Description

This invention relates to oximeter systems and, in particular, to a pulse oximetry system for measuring the oxygen content of arterial blood.

Pulse oximetry is a non-invasive medical technique useful for measuring certain vascular conditions. In practice of the technique, light is passed through a portion of a patient's body which contains arterial blood flow. An optical sensor is used to detect the light which has passed through the body, and variations in the detected light at various wavelengths are then used to determine arterial oxygen saturation and/or pulse rates. Oxygen saturation may be calculated using some form of the classical absorption equation known as Beer's Law.

In prior art oximeter systems, electrical signals are produced which are representative of the transmissions of two wavelengths of light through tissue where arterial blood flow is present. These signals are strongly dominated by a substantially constant component, with the component representative of pulsatile blood flow being a much smaller component. The received signal is normalized by dividing it by an average signal level, sometimes referred to as a DC component. The normalization is performed on signals of both wavelengths to produce comparably scaled signal samples.

After normalization the samples are often then converted to logarithmic values and then used to calculate oxygen saturation. The formulae used to calculate oxygen saturation are generally in the form of a quotient of series expansions of terms. These computations are often complex, time-consuming in their execution, and require substantial computational capability.

US-A-4,167,331 describes such a prior art oximeter in which the oxygen saturation is calculated in accordance with Beer's Law using logarithmic amplifiers and calculating oxygen saturation levels based on the output values of these log amplifiers.

According to the invention, there is provided an oximetry system for measuring blood oxygen saturation comprising:

means for illuminating tissue containing arterial blood with light of two different wavelengths;

means for receiving light from said illuminating means and producing corresponding electrical signals of said two wavelengths of light; characterised by having two continuously controllable shifting means, each having an input responsive to one of said electrical signals corresponding to said two wavelengths of light and an output providing a shifted signal;

means for measuring the peaks of said shifted signals at the transition of the illuminated blood from diastole to systole;

means for integrating said shifted signals during systole to produce integral values;

means for combining said integral values and signal peaks to determine two quotients;

means for combining these two quotients to form an index value; and

means responsive to said index value for producing an indication of oxygen saturation of the arterial blood.

In accordance with the principles of the present invention, a simple yet accurate pulse oximetry system is provided. Received analog signals from the transmission of two wavelengths of light are controllably offset so as to occupy a substantial portion of the dynamic range of an analog-to-digital (A/D) converter. The signals are then respectively monitored until the end of diastole is detected. The signal level at the end of diastole is used as a reference value in conjunction with the signals occurring during systole. The sequence of samples occurring during systole are used to compute an integral of each signal waveform over the systolic interval and the integral values are then divided by the corresponding reference value. At the end of systole the two terms so computed for the respective wavelengths of light are used to form a quotient of the two terms. This quotient is an index value, used to access a look-up table, whereby the level of oxygen saturation is read out and displayed. The terms forming the quotient effectively represent the integral of each optical waveform taken over systole, and divided by the signal level at the transition between diastole and systole.

In the drawings:

FIGURE 1 illustrates in block diagram form a pulse oximeter constructed in accordance with the principles of the present invention;

FIGURE 2 illustrates schematically a circuit used to emphasize the pulsatile signal waveform;

FIGURE 3 graphically illustrates operation of the circuit of FIGURE 2;

FIGURE 4 is a flowchart of a computer program used to determine oxygen saturation; and

FIGURE 5 graphically illustrates the operation of the computer program of FIGURE 4.

Referring first to FIGURE 1, a pulse oximetry system constructed in accordance with the principles of the present invention is shown. Two light emitting diodes (LEDs) 12 and 14 are connected by a suitable connector to a drive circuit 10, which alternately energizes the LEDs. The LEDs transmit light at two predetermined wavelengths, referred to herein as red and infrared (IR), through tissue containing a flow of arterial blood. The transmitted light, which has been affected by the pulsatile blood flow, is received by a photodiode 16. The photodiode converts the received optical signals to electrical signals, which are coupled by a suitable connector to a signal separator 20. The signal

separator 20 separates the red and IR signal components, which are then detected by an amplitude demodulator 22.

The separated red and IR signals are amplified by an amplifier 24 and coupled to an offset circuit 30. The offset circuit 30 controllably shifts the red and IR signal levels so that they occupy a significant portion of the input dynamic range of an A/D converter 32. The A/D converter 32 digitizes the offset and unoffset red and IR signals, which are then coupled to a digital processor 34. The digital processor 34, in a manner to be more fully described hereinafter, monitors the successive signal samples until the onset of systole is detected. The signal peak at the transition from diastole to systole is stored, and an integration of each signal waveform over systole is performed. Each integral is divided by its respective stored peak signal level, and the two resulting terms are used to form a quotient, referred to as an index value. The index value represents a highly resolved measurement of the degree of oxygen saturation of the arterial blood flow. The index value is used to access a corresponding oxygen saturation value in a look-up table 36, and this value is displayed on a display 38 as the percent of oxygen saturation.

The offset circuit 30 is schematically represented in FIGURE 2. Two such circuits are provided, one for the red signal and one for the IR signal; the circuit for the IR signal is shown in FIGURE 2, which is identical to the circuit for the red signal. In FIGURE 2, the IR signal is capacitively coupled by a capacitor 40 to the input of a high impedance amplifier 42, such as an FET amplifier. At the junction of the capacitor 40 and the input to the amplifier 42 is a switch 44. The switch 44 is controllably opened and closed by the digital processor 34 to selectively charge capacitor 40 from an offset voltage source Vo. The amplified signals produced by the amplifier 42 are coupled to the A/D converter 32.

The effect of the offset circuit is to "magnify" the pulsatile component of the received optical signal. The circuit does this by shifting the signal to an appropriate predetermined level, at which it is amplified to occupy a substantial portion of the dynamic input range of the A/D converter. FIGURE 3 explains how this shifting takes place. In the example of FIGURE 3, the time-varying pulsatile IR signal component IR(t) is initially seen to be in the center of a range extending from zero to "full". This is the signal appearing at the junction of the capacitor 40, the switch 44, and the amplifier 42. At the end of diastole the IR(t) signal reaches peaks shown at 440. The signal level drops during systole to the levels indicated as 442, whereafter the signal rises again during diastole to the level of 440. In this example it is desired to increase the peaks 440 so that they are near the "full" range level. Subsequent amplification of the signal at this level will cause it to occupy a substantial portion of the input range of the A/D converter.

The first few cycles of the IR(t) signal represent the signal condition when the switch 44 is open. At this time the capacitor 40 has a constant charge, and couples the IR(t) signal to the amplifier. The degree of offset is established by the charge on the capacitor. The digital processor will sense that the signal level is too low, and at time t_c the switch 44 is closed. The right plate of the capacitor 40 is now charged by current from the offset voltage source V_o, causing the signal level to rapidly rise. At time t_o the switch 44 is opened, and the charge on the capacitor remains constant. The input to amplifier 42 follows the IR(t) signal, but at a higher level. At times t_c' and t_o' the switch 44 is closed and opened once more, shifting the signal level higher yet. After time t_o' the signal at the input of amplifier 42 continues to follow the IR(t) signal until the peak at the end of diastole is reached as shown at 440'. The shifted IR(t) signal continues at this new level within the "magnified" desired range until deteriorated by current leakage, which is minimized by the high input impedance of amplifier 42. Should the IR(t) signal level drift outside the desired range due to leakage, the switch 44 is again periodically closed during diastole to again shift the signal. The offset circuit will always drive the signal to a level within the desired range, which is determined by the choice of offset voltage V_o. In the preferred embodiment of the present invention it is important to shift the signal only during diastole, as measurements are taken during systole as described below.

The digital processor 34 is responsive to sampled values of the IR(t) and Red(t) signals to produce an index value representative of oxygen saturation. The digital processor in a preferred embodiment executes a computer program illustrated by the flowchart of FIGURE 4. Samples of the IR(t) and Red(t) signals are continuously monitored until the signal peaks of the unoffset signals at the transition between diastole and systole are detected. This may be done by continuously calculating the slope of the waveform and looking for the inflection point. In the preferred embodiment the signal peaks IR_{peak} and RED_{peak} are located by calculating the derivatives of the respective signal waveforms. These peak values are stored and integrators of the signal waveforms are initialized. The integrators of the respective waveforms then integrate each offset signal during systole. The integration reduces noise effects, and is performed on the "magnified" (offset) signal for maximum resolution. The end of systole is indicated by the next inflection point of the signal waveform, or a

sign change of the derivative function.

The integral functions, $\int$IR and $\int$RED, each performed over the systolic interval, are then combined to compute an index value. The $\int$IR function is divided by the stored IR_{peak} value and the $\int$RED function is divided by the stored RED_{peak} value. The divided functions are combined in a quotient, which defines the index value. The index value is then used to access the look-up table 36 where the corresponding value of oxygen saturation is found and displayed.

The look-up table may be generated empirically by applying the LEDs and photodiode to tissue samples of known levels of oxygen saturation. As the level of oxygen saturation is changed the corresponding index values are noted, and oxygen saturation values are stored in the look-up table in correspondence to the index values.

Referring to FIGURE 5, the operation of the computer program of FIGURE 4 is graphically illustrated. The offset IR(t) waveform is seen to attain its peak value, IR_{max}, at the end of the diastole. (The RED(t) waveform has a similar shape and attains its peak value RED_{max} at the same time. Hence discussion of the IR signal is sufficient to describe both.) Once IR_{max} (or IR_{peak}) has been attained, the integrator begins to integrate the waveform during systole. The amplitude between each successive value IR_1, IR_2, ... IR_{n-1}, IR_{min}, taken at its respective point in time, and the IR_{max} level, defines the waveform integral which is shown as a stippled area in FIGURE 5. When the waveform reaches its minimum value at IR_{min}, the end of systole, the integration of the waveform ends. Thereafter, the waveform again rises during the nest diastolic interval.

Because the system does not use the information during diastole for integral calculations, it is during this period that the digital processor may activate the offset circuit to reposition the signal level.

It has been found that the index values calculated as illustrated herein provide sufficient resolution for an accurate indication of oxygen saturation.

Claims

1. An oximetry system for measuring blood oxygen saturation comprising:

   means (12, 14) for illuminating tissue containing arterial blood with light of two different wavelengths;

   means (16, 20, 22, 24) for receiving light from said illuminating means and producing corresponding electrical signals of said two wavelengths of light characterised by having:

   two continuously controllable shifting means (30) each having an input responsive to one of said electrical signals corresponding to said two wavelengths of light and an output providing a shifted signal;

   means 34 for measuring the peaks of said shifted signals at the transition of the illuminated blood from diastole to systole;

   means 34 for integrating said shifted signals during systole to produce integral values;

   means 34 for combining said integral values and signal peaks to determine two quotients means (34) for combining these two quotients to form an index value, and

   means 36 responsive to said index value for producing an indication of oxygen saturation of the arterial blood.

2. The oximetry system of claim 1, wherein said receiving means includes

   means (20) responsive to said received light, for producing separated signal components representative of light of two different wavelengths.

3. The oximetry system of claim 2, wherein said receiving means further includes demodulator means (22) responsive to said separated signal components for producing electrical signals of two wavelengths of light.

4. The oximetry system of claim 3, wherein said demodulator means comprises an amplitude demodulator.

5. The oximetry system of any one of claims 1 to 4, further comprising:

   means (32) for converting analog signals to digital signals, said converting means exhibiting a defined input dynamic range; and in which the shifting means output is coupled to the input of said converting means and the shifting means shifts the levels of said received signals to a significant portion of said input dynamic range of said converting means.

6. The oximetry system of any one of claims 1 to 5, wherein said shifting means includes an offset voltage source (Vo) and a capacitor (40) which is selectively charged by said offset voltage source to shift said electrical signals.

7. The oximetry system of claim 5, wherein said converting means (32) is further coupled to receive said electrical signals corresponding to said two wavelengths of light which have not been level-shifted.

8. The oximetry system of any one of claims 1 to 7, wherein said measuring means is respon-

sign change of the derivative function.

The integral functions, $\int$IR and $\int$RED, each performed over the systolic interval, are then combined to compute an index value. The $\int$IR function is divided by the stored IR_{peak} value and the $\int$RED function is divided by the stored RED_{peak} value. The divided functions are combined in a quotient, which defines the index value. The index value is then used to access the look-up table 36 where the corresponding value of oxygen saturation is found and displayed.

The look-up table may be generated empirically by applying the LEDs and photodiode to tissue samples of known levels of oxygen saturation. As the level of oxygen saturation is changed the corresponding index values are noted, and oxygen saturation values are stored in the look-up table in correspondence to the index values.

Referring to FIGURE 5, the operation of the computer program of FIGURE 4 is graphically illustrated. The offset IR(t) waveform is seen to attain its peak value, IR_{max}, at the end of the diastole. (The RED(t) waveform has a similar shape and attains its peak value RED_{max} at the same time. Hence discussion of the IR signal is sufficient to describe both.) Once IR_{max} (or IR_{peak}) has been attained, the integrator begins to integrate the waveform during systole. The amplitude between each successive value IR_1, IR_2, ... IR_{n-1}, IR_{min}, taken at its respective point in time, and the IR_{max} level, defines the waveform integral which is shown as a stippled area in FIGURE 5. When the waveform reaches its minimum value at IR_{min}, the end of systole, the integration of the waveform ends. Thereafter, the waveform again rises during the nest diastolic interval.

Because the system does not use the information during diastole for integral calculations, it is during this period that the digital processor may activate the offset circuit to reposition the signal level.

It has been found that the index values calculated as illustrated herein provide sufficient resolution for an accurate indication of oxygen saturation.

Claims

1. An oximetry system for measuring blood oxygen saturation comprising:

   means (12, 14) for illuminating tissue containing arterial blood with light of two different wavelengths;

   means (16, 20, 22, 24) for receiving light from said illuminating means and producing corresponding electrical signals of said two wavelengths of light characterised by having:

   two continuously controllable shifting means (30) each having an input responsive to one of said electrical signals corresponding to said two wavelengths of light and an output providing a shifted signal;

   means 34 for measuring the peaks of said shifted signals at the transition of the illuminated blood from diastole to systole;

   means 34 for integrating said shifted signals during systole to produce integral values;

   means 34 for combining said integral values and signal peaks to determine two quotients means (34) for combining these two quotients to form an index value, and

   means 36 responsive to said index value for producing an indication of oxygen saturation of the arterial blood.

2. The oximetry system of claim 1, wherein said receiving means includes

   means (20) responsive to said received light, for producing separated signal components representative of light of two different wavelengths.

3. The oximetry system of claim 2, wherein said receiving means further includes demodulator means (22) responsive to said separated signal components for producing electrical signals of two wavelengths of light.

4. The oximetry system of claim 3, wherein said demodulator means comprises an amplitude demodulator.

5. The oximetry system of any one of claims 1 to 4, further comprising:

   means (32) for converting analog signals to digital signals, said converting means exhibiting a defined input dynamic range; and in which the shifting means output is coupled to the input of said converting means and the shifting means shifts the levels of said received signals to a significant portion of said input dynamic range of said converting means.

6. The oximetry system of any one of claims 1 to 5, wherein said shifting means includes an offset voltage source (Vo) and a capacitor (40) which is selectively charged by said offset voltage source to shift said electrical signals.

7. The oximetry system of claim 5, wherein said converting means (32) is further coupled to receive said electrical signals corresponding to said two wavelengths of light which have not been level-shifted.

8. The oximetry system of any one of claims 1 to 7, wherein said measuring means is respon-

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sive to successive signals for detecting the signal peak at the transition from diastole to systole.

9. The oximetry system of any one of claims 1 to 8, wherein said measuring means is responsive to successive signals for detecting the minimum signal level at the end of systole.

10. The oximetry system of claim 9, wherein said integrating means is initialized in response to the detection of said signal peak by said measuring means, and integration of said signal waveform ends upon detection of said minimum signal level by said measuring means.

11. The oximetry system of claim 10, further including means, responsive to said measuring means, for storing the values of detected signal peaks.

12. The oximetry system of any one of claims 8 to 11, wherein said combining means produces a quotient by dividing said integral values by said signal peak values.

13. The oximetry system of claim 12, wherein said combining means produces a first quotient corresponding to one of said wavelengths of light and a second quotient corresponding to the other of said wavelengths of light.

14. The oximetry system of claim 13, wherein said combining means produces the index value by dividing said first quotient by said second quotient.

15. The oximetry system of claim 14, wherein one of said wavelengths of light is in the infrared region and the other of said wavelengths of light is in the red region, said first quotient corresponds to infrared light signals and said second quotient corresponds to red light signals.

16. The oximetry system of any one of claims 1 to 15, wherein said means responsive to said index value comprises a look-up table (36).

17. The oximetry system of any one of claims 1 to 16, wherein said electrical signal producing means includes

means for shifting the levels of said electrical signals corresponding to said two wavelengths of light; and

means for producing digitized samples of said shifted received signals and of received signals which have not been shifted;

wherein said measuring means is responsive to received signals which have not been shifted and said integrating means is responsive to said shifted received signals.

18. The oximetry system of any one of claims 1 to 17, wherein said shifting means is selectively operable during the diastolic interval.

Patentansprüche

1. Oximetrisches System zum Messen der Sättigung von Blut mit Sauerstoff, bestehend aus:
Mitteln (12, 14) zum Beleuchten von arterielles Blut enthaltendem Gewebe mit Licht zweier unterschiedlicher Wellenlängen;
Mitteln (16, 20, 22, 24) zum Empfang des Lichtes von den genannten Beleuchtungsmitteln und zum Erzeugen entsprechender elektrischer Signale der genannten beiden Wellenlängen des Lichtes,
gekennzeichnet durch zwei kontinuierlich steuerbare Verstellvorrichtungen (30), von denen jede einen Eingang, der auf eines der genannten elektrischen, den genannten beiden Wellenlängen des Lichts entsprechenden Signale anspricht, und einen Ausgang aufweist, der ein verändertes Signal bereitstellt;
Mittel (34) zum Messen der Spitzen der genannten veränderten Signale an dem Übergang des beleuchteten Blutes von der Diastole zur Systole;
Mittel (34) zum Integrieren der genannten veränderten Signale während der Systole zur Erzeugung integraler Werte;
Mittel (34) zum Kombinieren der genannten integralen Werte und der Signalspitzen zur Bestimmung von zwei Quotienten;
Mittel (34) zum Kombinieren dieser beiden Quotienten zur Bildung eines Indexwertes, und
Mittel (36), die auf den genannten Indexwert zur Erzeugung einer Anzeige der Sauerstoffsättigung des arteriellen Blutes ansprechen.

2. Oximetrisches System nach Anspruch 1, bei dem das genannte Empfangsmittel eine Vorrichtung (20) umfaßt, die auf das genannte empfangene Licht zur Erzeugung getrennter Signalkomponenten anspricht, die für das Licht der beiden unterschiedlichen Wellenlängen stehen.

3. Oximetrisches System nach Anspruch 2, wobei die genannte Empfangsvorrichtung ferner einen Demodulator (22) umfaßt, der auf die genannten getrennten Signalkomponenten zur Erzeugung elektrischer Signale von zwei Wellenlängen des Lichtes anspricht.

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4. Oximetrisches System nach Anspruch 3, wobei der Demodulator aus einem Amplitudendemodulator besteht.

5. Oximetrisches System nach einem der Ansprüche 1 bis 4, ferner bestehend aus:
Mitteln (32) zur Umwandlung analoger Signale in digitale Signale, wobei die genannten Umwandlungsmittel einen bestimmten dynamischen Eingangsbereich aufweisen; und bei der der Ausgang der Verstellmittel mit dem Eingang der genannten Umwandlungsmittel gekoppelt ist und die Verstellvorrichtung die Pegel der genannten empfangenen Signale in einen signifikanten Teil des genannten dynamischen Eingangsbereichs der genannten Umwandlungsmittel verändert.

6. Oximetrisches System nach einem der Ansprüche 1 bis 5, bei dem das genannte Verstellmittel eine Offset-Spannungsquelle (Vo) und einen Kondensator (40) umfaßt, der wahlweise durch die genannte Offset-Spannungsquelle geladen wird, um die genannten elektrischen Signale zu verändern.

7. Oximetrisches System nach Anspruch 5, bei dem das genannte Umwandlungsmittel (32) ferner zum Empfang der genannten elektrischen, den beiden genannten Wellenlängen des Lichtes entsprechenden Signalen gekoppelt ist, deren Pegel nicht verändert worden ist.

8. Oximetrisches System nach einem der Ansprüche 1 bis 7, bei dem die genannte Meßvorrichtung auf aufeinanderfolgende Signale zur Feststellung der Signalspitze an dem Übergang von der Diastole zur Systole anspricht.

9. Oximetrisches System nach einem der Ansprüche 1 bis 8, bei dem die genannte Meßvorrichtung auf aufeinanderfolgende Signale zur Feststellung des geringsten Signalpegels am Ende der Systole anspricht.

10. Oximetrisches System nach Anspruch 9, bei dem das genannte integrierende Mittel in Abhängigkeit von der Feststellung der genannten Signalspitze durch die genannte Meßvorrichtung ausgelöst wird und die Integration der genannten Signalwellenform nach der Feststellung des genannten kleinsten Signalpegels durch die genannte Meßvorrichtung endet.

11. Oximetrisches System nach Anspruch 10, ferner umfassend auf die genannte Meßvorrichtung ansprechende Mittel zum Speichern der Werte der festgestellten Signalspitzen.

12. Oximetrisches System nach einem der Ansprüche 8 bis 11, bei dem das genannte kombinierende Mittel einen Quotienten durch Teilung der genannten integralen Werte durch die genannten Signalspitzenwerte erzeugt.

13. Oximetrisches System nach Anspruch 12, bei dem das kombinierende Mittel einen ersten Quotienten erzeugt, der einer der genannten Wellenlängen des Lichtes entspricht, und einen zweiten Quotienten, der der anderen der genannten Wellenlängen des Lichtes entspricht.

14. Oximetrisches System nach Anspruch 13, bei dem das kombinierende Mittel den Indexwert durch Teilung des ersten Quotienten durch den genannten zweiten Quotienten erzeugt.

15. Oximetrisches System nach Anspruch 14, bei dem eine der genannten Wellenlängen des Lichtes im Infrarotbereich und die andere der genannten Wellenlängen des Lichtes im roten Bereich liegen, wobei der erste Quotient den Infrarot-Lichtsignalen und der genannte zweite Quotient den roten Lichtsignalen entspricht.

16. Oximetrisches System nach einem der Ansprüche 1 bis 15, wobei das genannte, auf den erwähnten Indexwert ansprechende Mittel eine Tabelle (36) umfaßt.

17. Oximetrisches System nach einem der Ansprüche 1 bis 16, wobei das genannte, ein elektrisches Signal erzeugende Mittel umfaßt
Mittel zum Verstellen der Pegel der genannten elektrischen Signale entsprechend den genannten beiden Wellenlängen des Lichtes; und
Mittel zum Erzeugen digitalisierter Muster der genannten verstellten Empfangssignale und der Empfangssignale, die nicht verändert worden sind;
wobei die genannte Meßvorrichtung auf die Empfangssignale anspricht, die nicht verändert worden sind, und das erwähnte integrierende Mittel auf die genannten veränderten Empfangssignale anspricht.

18. Oximetrisches System nach einem der Ansprüche 1 bis 17, wobei die genannte Verstellvorrichtung während des diastolischen Intervalls wahlweise betätigbar ist.

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Revendications

1. Système d'oxymètre pour mesurer une saturation d'oxygène dans le sang comprenant :

un moyen (12, 14) pour éclairer un tissu contenant du sang artériel avec une lumière présentant deux longueurs d'onde différentes ;

un moyen (16, 20, 22, 24) pour recevoir de la lumière en provenance dudit moyen d'éclairement et pour produire des signaux électriques correspondant auxdites deux longueurs d'onde de lumière,

caractérisé en ce qu'il comprend :

deux moyens de décalage commandables en continu (30) dont chacun comporte une entrée sensible à l'un desdits signaux électriques correspondant auxdites deux longueurs d'onde de la lumière et une sortie produisant un signal décalé ;

un moyen (34) pour mesurer les pics desdits signaux décalés pour la transition d'une diastole à une systole du sang éclairé ;

un moyen (34) pour intégrer lesdits signaux décalés pendant une systole pour produire des valeurs d'intégration ;

un moyen (34) pour combiner lesdites valeurs d'intégration et lesdits pics de signal afin de déterminer deux quotients ;

un moyen (34) pour combiner ces deux quotients afin de former une valeur d'indexage ; et

un moyen (36) sensible à ladite valeur d'indexage pour produire une indication d'une saturation d'oxygène pour le sang artériel.

2. Système d'oxymètre selon la revendication 1, dans lequel ledit moyen de réception inclut :

un moyen (20) sensible à ladite lumière reçue pour produire des composantes de signal séparées représentatives de la lumière de deux longueurs d'onde différentes.

3. Système d'oxymètre selon la revendication 2, dans lequel ledit moyen de réception inclut en outre un moyen de démodulateur (22) sensible auxdites composantes de signal séparées pour produire des signaux électriques de deux longueurs d'onde de la lumière.

4. Système d'oxymètre selon la revendication 3, dans lequel ledit moyen de démodulateur comprend un démodulateur d'amplitude.

5. Système d'oxymètre selon l'une quelconque des revendications 1 à 4, comprenant en outre :

un moyen (32) pour convertir des signaux analogiques en signaux numériques, ledit moyen de conversion présentant une plage dynamique d'entrée définie ; et dans lequel la sortie du moyen de décalage est couplée à l'entrée dudit moyen de conversion et le moyen de décalage décale les niveaux desdits signaux reçus jusqu'à une partie significative de ladite plage dynamique d'entrée dudit moyen de conversion.

6. Système d'oxymètre selon l'une quelconque des revendications 1 à 5, dans lequel ledit moyen de décalage inclut une source de tension de décalage (Vo) et une capacité (40) qui est chargée sélectivement par la source de tension de décalage afin de décaler lesdits signaux électriques.

7. Système d'oxymètre selon la revendication 5, dans lequel ledit moyen de conversion (32) est en outre couplé pour recevoir des signaux électriques correspondant auxdites deux longueurs d'onde de la lumière qui n'ont pas été décalées en niveau.

8. Système d'oxymètre selon l'une quelconque des revendications 1 à 7, dans lequel ledit moyen de mesure est sensible à des signaux successifs pour détecter le pic de signal pour la transition d'une diastole à une systole.

9. Système d'oxymètre selon l'une quelconque des revendications 1 à 8, dans lequel ledit moyen de mesure est sensible à des signaux successifs pour détecter le niveau de signal minimum à la fin d'une systole.

10. Système d'oxymètre selon la revendication 9, dans lequel ledit moyen d'intégration est initialisé en réponse à la détection dudit pic de signal par ledit moyen de mesure et une intégration de ladite forme d'onde de signal se termine suite à la détection dudit niveau de signal minimum par ledit moyen de mesure.

11. Système d'oxymètre selon la revendication 10, incluant en outre un moyen sensible audit moyen de mesure pour stocker les valeurs des pics de signal détectés.

12. Système d'oxymètre selon l'une quelconque des revendications 8 à 11, dans lequel ledit moyen de combinaison produit un quotient en divisant lesdites valeurs d'intégration par lesdites valeurs de pic de signal.

13. Système d'oxymètre selon la revendication 12, dans lequel ledit moyen de combinaison produit un premier quotient correspondant à l'une

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desdites longueurs d'onde de la lumière et un second quotient correspondant à l'autre desdites longueurs d'onde de la lumière.

14. Système d'oxymètre selon la revendication 13, dans lequel ledit moyen de combinaison produit la valeur d'indexage en divisant ledit premier quotient par ledit second quotient.

15. Système d'oxymètre selon la revendication 14, dans lequel l'une desdites longueurs d'onde de la lumière se situe dans la région des infrarouges et l'autre desdites longueurs d'onde de le lumière se situe dans la région du rouge, ledit premier quotient correspondant à des signaux de lumière infrarouge et ledit second quotient correspondant à des signaux de lumière rouge.

16. Système d'oxymètre selon l'une quelconque des revendications 1 à 15, dans lequel ledit moyen sensible à ladite valeur d'indexage comprend une table de consultation (36).

17. Système d'oxymètre selon l'une quelconque des revendication 1 à 16, dans lequel ledit moyen de production de signal électrique inclut un moyen pour décaler les niveaux desdits signaux électriques correspondant auxdites deux longueurs d'onde de la lumière ; et

un moyen pour produire des échantillons numérisés desdits signaux reçus décalés et de signaux reçus qui n'ont pas été décalés ;

dans lequel ledit moyen de mesure est sensible à des signaux reçus qui n'ont pas été décalés et ledit moyen d'intégration est sensible auxdits signaux reçus décalés.

18. Système d'oxymètre selon l'une quelconque des revendications 1 à 17, dans lequel ledit moyen de décalage est actionné sélectivement pendant l'intervalle diastolique.

* C L M S *