a network controller 681, which can be arranged to facilitate communications with one or more other computing devices 690 over a network communication via one or more communication ports 682. The Communication connection is one example of a communication media. Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and includes any information delivery media. A "modulated data signal" can be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media can include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), infrared (IR) and other wireless media. The term computer readable media (or medium) as used herein can include both storage media and communication media.

[0048] Computing device 600 can be implemented as a portion of a small-form factor portable (or mobile) electronic device such as a cell phone, a personal data assistant (PDA), a personal media player device, a wireless web-watch device, a personal headset device, an application specific device, or a hybrid device that include any of the above functions. Computing device 600 can also be implemented as a personal computer including both laptop computer and non-laptop computer configurations.

[0049] While the invention has been described herein with relation to certain embodiments and applications, those with skill in the art will recognize changes, modifications, alterations, and the like which still come within the spirit of the inventive concept, and such are intended to be within the scope of the invention as expressed in the following claims.

Claims

1. A device for continuous blood pressure measurement comprising:

a pressure cuff (102) adapted to be placed over an artery (110) in a human finger (108), the cuff (102) including a PPG system having at least one light source (104) and at least one light detector (106);
a pressure system comprising:

at least one pump (304),

at least one valve or valve system (302), and
at least one pressure sensor (306); and

a controller (114) for controlling pressure in the cuff (102) by altering the valve or valve system (302), **characterised in that** the one or more light detectors (106) are associated with at least one light-to-frequency conversion (LFC) device (202),
wherein the LFC device (202) is configured for producing an AC signal based on light intensity measured from the one or more light detectors (106), and
wherein the controller (114) is configured for holding the AC signal substantially constant by altering the pressure in the cuff (102).

2. The blood pressure measurement device according to claim 1, wherein the controller (114) is a computing device (204).

3. The blood pressure measurement device according to claim 2, wherein the LFC device (202) is electrically connected to a digital input of the computing device (204).

4. The blood pressure measurement device according to claim 2, wherein the at least one light source (104) and the at least one light detector (106) are controlled via a digital output of the computing device (204).

5. The blood pressure measurement device according to claim 2, wherein the computing device (204) receives information from a calibration device.

6. The blood pressure measurement device according to claim 1, wherein the blood pressure measurement device receives information from a hydrostatic correction system.

7. The blood pressure measurement device according to claim 1, wherein the blood pressure measurement device receives scaling information from at least one other device.

8. The blood pressure measurement device according to claim 7, wherein the blood pressure measurement device calculates a scaled blood pressure curve and transmits the scaled blood pressure curve to the other device.

9. A method for continuously measuring blood pressure comprising:

placing a photo-plethysmographic (PPG) system over an artery (110) or vein (112) in a human finger (108), the PPG system producing a PPG signal based on volume of the artery or vein, the PPG system including at least one light source (104) and at least one light detector (106);
utilizing a computing device (204) to alter a pressure inside the cuff (102) by altering a valve or valve system (302) that is connected to a pump (304) and pressure sensor (306),
characterised in that based on the measured blood volume of the artery (110) or vein (112), a frequency signal is produced by a light-to-frequency conversion (LFC) device (202), and
wherein the computing device (204) holds the frequency signal substantially constant by altering the cuff pressure.

10. The method of claim 9, wherein the computing device (204) alters the valve or valve system (302) based on the frequency signal.

11. The method of claim 9, wherein the LFC device (202) produces a frequency output based on light intensity measured from the one or more light detectors (106).

Patentansprüche

1. Vorrichtung zur kontinuierlichen Blutdruckmessung, umfassend:

eine Druckmanschette (102), die dafür angepasst ist, über einer Arterie (110) eines menschlichen Fingers (108) angeordnet zu werden, wobei die Manschette (102) ein PPG-System mit wenigstens einer Lichtquelle (104) und wenigstens einem Lichtdetektor (106) enthält;

ein Drucksystem, umfassend:

wenigstens eine Pumpe (304),
wenigstens ein Ventil oder Ventilsystem (302), und
wenigstens einen Drucksensor (306); und

eine Steuervorrichtung (114) zum Steuern des Drucks in der Manschette (102) durch Verändern des Ventils oder Ventilsystems (302),
dadurch gekennzeichnet, dass der eine oder die mehreren Lichtdetektoren (106) mit wenigstens einer Licht-Frequenz-Wandler(LFC)-Vorrichtung (202) assoziiert sind,
wobei die LFC-Vorrichtung (202) dafür konfiguriert ist, basierend auf der von dem einen oder den mehreren Lichtdetektoren (106) gemessenen Lichtintensität ein AC-Signal zu erzeugen, und
wobei die Steuervorrichtung (114) dafür konfiguriert ist, das AC-Signal durch Ändern des Drucks in der Manschette (102) im Wesentlichen konstant zu halten.

2. Blutdruckmessvorrichtung nach Anspruch 1, worin die Steuervorrichtung (114) eine Rechnervorrichtung (204) ist.

3. Blutdruckmessvorrichtung nach Anspruch 2, worin die LFC-Vorrichtung (202) mit einem Digitaleingang der Rechnervorrichtung (204) elektrisch verbunden ist.

4. Blutdruckmessvorrichtung nach Anspruch 2, worin die wenigstens eine Lichtquelle (104) und der wenigstens eine Lichtdetektor (106) über einen Digitalausgang der Rechnervorrichtung (204) gesteuert werden.

5. Blutdruckmessvorrichtung nach Anspruch 2, worin die Rechnervorrichtung (204) Informationen von einer Kalibrierungsvorrichtung empfängt.

6. Blutdruckmessvorrichtung nach Anspruch 1, worin die Blutdruck-Messvorrichtung Informationen von einem hydrostatischen Korrektursystem empfängt.

7. Blutdruckmessvorrichtung nach Anspruch 1, worin the Blutdruckmessvorrichtung von wenigstens einer anderen Vorrichtung Skalierungsinformationen empfängt.

8. Blutdruckmessvorrichtung nach Anspruch 7, worin die Blutdruckmessvorrichtung eine skalierte Blutdruckkurve berechnet und die skalierte Blutdruckkurve zur anderen Vorrichtung überträgt.

9. Verfahren zur kontinuierlichen Messung des Blutdrucks, umfassend:

das Anordnen eines photoplethysmographischen (PPG-)Systems über einer Arterie (110) oder Vene (112) eines menschlichen Fingers (108), wobei das PPG-System basierend auf dem Volumen der Arterie oder Vene ein PPG-Signal erzeugt, wobei das PPG-System wenigstens eine Lichtquelle (104) und wenigstens einen Lichtdetektor (106) umfasst;
Verwenden einer Rechnervorrichtung (204) zum Ändern eines Drucks im Innern der Manschette (102) durch Ändern eines Ventils oder eines Ventilsystems (302), das mit einer Pumpe (304) und einem Drucksensor (306) verbunden ist,
dadurch gekennzeichnet, dass basierend auf dem gemessenen Blutvolumen der Arterie (110) oder Vene (112) von einer Licht-FrequenzWandler(LFC)-Vorrichtung (202) ein Frequenzsignal erzeugt wird, und
wobei die Rechnervorrichtung (204) das Frequenzsignal durch Ändern des Manschettendrucks im Wesentlichen konstant hält.

10. Verfahren nach Anspruch 9, worin die Rechnervorrichtung (204) das Ventil oder Ventilsystem (302) auf Basis des Frequenzsignals ändert.

11. Verfahren nach Anspruch 9, worin die LFC-Vorrichtung (202) basierend auf der von dem einen oder den mehreren Lichtdetektoren (106) gemessenen Lichtintensität ein Frequenzausgangssignal erzeugt.

Revendications

1. Dispositif de mesure en continu de la pression sanguine comprenant :

    une manchette de pression (102) destinée à être placée sur une artère (110) d'un doigt humain (108), cette manchette (102) comprenant un système PPG ayant au moins une source de lumière (104) et au moins un détecteur de lumière (106),
    un système de pression comprenant :

        au moins une pompe (304), au moins une soupape ou système de soupape (302), et
        au moins un détecteur de pression (306),
        un régulateur (114) pour commander la pression dans la manchette (102) en agissant sur la soupape ou le système de soupape (302), **caractérisé en ce que**
        le détecteur de lumière (106) est associé à un dispositif de conversion lumière-fréquence (202) dispositif (LFC),
        ce dispositif LFC (202) étant conformé pour produire un signal AC en fonction de l'intensité lumineuse mesurée par le détecteur de lumière (106), et
        le régulateur (114) étant conformé pour maintenir le signal AC essentiellement constant en agissant sur la pression dans la manchette (102).

2. Dispositif de mesure de la pression sanguine conforme à la revendication 1, dans lequel le régulateur (114) est un dispositif informatique (204).

3. Dispositif de mesure de la pression sanguine conforme à la revendication 2, dans lequel le dispositif LFC (202) est relié électriquement à une entrée numérique du dispositif informatique (204).

4. Dispositif de mesure de la pression sanguine conforme à la revendication 2, dans lequel la source de lumière (104) et le détecteur de lumière (106) sont commandés par une sortie numérique du dispositif informatique (204).

5. Dispositif de mesure de la pression sanguine conforme à la revendication 2, dans lequel le dispositif informatique (204) reçoit une information provenant d'un dispositif de calibrage.

6. Dispositif de mesure de la pression sanguine conforme à la revendication 1, qui reçoit une information provenant d'un système de correction hydrostatique.

7. Dispositif de mesure de la pression sanguine conforme à la revendication 1, qui reçoit une information de mise à l'échelle provenant d'au moins un autre dispositif.

8. Dispositif de mesure de la pression sanguine conforme à la revendication 7, qui calcule une courbe de pression sanguine mise à l'échelle et transmet cette courbe de pression sanguine mise à l'échelle à l'autre dispositif.

9. Procédé de mesure en continu de la pression sanguine comprenant des étapes consistant à :

    positionner un système photo-pléthysmographique système (PPG) sur une artère (110) ou une veine (112) d'un doigt humain (108), ce système PPG produisant un signal PPG fonction du volume de l'artère ou de la veine, le système PPG comprenant au moins une source de lumière (104) et au moins un détecteur de lumière (106),
    utiliser un dispositif informatique (204) pour modifier la pression à la partie interne de la manchette (102) en agissant sur une soupape ou un système de soupape (302) qui est relié à une pompe (304) et à un détecteur de pression (306),
    caractérisé en ce qu'
    un signal de fréquence est produit par un dispositif (LFC) de conversion lumière-fréquence (202) en fonction du volume de sang mesuré dans l'artère (110) ou la veine (112), et
    le dispositif informatique (204) maintient le signal de fréquence essentiellement constant en modifiant la pression de la manchette.

10. Procédé conforme à la revendication 9, selon lequel le dispositif informatique (204) agit sur la soupape ou le système de soupape (302) en fonction du signal de fréquence.

11. Procédé conforme à la revendication 9, selon lequel le dispositif LFC (202) produit une sortie de fréquence fonction de l’intensité lumineuse mesurée par le détecteur de lumière (106).

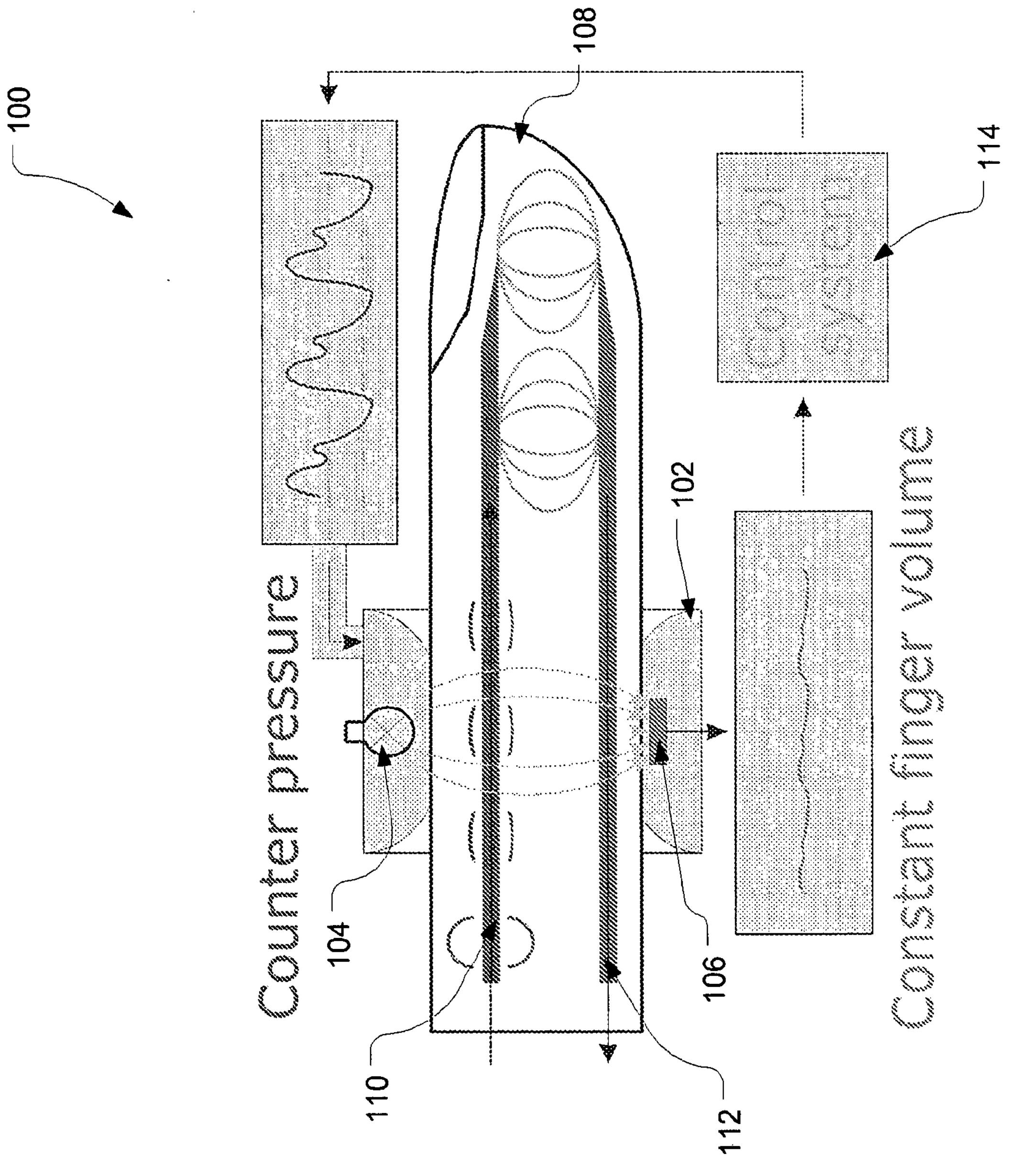
100
108
Counter pressure
104
110
102
106
112
114
Control system
Constant finger volume

Figure 1

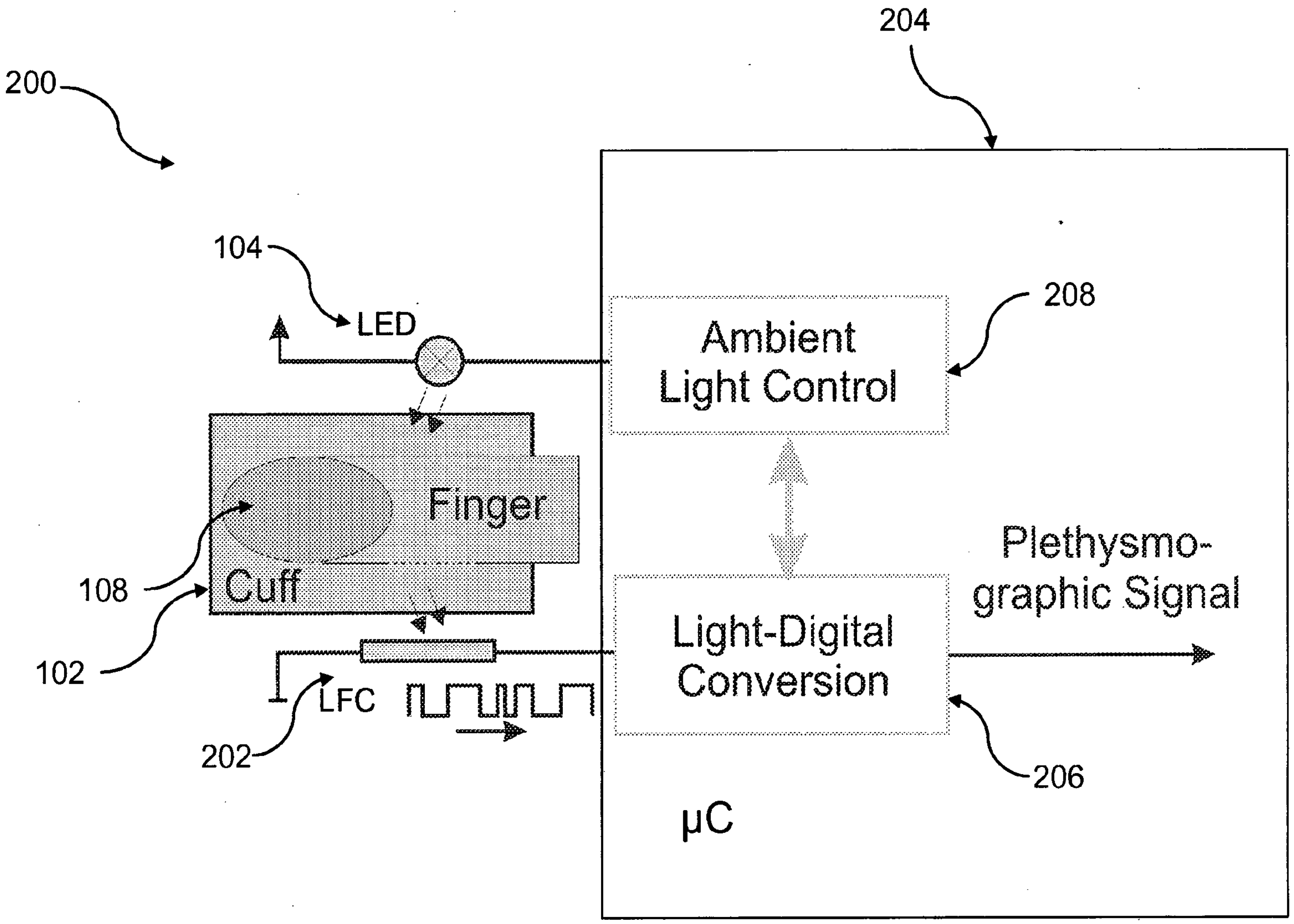
200
204
104
LED
208
Ambient
Light Control
Finger
Cuff
108
102
Plethysmo-
graphic Signal
Light-Digital
Conversion
LFC
202
206
μC

Figure 2

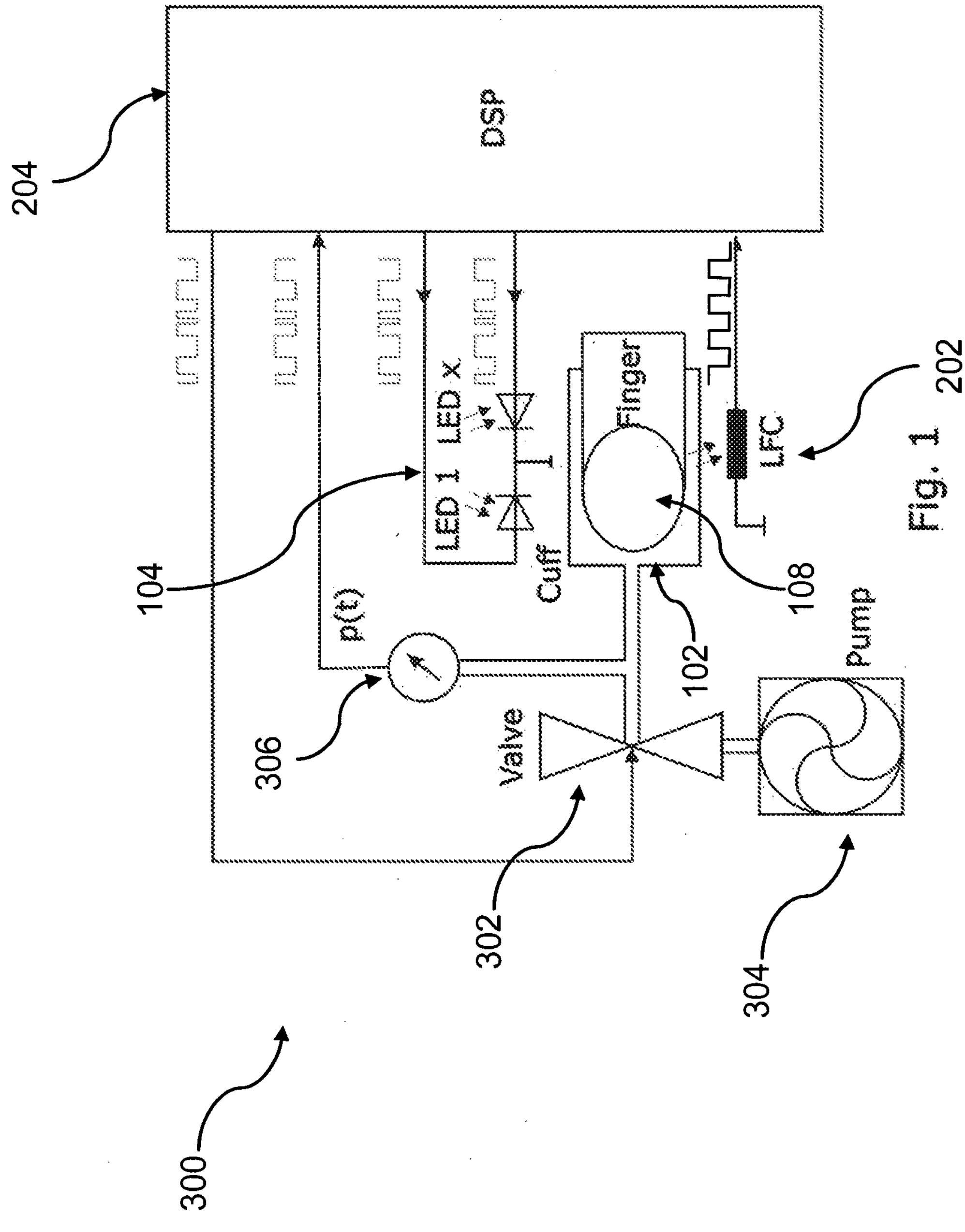
204
DSP
104
LED 1
LED X
Cuff
Finger
102
108
202
LFC
Fig. 1
p(t)
306
Valve
302
Pump
304
300

Figure 3

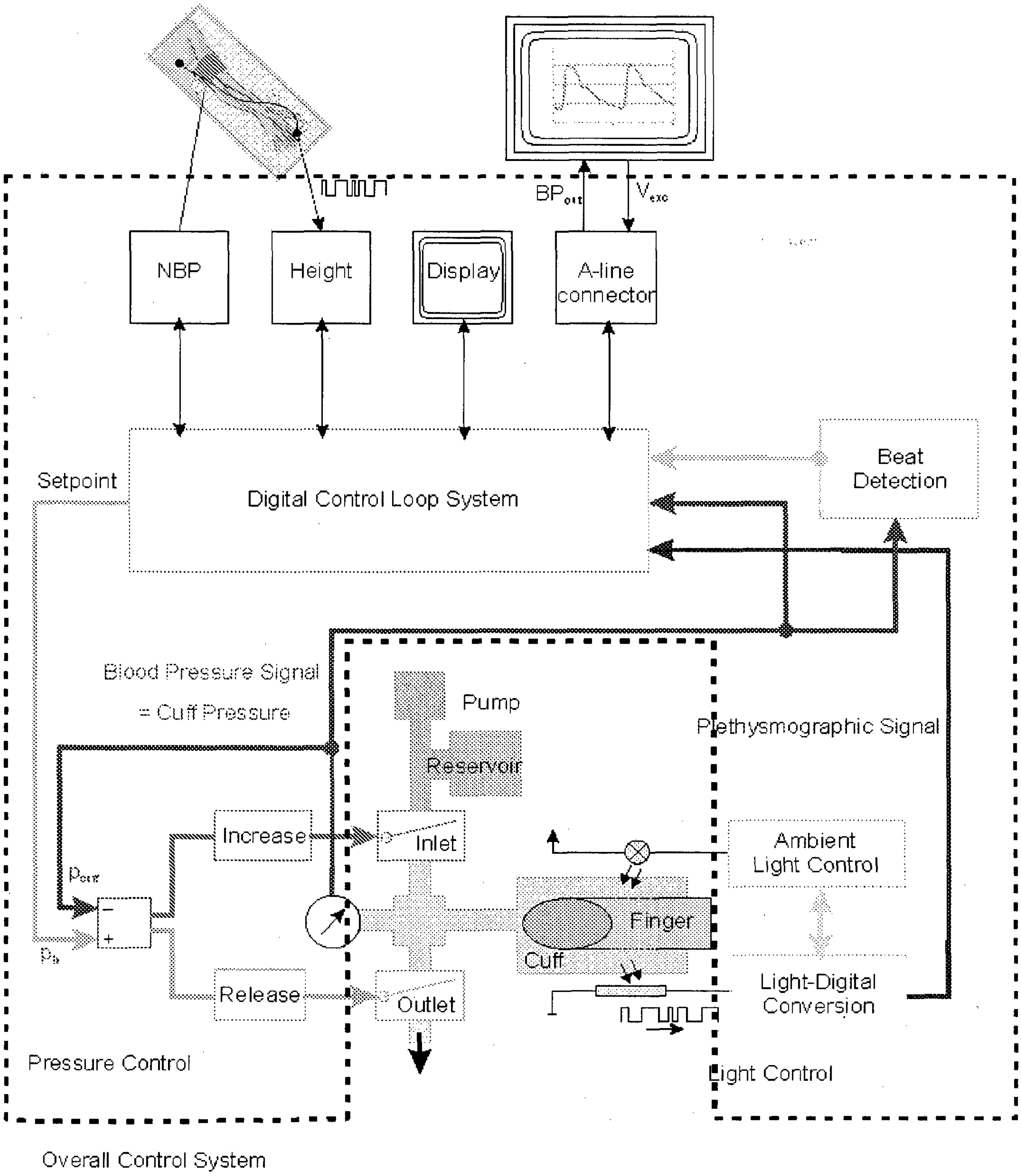
BP$_{out}$
V$_{exc}$
NBP
Height
Display
A-line connector
Setpoint
Digital Control Loop System
Beat Detection
Blood Pressure Signal
= Cuff Pressure
Pump
Reservoir
Plethysmographic Signal
Increase
Inlet
Ambient Light Control
p$_{cuff}$
p$_{s}$
Finger
Cuff
Release
Outlet
Light-Digital Conversion
Pressure Control
Light Control
Overall Control System

Figure 4

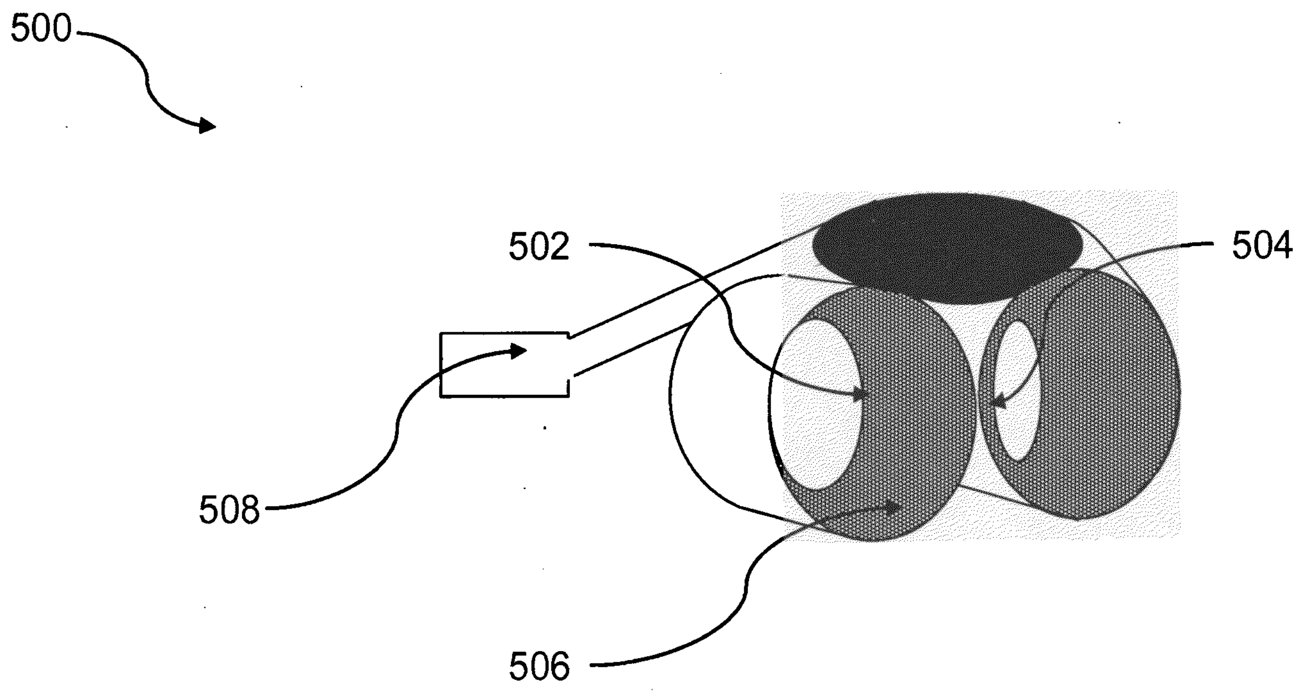

Figure 5

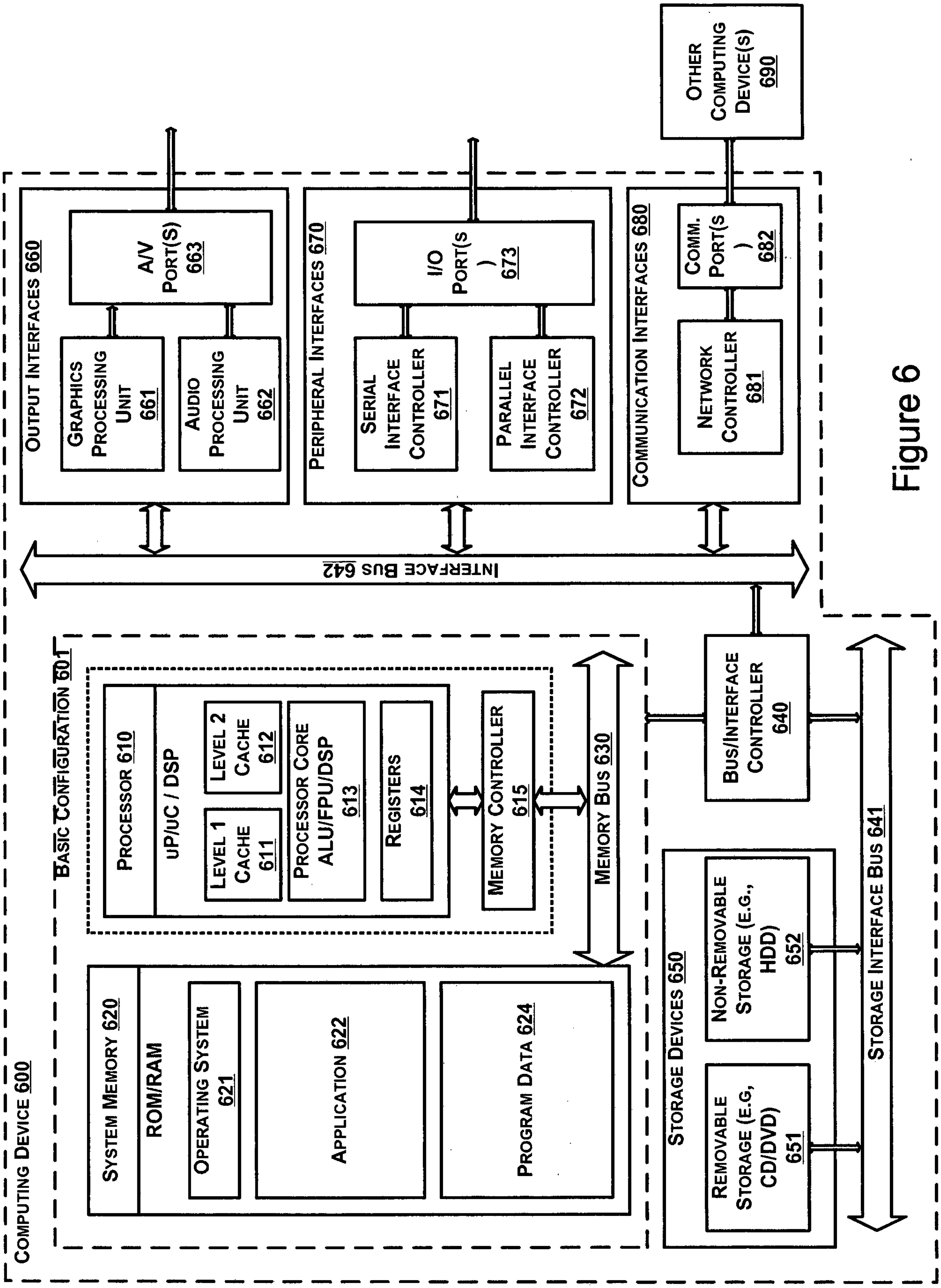
Computing Device 600
Basic Configuration 601
Processor 610
uP/uC / DSP
Level 1 Cache 611
Level 2 Cache 612
Processor Core ALU/FPU/DSP 613
Registers 614
Memory Controller 615
Memory Bus 630
System Memory 620
ROM/RAM
Operating System 621
Application 622
Program Data 624
Bus/Interface Controller 640
Storage Interface Bus 641
Interface Bus 642
Storage Devices 650
Removable Storage (E.G, CD/DVD) 651
Non-Removable Storage (E.G., HDD) 652
Output Interfaces 660
Graphics Processing Unit 661
Audio Processing Unit 662
A/V Port(S) 663
Peripheral Interfaces 670
Serial Interface Controller 671
Parallel Interface Controller 672
I/O Port(s) 673
Communication Interfaces 680
Network Controller 681
Comm. Port(s) 682
Other Computing Device(s) 690

Figure 6

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 61256081 A **[0001]**
- US 61256110 A **[0001]**
- WO 2004086963 A2 **[0009]**
- WO 2007134062 A2 **[0010]**
- US 20110105918 A1 **[0016]**

专利名称(译)	数字控制血压测量方法		
公开(公告)号	EP2493370B1	公开(公告)日	2016-03-16
申请号	EP2010805828	申请日	2010-10-29
[标]申请(专利权)人(译)	CNSYST MEDIZINTECHN		
申请(专利权)人(译)	CNSYSTEMS MEDIZINTECHNIK AG		
当前申请(专利权)人(译)	CNSYSTEMS MEDIZINTECHNIK AG		
[标]发明人	FORTIN JURGEN GRULLENBERGER RUPERT		
发明人	FORTIN, JURGEN GRULLENBERGER, RUPERT		
IPC分类号	A61B5/00 A61B5/022		
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代理机构(译)	Babeluk，MICHAEL		
优先权	61/256110 2009-10-29 US 61/256081 2009-10-29 US		
其他公开文献	EP2493370A1		
外部链接	Espacenet		

摘要(译)

提供了一种用于血压测量系统的数字控制的系统和方法。根据至少一个实施例，光电体积描记（PPG）系统产生与PPG系统中的测量光相对应的频率信号。这种光可能表示静脉或动脉中的血容量。频率信号可用于控制系统的一个或多个压力阀，以便测量血压并保持频率信号恒定。