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- (54) **MEDICAL SENSOR AND TECHNIQUE FOR USING THE SAME**
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4,694,833 A	9/1987	Hamaguri
4,697,593 A	10/1987	Evans et al.
4,700,708 A	10/1987	New, Jr. et al.
4,714,080 A	12/1987	Edgar, Jr. et al.
4,714,341 A	12/1987	Hamaguri et al.
4,759,369 A	7/1988	Taylor
4,770,179 A	9/1988	New, Jr. et al.
4,773,422 A	9/1988	Isacson et al.
4,776,339 A	10/1988	Schreiber
4,781,195 A	11/1988	Martin
4,796,636 A	1/1989	Branstetter et al.

(Continued)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,721,813 A	3/1973	Condon et al.
4,586,513 A	5/1986	Hamaguri
4,603,700 A	8/1986	Nichols et al.
4,621,643 A	11/1986	New, Jr. et al.
4,653,498 A	3/1987	New, Jr. et al.
4,685,464 A	8/1987	Goldberger et al.

FOREIGN PATENT DOCUMENTS

DE	19640807	9/1997
EP	0724860	8/1996

(Continued)

OTHER PUBLICATIONS

Lutter, N., et al.; "Comparison of Different Evaluation Methods for a Multi-wavelength Pulse Oximeter," *Biomedizinische Technik*, vol. 43, (1998).

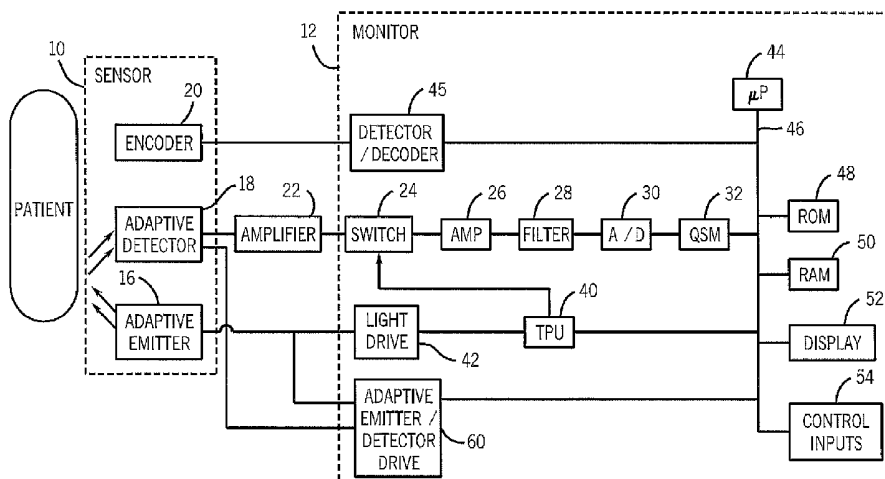
(Continued)

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(57) **ABSTRACT**

According to embodiments, sensors and systems for medical spectroscopy may include adaptive optical components, such as digital light processing components. Adaptive light emitting elements may allow such sensors to alter the intensity profile of emitted light photons to change the distribution of photons through the tissue or to scan areas of tissue to determine if certain areas may be associated with improved measurements. In addition, sensors with adaptive light detecting elements as provided may adapt to selectively detect light of certain wavelengths or from certain regions of the tissue.

9 Claims, 7 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

4,800,495 A	1/1989	Smith	5,170,786 A	12/1992	Thomas et al.
4,800,885 A	1/1989	Johnson	5,188,108 A	2/1993	Secker et al.
4,802,486 A	2/1989	Goodman et al.	5,190,038 A	3/1993	Polson et al.
4,805,623 A	2/1989	Jöbbsis	5,193,542 A	3/1993	Missanelli et al.
4,807,630 A	2/1989	Malinouskas	5,193,543 A	3/1993	Yelderman
4,807,631 A	2/1989	Hersh et al.	5,203,329 A	4/1993	Takatani et al.
4,819,646 A	4/1989	Cheung et al.	5,209,230 A	5/1993	Swedlow et al.
4,819,752 A	4/1989	Zelin	5,213,099 A	5/1993	Tripp et al.
4,824,242 A	4/1989	Frick et al.	5,216,598 A	6/1993	Branstetter et al.
4,825,872 A	5/1989	Tan et al.	5,217,012 A	6/1993	Young et al.
4,825,879 A	5/1989	Tan et al.	5,217,013 A	6/1993	Lewis et al.
4,830,014 A	5/1989	Goodman et al.	5,218,962 A	6/1993	Mannheimer et al.
4,832,484 A	5/1989	Aoyagi et al.	5,224,478 A	7/1993	Sakai et al.
4,846,183 A	7/1989	Martin	5,226,417 A	7/1993	Swedlow et al.
4,848,901 A	7/1989	Hood, Jr.	5,228,440 A	7/1993	Chung et al.
4,854,699 A	8/1989	Edgar, Jr.	5,237,994 A	8/1993	Goldberger
4,859,056 A	8/1989	Prosser et al.	5,239,185 A	8/1993	Ito et al.
4,859,057 A	8/1989	Taylor et al.	5,246,002 A *	9/1993	Prosser 600/336
4,863,265 A	9/1989	Flower et al.	5,246,003 A	9/1993	DeLonzor
4,865,038 A	9/1989	Rich et al.	5,247,931 A	9/1993	Norwood
4,867,557 A	9/1989	Takatani et al.	5,247,932 A	9/1993	Chung et al.
4,869,253 A	9/1989	Craig, Jr. et al.	5,249,576 A	10/1993	Goldberger et al.
4,869,254 A	9/1989	Stone et al.	5,253,645 A	10/1993	Friedman et al.
4,880,304 A	11/1989	Jaeb et al.	5,253,646 A	10/1993	Delpy et al.
4,883,055 A	11/1989	Merrick	5,259,381 A	11/1993	Cheung et al.
4,883,353 A	11/1989	Hausman et al.	5,259,761 A	11/1993	Schnettler et al.
4,890,619 A	1/1990	Hatschek	5,263,244 A	11/1993	Centa et al.
4,892,101 A	1/1990	Cheung et al.	5,267,562 A	12/1993	Ukawa et al.
4,901,238 A	2/1990	Suzuki et al.	5,267,563 A	12/1993	Swedlow et al.
4,908,762 A	3/1990	Suzuki et al.	5,273,036 A	12/1993	Kronberg et al.
4,911,167 A	3/1990	Corenman et al.	5,275,159 A	1/1994	Griebel
4,913,150 A	4/1990	Cheung et al.	5,279,295 A	1/1994	Martens et al.
4,926,867 A	5/1990	Kanda et al.	5,285,783 A	2/1994	Secker
4,927,264 A	5/1990	Shiga et al.	5,285,784 A	2/1994	Seeker
4,928,692 A	5/1990	Goodman et al.	5,287,853 A	2/1994	Vester et al.
4,934,372 A	6/1990	Corenman et al.	5,291,884 A	3/1994	Heinemann et al.
4,938,218 A	7/1990	Goodman et al.	5,297,548 A	3/1994	Pologe
4,942,877 A	7/1990	Sakai et al.	5,299,120 A	3/1994	Kaestle
4,948,248 A	8/1990	Lehman	5,299,570 A	4/1994	Hatschek
4,955,379 A	9/1990	Hall	5,309,908 A	5/1994	Friedman et al.
4,960,126 A	10/1990	Conlon et al.	5,311,865 A	5/1994	Mayeux
4,964,408 A	10/1990	Hink et al.	5,313,940 A	5/1994	Fuse et al.
4,971,062 A	11/1990	Hasebe et al.	5,323,776 A	6/1994	Blakeley et al.
4,974,591 A	12/1990	Awazu et al.	5,329,922 A	7/1994	Atlee, III
5,007,423 A	4/1991	Branstetter et al.	5,337,744 A	8/1994	Branigan
5,025,791 A	6/1991	Niwa	5,339,810 A	8/1994	Ivers et al.
RE33,643 E	7/1991	Isaacson et al.	5,343,818 A	9/1994	McCarthy et al.
5,028,787 A	7/1991	Rosenthal et al.	5,343,869 A	9/1994	Pross et al.
5,040,539 A	8/1991	Schmitt et al.	5,348,003 A	9/1994	Caro
5,054,488 A	10/1991	Muz	5,348,004 A	9/1994	Hollub et al.
5,055,671 A	10/1991	Jones	5,349,519 A	9/1994	Kaestle
5,058,588 A	10/1991	Kaestle	5,349,952 A	9/1994	McCarthy et al.
5,065,749 A	11/1991	Hasebe et al.	5,349,953 A	9/1994	McCarthy et al.
5,066,859 A	11/1991	Karkar et al.	5,351,685 A	10/1994	Potratz
5,069,213 A	12/1991	Polczynski	5,353,799 A	10/1994	Chance
5,078,136 A	1/1992	Stone et al.	5,355,880 A	10/1994	Thomas et al.
5,084,327 A	1/1992	Stengel	5,355,882 A	10/1994	Ukawa et al.
5,088,493 A	2/1992	Giannini et al.	5,361,758 A	11/1994	Hall et al.
5,090,410 A	2/1992	Saper et al.	5,365,066 A	11/1994	Krueger, Jr. et al.
5,094,239 A	3/1992	Jaeb et al.	5,368,025 A	11/1994	Young et al.
5,094,240 A	3/1992	Muz	5,368,026 A	11/1994	Swedlow et al.
5,099,841 A	3/1992	Heinonen et al.	5,368,224 A	11/1994	Richardson et al.
5,099,842 A	3/1992	Mannheimer et al.	5,372,136 A	12/1994	Steuer et al.
H1039 H	4/1992	Tripp et al.	5,377,675 A	1/1995	Ruskevicz et al.
5,104,623 A	4/1992	Miller	5,385,143 A	1/1995	Aoyagi
5,109,849 A	5/1992	Goodman et al.	5,387,122 A	2/1995	Goldberger et al.
5,111,817 A	5/1992	Clark et al.	5,390,670 A	2/1995	Centa et al.
5,113,861 A	5/1992	Rother	5,392,777 A	2/1995	Swedlow et al.
5,125,403 A	6/1992	Culp	5,398,680 A	3/1995	Polson et al.
5,127,406 A	7/1992	Yamaguchi	5,402,777 A	4/1995	Warring et al.
5,131,391 A	7/1992	Sakai et al.	5,411,023 A	5/1995	Morris, Sr. et al.
5,140,989 A	8/1992	Lewis et al.	5,411,024 A	5/1995	Thomas et al.
5,152,296 A	10/1992	Simons	5,413,099 A	5/1995	Schmidt et al.
5,154,175 A	10/1992	Gunther	5,413,100 A	5/1995	Barthelemy et al.
5,158,082 A	10/1992	Jones	5,413,101 A	5/1995	Sugiura
			5,413,102 A	5/1995	Schmidt et al.
			5,417,207 A	5/1995	Young et al.
			5,421,329 A	6/1995	Casciani et al.
			5,425,360 A	6/1995	Nelson

(56)

References Cited

U.S. PATENT DOCUMENTS

5,425,362 A	6/1995	Siker et al.	5,685,301 A	11/1997	Klomhaus
5,427,093 A	6/1995	Ogawa et al.	5,687,719 A	11/1997	Sato et al.
5,429,128 A	7/1995	Cadell et al.	5,687,722 A	11/1997	Tien et al.
5,429,129 A	7/1995	Lovejoy et al.	5,692,503 A	12/1997	Kuenstner
5,431,159 A	7/1995	Baker et al.	5,692,505 A	12/1997	Fouts
5,431,170 A	7/1995	Mathews	5,709,205 A	1/1998	Bukta
5,437,275 A	8/1995	Amundsen et al.	5,713,355 A	2/1998	Richardson et al.
5,438,986 A	8/1995	Disch et al.	5,724,967 A	3/1998	Venkatachalam
5,448,991 A	9/1995	Polson et al.	5,727,547 A	3/1998	Levinson et al.
5,452,717 A	9/1995	Branigan et al.	5,731,582 A	3/1998	West
5,465,714 A	11/1995	Scheuing	D393,830 S	4/1998	Tobler et al.
5,469,845 A	11/1995	DeLonzor et al.	5,743,260 A	4/1998	Chung et al.
RE35,122 E	12/1995	Corenman et al.	5,743,263 A	4/1998	Baker, Jr.
5,482,034 A	1/1996	Lewis et al.	5,746,206 A	5/1998	Mannheimer
5,482,036 A	1/1996	Diab et al.	5,746,697 A	5/1998	Swedlow et al.
5,483,646 A	1/1996	Uchikoga	5,752,914 A	5/1998	DeLonzor et al.
5,485,847 A	1/1996	Baker, Jr.	5,755,226 A	5/1998	Carim et al.
5,490,505 A	2/1996	Diab et al.	5,758,644 A	6/1998	Diab et al.
5,490,523 A	2/1996	Isaacson et al.	5,760,910 A	6/1998	Lepper, Jr. et al.
5,491,299 A	2/1996	Naylor et al.	5,766,125 A	6/1998	Aoyagi et al.
5,494,032 A	2/1996	Robinson et al.	5,766,127 A	6/1998	Pologe et al.
5,497,771 A	3/1996	Rosenheimer	5,769,785 A	6/1998	Diab et al.
5,499,627 A	3/1996	Steuer et al.	5,772,587 A	6/1998	Gratton et al.
5,503,148 A	4/1996	Pologe et al.	5,774,213 A	6/1998	Trebino et al.
5,505,199 A	4/1996	Kim	5,776,058 A	7/1998	Levinson et al.
5,507,286 A	4/1996	Solenberger	5,776,059 A	7/1998	Kaestle
5,517,988 A	5/1996	Gerhard	5,779,630 A	7/1998	Fein et al.
5,520,177 A	5/1996	Ogawa et al.	5,779,631 A	7/1998	Chance
5,521,851 A	5/1996	Wei et al.	5,782,237 A	7/1998	Casciani et al.
5,522,388 A	6/1996	Ishikawa et al.	5,782,756 A	7/1998	Mannheimer
5,524,617 A	6/1996	Mannheimer	5,782,757 A	7/1998	Diab et al.
5,529,064 A	6/1996	Rall et al.	5,782,758 A	7/1998	Ausec et al.
5,533,507 A	7/1996	Potratz et al.	5,786,592 A	7/1998	Hök
5,551,423 A	9/1996	Sugiura	5,790,729 A	8/1998	Pologe et al.
5,551,424 A	9/1996	Morrison et al.	5,792,052 A	8/1998	Isaacson et al.
5,553,614 A	9/1996	Chance	5,795,292 A	8/1998	Lewis et al.
5,553,615 A	9/1996	Carim et al.	5,797,841 A	8/1998	DeLonzor et al.
5,555,882 A	9/1996	Richardson et al.	5,800,348 A	9/1998	Kaestle
5,558,096 A	9/1996	Palatnik	5,800,349 A	9/1998	Isaacson et al.
5,560,355 A	10/1996	Merchant et al.	5,803,910 A	9/1998	Potratz
5,564,417 A	10/1996	Chance	5,807,246 A	9/1998	Sakaguchi et al.
5,575,284 A	11/1996	Athan et al.	5,807,247 A	9/1998	Merchant et al.
5,575,285 A	11/1996	Takanashi et al.	5,807,248 A	9/1998	Mills
5,577,500 A	11/1996	Potratz	5,810,723 A	9/1998	Aldrich
5,582,169 A	12/1996	Oda et al.	5,810,724 A	9/1998	Gronvall
5,584,296 A	12/1996	Cui et al.	5,813,980 A	9/1998	Levinson et al.
5,588,425 A	12/1996	Sackner et al.	5,817,008 A	10/1998	Rafert et al.
5,588,427 A	12/1996	Tien	5,817,009 A	10/1998	Rosenheimer et al.
5,590,652 A	1/1997	Inai	5,817,010 A	10/1998	Hibl
5,595,176 A	1/1997	Yamaura	5,818,985 A	10/1998	Merchant et al.
5,596,986 A	1/1997	Goldfarb	5,820,550 A	10/1998	Polson et al.
5,611,337 A	3/1997	Bukta	5,823,950 A	10/1998	Diab et al.
5,617,852 A	4/1997	MacGregor	5,823,952 A	10/1998	Levinson et al.
5,619,992 A	4/1997	Guthrie et al.	5,827,182 A	10/1998	Raley et al.
5,626,140 A	5/1997	Feldman et al.	5,830,135 A	11/1998	Bosque et al.
5,630,413 A	5/1997	Thomas et al.	5,830,136 A	11/1998	DeLonzor et al.
5,632,272 A	5/1997	Diab et al.	5,830,137 A	11/1998	Scharf
5,632,273 A	5/1997	Suzuki	5,839,439 A	11/1998	Nierlich et al.
5,634,459 A	6/1997	Gardosi	RE36,000 E	12/1998	Swedlow et al.
5,638,593 A	6/1997	Gerhardt et al.	5,842,979 A	12/1998	Jarman et al.
5,638,818 A	6/1997	Diab et al.	5,842,981 A	12/1998	Larsen et al.
5,645,060 A	7/1997	Yorkey et al.	5,842,982 A	12/1998	Mannheimer
5,645,440 A	7/1997	Tobler et al.	5,846,190 A	12/1998	Woehrl
5,660,567 A	8/1997	Nierlich et al.	5,851,178 A	12/1998	Aronow
5,662,105 A	9/1997	Tien	5,851,179 A	12/1998	Ritson et al.
5,662,106 A	9/1997	Swedlow et al.	5,853,364 A	12/1998	Baker, Jr. et al.
5,666,952 A	9/1997	Fuse et al.	5,860,919 A	1/1999	Kiani-Azarbayjany et al.
5,671,529 A	9/1997	Nelson	5,865,736 A	2/1999	Baker, Jr. et al.
5,673,692 A	10/1997	Schulze et al.	5,871,442 A	2/1999	Madarasz et al.
5,673,693 A	10/1997	Solenberger	5,879,294 A	3/1999	Anderson et al.
5,676,139 A	10/1997	Goldberger et al.	5,885,213 A	3/1999	Richardson et al.
5,676,141 A	10/1997	Hollub	5,890,929 A	4/1999	Mills et al.
5,678,544 A	10/1997	DeLonzor et al.	5,891,021 A	4/1999	Dillon et al.
5,680,857 A	10/1997	Pelikan et al.	5,891,022 A	4/1999	Pologe
5,685,299 A	11/1997	Diab et al.	5,891,024 A	4/1999	Jarman et al.
			5,891,025 A	4/1999	Buschmann et al.
			5,891,026 A	4/1999	Wang et al.
			5,902,235 A	5/1999	Lewis et al.
			5,910,108 A	6/1999	Solenberger

(56)

References Cited

U.S. PATENT DOCUMENTS

5,911,690	A	6/1999	Rall	6,149,481	A	11/2000	Wang et al.
5,912,656	A	6/1999	Tham et al.	6,150,951	A	11/2000	Olejniczak
5,913,819	A	6/1999	Taylor et al.	6,151,107	A	11/2000	Schöllerman et al.
5,916,154	A	6/1999	Hobbs et al.	6,151,518	A	11/2000	Hayashi
5,916,155	A	6/1999	Levinson et al.	6,152,754	A	11/2000	Gerhardt et al.
5,919,133	A	7/1999	Taylor et al.	6,154,667	A	11/2000	Miura et al.
5,919,134	A	7/1999	Diab	6,157,850	A	12/2000	Diab et al.
5,920,263	A	7/1999	Huttenhoff et al.	6,163,715	A	12/2000	Larsen et al.
5,921,921	A	7/1999	Potratz et al.	6,165,005	A	12/2000	Mills et al.
5,922,607	A	7/1999	Bernreuter	6,173,196	B1	1/2001	Delonzor et al.
5,924,979	A	7/1999	Swedlow et al.	6,178,343	B1	1/2001	Bindszus et al.
5,924,980	A	7/1999	Coetzee	6,181,958	B1	1/2001	Steuer et al.
5,924,982	A	7/1999	Chin	6,181,959	B1	1/2001	Schöllerman et al.
5,924,985	A	7/1999	Jones	6,184,521	B1	2/2001	Coffin, IV et al.
5,934,277	A	8/1999	Mortz	6,188,470	B1	2/2001	Grace
5,934,925	A	8/1999	Tobler et al.	6,192,260	B1	2/2001	Chance
5,940,182	A	8/1999	Lepper, Jr. et al.	6,195,575	B1	2/2001	Levinson
5,954,644	A	9/1999	Detfling et al.	6,198,951	B1	3/2001	Kosuda et al.
5,960,610	A	10/1999	Levinson et al.	6,206,830	B1	3/2001	Diab et al.
5,961,450	A	10/1999	Merchant et al.	6,213,952	B1	4/2001	Finarov et al.
5,961,452	A	10/1999	Chung et al.	6,217,523	B1	4/2001	Amano et al.
5,964,701	A	10/1999	Asada et al.	6,222,189	B1	4/2001	Misner et al.
5,971,930	A	10/1999	Elghazzawi	6,226,539	B1	5/2001	Potratz
5,978,691	A	11/1999	Mills	6,226,540	B1	5/2001	Bernreuter et al.
5,978,693	A	11/1999	Hamilton et al.	6,229,856	B1	5/2001	Diab et al.
5,983,122	A	11/1999	Jarman et al.	6,230,035	B1	5/2001	Aoyagi et al.
5,987,343	A	11/1999	Kinast	6,233,470	B1	5/2001	Tsuchiya
5,991,648	A	11/1999	Levin	6,236,871	B1	5/2001	Tsuchiya
5,995,855	A	11/1999	Kiani et al.	6,236,872	B1	5/2001	Diab et al.
5,995,856	A	11/1999	Mannheimer et al.	6,240,305	B1	5/2001	Tsuchiya
5,995,858	A	11/1999	Kinast	6,253,097	B1	6/2001	Aronow et al.
5,995,859	A	11/1999	Takahashi	6,253,098	B1	6/2001	Walker et al.
5,997,343	A	12/1999	Mills et al.	6,256,523	B1	7/2001	Diab et al.
5,999,834	A	12/1999	Wang et al.	6,256,524	B1	7/2001	Walker et al.
6,002,952	A	12/1999	Diab et al.	6,261,236	B1	7/2001	Grimblatov
6,005,658	A	12/1999	Kaluza et al.	6,263,221	B1	7/2001	Chance et al.
6,006,120	A	12/1999	Levin	6,263,222	B1	7/2001	Diab et al.
6,011,985	A	1/2000	Athan et al.	6,263,223	B1	7/2001	Shepherd et al.
6,011,986	A	1/2000	Diab et al.	6,266,546	B1	7/2001	Steuer et al.
6,014,576	A	1/2000	Raley et al.	6,266,547	B1	7/2001	Walker et al.
6,018,673	A	1/2000	Chin et al.	6,272,363	B1	8/2001	Casciani et al.
6,018,674	A	1/2000	Aronow	6,278,522	B1	8/2001	Lepper, Jr. et al.
6,022,321	A	2/2000	Amano et al.	6,280,213	B1	8/2001	Tobler et al.
6,023,541	A	2/2000	Merchant et al.	6,280,381	B1	8/2001	Malin et al.
6,026,312	A	2/2000	Shemwell et al.	6,285,894	B1	9/2001	Oppelt et al.
6,026,314	A	2/2000	Amerov et al.	6,285,895	B1	9/2001	Ristolainen et al.
6,031,603	A	2/2000	Fine et al.	6,285,896	B1	9/2001	Tobler et al.
6,035,223	A	3/2000	Baker, Jr.	6,298,252	B1	10/2001	Kovach et al.
6,036,642	A	3/2000	Diab et al.	6,308,089	B1	10/2001	Von der Ruhr et al.
6,041,247	A	3/2000	Weckstrom et al.	6,321,100	B1	11/2001	Parker
6,044,283	A	3/2000	Fein et al.	6,330,468	B1	12/2001	Scharf
6,047,201	A	4/2000	Jackson, III	6,334,065	B1	12/2001	Al-Ali et al.
6,061,584	A	5/2000	Lovejoy et al.	6,339,715	B1	1/2002	Bahr et al.
6,064,898	A	5/2000	Aldrich	6,343,223	B1	1/2002	Chin et al.
6,064,899	A	5/2000	Fein et al.	6,343,224	B1	1/2002	Parker
6,067,462	A	5/2000	Diab et al.	6,349,228	B1	2/2002	Kiani et al.
6,073,038	A	6/2000	Wang et al.	6,351,658	B1	2/2002	Middleman et al.
6,078,833	A	6/2000	Hueber	6,353,750	B1	3/2002	Kimura et al.
6,081,735	A	6/2000	Diab et al.	6,356,774	B1	3/2002	Bernstein et al.
6,081,742	A	6/2000	Amano et al.	6,360,113	B1	3/2002	Detfling
6,083,157	A	7/2000	Noller	6,360,114	B1	3/2002	Diab et al.
6,083,172	A	7/2000	Baker, Jr. et al.	6,361,501	B1	3/2002	Amano et al.
6,088,607	A	7/2000	Diab et al.	6,363,269	B1	3/2002	Hanna et al.
6,094,592	A	7/2000	Yorkey et al.	6,369,954	B1	4/2002	Berge et al.
6,095,974	A	8/2000	Shemwell et al.	6,370,408	B1	4/2002	Merchant et al.
6,104,938	A	8/2000	Huiku et al.	6,370,409	B1	4/2002	Chung et al.
6,112,107	A	8/2000	Hannula	6,374,129	B1	4/2002	Chin et al.
6,113,541	A	9/2000	Dias et al.	6,377,829	B1	4/2002	Al-Ali et al.
6,115,621	A	9/2000	Chin	6,381,479	B1	4/2002	Norris
6,122,535	A	9/2000	Kaestle et al.	6,381,480	B1	4/2002	Stoddard et al.
6,133,994	A	10/2000	Mathews et al.	6,385,471	B1	5/2002	Mortz
6,135,952	A	10/2000	Coetzee	6,385,821	B1	5/2002	Modgil et al.
6,144,444	A	11/2000	Haworth et al.	6,388,240	B2	5/2002	Schulz et al.
6,144,867	A	11/2000	Walker et al.	6,393,310	B1	5/2002	Kuenster
6,144,868	A	11/2000	Parker	6,397,091	B2	5/2002	Diab et al.
				6,397,092	B1	5/2002	Norris et al.
				6,397,093	B1	5/2002	Aldrich
				6,400,971	B1	6/2002	Finarov et al.
				6,400,972	B1	6/2002	Fine

(56)

References Cited

U.S. PATENT DOCUMENTS

6,402,690	B1	6/2002	Rhee et al.	6,631,281	B1	10/2003	Kästle
6,408,198	B1	6/2002	Hanna et al.	6,643,530	B2	11/2003	Diab et al.
6,411,832	B1	6/2002	Guthermann	6,643,531	B1	11/2003	Katarow
6,411,833	B1	6/2002	Baker, Jr. et al.	6,647,279	B2	11/2003	Pologe
6,419,671	B1	7/2002	Lemberg	6,647,280	B2	11/2003	Bahr et al.
6,421,549	B1	7/2002	Jacques	6,650,917	B2	11/2003	Diab et al.
6,430,423	B2	8/2002	DeLonzor et al.	6,650,918	B2	11/2003	Terry
6,430,513	B1	8/2002	Wang et al.	6,654,621	B2	11/2003	Palatnik et al.
6,430,525	B1	8/2002	Weber et al.	6,654,622	B1	11/2003	Eberhard et al.
6,434,408	B1	8/2002	Heckel et al.	6,654,623	B1	11/2003	Kästle
6,438,399	B1	8/2002	Kurth	6,654,624	B2	11/2003	Diab et al.
6,449,501	B1	9/2002	Reuss	6,658,276	B2	12/2003	Kianl et al.
6,453,183	B1	9/2002	Walker	6,658,277	B2	12/2003	Wasserman
6,453,184	B1	9/2002	Hyogo et al.	6,662,033	B2	12/2003	Casciani et al.
6,456,862	B2	9/2002	Benni	6,665,127	B2	12/2003	Bao et al.
6,461,305	B1	10/2002	Schnall	6,665,551	B1	12/2003	Suzuki
6,463,310	B1	10/2002	Swedlow et al.	6,668,182	B2	12/2003	Hubelbank
6,463,311	B1	10/2002	Diab	6,668,183	B2	12/2003	Hicks et al.
6,466,808	B1	10/2002	Chin et al.	6,671,526	B1	12/2003	Aoyagi et al.
6,466,809	B1	10/2002	Riley	6,671,528	B2	12/2003	Steuer et al.
6,470,199	B1	10/2002	Kopotic et al.	6,671,530	B2	12/2003	Chung et al.
6,470,200	B2	10/2002	Walker et al.	6,671,531	B2	12/2003	Al-Ali et al.
6,480,729	B2	11/2002	Stone	6,671,532	B1	12/2003	Fudge et al.
6,490,466	B1	12/2002	Fein et al.	6,675,031	B1	1/2004	Porges et al.
6,496,711	B1	12/2002	Athan et al.	6,678,543	B2	1/2004	Diab et al.
6,498,942	B1	12/2002	Esenaliev et al.	6,681,126	B2	1/2004	Solenberger
6,501,974	B2	12/2002	Huiku	6,681,128	B2	1/2004	Steuer et al.
6,501,975	B2	12/2002	Diab et al.	6,681,454	B2	1/2004	Modgil et al.
6,505,060	B1	1/2003	Norris	6,684,090	B2	1/2004	Ali et al.
6,505,061	B2	1/2003	Larson	6,684,091	B2	1/2004	Parker
6,505,133	B1	1/2003	Hanna et al.	6,694,160	B2	2/2004	Chin
6,510,329	B2	1/2003	Heckel	6,697,653	B2	2/2004	Hanna
6,510,331	B1	1/2003	Williams et al.	6,697,655	B2	2/2004	Sueppel et al.
6,512,937	B2	1/2003	Blank et al.	6,697,656	B1	2/2004	Al-Ali
6,515,273	B2	2/2003	Al-Ali	6,697,658	B2	2/2004	Al-Ali
6,519,484	B1	2/2003	Lovejoy et al.	RE38,476	E	3/2004	Diab et al.
6,519,486	B1	2/2003	Edgar, Jr. et al.	6,699,194	B1	3/2004	Diab et al.
6,519,487	B1	2/2003	Parker	6,699,199	B2	3/2004	Asada et al.
6,525,386	B1	2/2003	Mills et al.	6,701,170	B2	3/2004	Stetson
6,526,300	B1	2/2003	Kiani et al.	6,702,752	B2	3/2004	Dekker
6,526,301	B2	2/2003	Larsen et al.	6,707,257	B2	3/2004	Norris
6,541,756	B2	4/2003	Schulz et al.	6,708,049	B1	3/2004	Berson et al.
6,542,764	B1	4/2003	Al-Ali et al.	6,709,402	B2	3/2004	Dekker
6,546,267	B1	4/2003	Sugiura et al.	6,711,424	B1	3/2004	Fine et al.
6,553,241	B2	4/2003	Mannheimer et al.	6,711,425	B1	3/2004	Reuss
6,553,242	B1	4/2003	Sarussi	6,711,426	B2	3/2004	Benaron et al.
6,553,243	B2	4/2003	Gurley	6,714,803	B1	3/2004	Mortz
6,556,852	B1	4/2003	Schulze et al.	6,714,804	B2	3/2004	Al-Ali et al.
6,560,470	B1	5/2003	Pologe	6,714,805	B2	3/2004	Jeon et al.
6,564,077	B2	5/2003	Mortara	RE38,492	E	4/2004	Diab et al.
6,564,088	B1	5/2003	Soller et al.	6,719,686	B2	4/2004	Coakley et al.
6,571,113	B1	5/2003	Fein et al.	6,719,705	B2	4/2004	Mills
6,571,114	B1	5/2003	Koike et al.	6,720,734	B2	4/2004	Norris
6,574,491	B2	6/2003	Elghazzawi	6,721,584	B2	4/2004	Baker, Jr. et al.
6,580,086	B1	6/2003	Schulz et al.	6,721,585	B1	4/2004	Parker
6,584,336	B1	6/2003	Ali et al.	6,725,074	B1	4/2004	Kästle
6,587,703	B2	7/2003	Cheng et al.	6,725,075	B2	4/2004	Al-Ali
6,587,704	B1	7/2003	Fine et al.	6,731,963	B2	5/2004	Finarov et al.
6,589,172	B2	7/2003	Williams et al.	6,731,967	B1	5/2004	Turcott
6,591,122	B2	7/2003	Schmitt	6,735,459	B2	5/2004	Parker
6,591,123	B2	7/2003	Fein et al.	6,745,060	B2	6/2004	Diab et al.
6,594,511	B2	7/2003	Stone et al.	6,745,061	B1	6/2004	Hicks et al.
6,594,512	B2	7/2003	Huang	6,748,253	B2	6/2004	Norris et al.
6,594,513	B1	7/2003	Jobsis et al.	6,748,254	B2	6/2004	O'Neill et al.
6,597,931	B1	7/2003	Cheng et al.	6,754,515	B1	6/2004	Pologe
6,597,933	B2	7/2003	Kiani et al.	6,754,516	B2	6/2004	Mannheimer
6,600,940	B1	7/2003	Fein et al.	6,760,607	B2	7/2004	Al-Ali
6,606,510	B2	8/2003	Swedlow et al.	6,760,609	B2	7/2004	Jacques
6,606,511	B1	8/2003	Ali et al.	6,760,610	B2	7/2004	Tschupp et al.
6,606,512	B2	8/2003	Muz et al.	6,763,255	B2	7/2004	DeLonzor et al.
6,615,064	B1	9/2003	Aldrich	6,763,256	B2	7/2004	Kimball et al.
6,615,065	B1	9/2003	Barrett et al.	6,770,028	B1	8/2004	Ali et al.
6,618,602	B2	9/2003	Levin et al.	6,771,994	B2	8/2004	Kiani et al.
6,622,034	B1	9/2003	Gorski et al.	6,773,397	B2	8/2004	Kelly
6,628,975	B1	9/2003	Fein et al.	6,778,923	B2	8/2004	Norris et al.
				6,780,158	B2	8/2004	Yarita
				6,792,300	B1	9/2004	Diab et al.
				6,793,654	B2	9/2004	Lemberg
				6,801,797	B2	10/2004	Mannheimer et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

6,801,798 B2	10/2004	Geddes et al.	7,072,701 B2	7/2006	Chen et al.
6,801,799 B2	10/2004	Mendelson	7,072,702 B2	7/2006	Edgar, Jr. et al.
6,801,802 B2	10/2004	Sitzman et al.	7,079,880 B2	7/2006	Stetson
6,802,812 B1*	10/2004	Walker et al. 600/309	7,085,597 B2	8/2006	Fein et al.
6,805,673 B2	10/2004	Dekker	7,096,052 B2	8/2006	Mason et al.
6,810,277 B2	10/2004	Edgar, Jr. et al.	7,096,054 B2	8/2006	Abdul-Hafiz et al.
6,813,511 B2	11/2004	Diab et al.	7,107,088 B2	9/2006	Aceti
6,816,266 B2	11/2004	Varshneya et al.	7,107,116 B2	9/2006	Geng
6,816,741 B2	11/2004	Diab	7,113,815 B2	9/2006	O'Neil et al.
6,819,950 B2	11/2004	Mills	7,123,950 B2	10/2006	Mannheimer
6,822,564 B2	11/2004	Al-Ali	7,127,278 B2	10/2006	Melker et al.
6,825,619 B2	11/2004	Norris	7,130,671 B2	10/2006	Baker, Jr. et al.
6,826,419 B2	11/2004	Diab et al.	7,130,672 B2	10/2006	Pewzner et al.
6,829,496 B2	12/2004	Nagai et al.	7,132,641 B2	11/2006	Schulz et al.
6,830,711 B2	12/2004	Mills et al.	7,133,711 B2	11/2006	Chernoguz et al.
6,836,679 B2	12/2004	Baker, Jr. et al.	7,134,754 B2	11/2006	Kerr
6,839,579 B1	1/2005	Chin	7,139,599 B2	11/2006	Terry
6,839,580 B2	1/2005	Zonios et al.	7,142,901 B2	11/2006	Kiani et al.
6,839,582 B2	1/2005	Heckel	7,149,293 B1	12/2006	Coppage et al.
6,839,659 B2	1/2005	Tarassenko et al.	7,162,288 B2	1/2007	Nordstrom
6,842,635 B1	1/2005	Parker	7,190,987 B2	3/2007	Lindekugel et al.
6,845,256 B2	1/2005	Chin et al.	7,198,778 B2	4/2007	Achilefu et al.
6,850,787 B2	2/2005	Weber et al.	7,209,775 B2	4/2007	Bae et al.
6,850,788 B2	2/2005	Al-Ali	7,215,984 B2	5/2007	Diab et al.
6,850,789 B2	2/2005	Schweitzer, Jr. et al.	7,221,969 B2	5/2007	Stoddart et al.
6,861,639 B2	3/2005	Al-Ali	7,225,006 B2	5/2007	Al-Ali et al.
6,862,091 B2	3/2005	Johnson	7,236,811 B2	6/2007	Schmitt
6,863,652 B2	3/2005	Huang et al.	7,242,997 B2	7/2007	Geng
6,865,407 B2	3/2005	Kimball et al.	7,248,910 B2	7/2007	Li et al.
6,879,850 B2	4/2005	Kimball	7,254,433 B2	8/2007	Diab et al.
6,882,874 B2	4/2005	Huiku	7,254,434 B2	8/2007	Schulz et al.
6,889,153 B2	5/2005	Dietiker	7,263,395 B2	8/2007	Chan et al.
6,898,452 B2	5/2005	Al-Ali et al.	7,272,426 B2	9/2007	Schmid
6,909,912 B2	6/2005	Melker et al.	7,280,858 B2	10/2007	Al-Ali et al.
6,912,413 B2	6/2005	Rantala et al.	7,283,242 B2	10/2007	Thornton
6,916,289 B2	7/2005	Schnall	7,295,866 B2	11/2007	Al-Ali et al.
6,920,345 B2	7/2005	Al-Ali et al.	7,305,262 B2	12/2007	Brodnick et al.
6,931,269 B2	8/2005	Tery	7,315,753 B2	1/2008	Baker, Jr. et al.
6,934,570 B2	8/2005	Kiani et al.	7,356,365 B2	4/2008	Schurman
6,939,307 B1	9/2005	Dunlop	7,389,131 B2*	6/2008	Kanayama 600/322
6,941,162 B2	9/2005	Fudge et al.	2001/0021803 A1	9/2001	Blank et al.
6,947,781 B2	9/2005	Asada et al.	2001/0051767 A1	12/2001	Williams et al.
6,950,687 B2	9/2005	Al-Ali	2002/0026109 A1	2/2002	Diab et al.
6,963,767 B2	11/2005	Rantala et al.	2002/0028990 A1	3/2002	Shepherd et al.
6,971,580 B2	12/2005	DeLonzor et al.	2002/0038078 A1	3/2002	Ito
6,983,178 B2	1/2006	Fine et al.	2002/0042558 A1	4/2002	Mendelson
6,985,763 B2	1/2006	Boas et al.	2002/0068859 A1	6/2002	Knopp
6,985,764 B2	1/2006	Mason et al.	2002/0128544 A1	9/2002	Diab et al.
6,990,426 B2	1/2006	Yoon et al.	2002/0133067 A1	9/2002	Jackson, III
6,992,751 B2	1/2006	Okita et al.	2002/0156354 A1	10/2002	Larson
6,992,772 B2	1/2006	Block et al.	2002/0173706 A1	11/2002	Takatani
6,993,371 B2	1/2006	Kiani et al.	2002/0173709 A1	11/2002	Fine et al.
6,993,372 B2	1/2006	Fine et al.	2002/0190863 A1	12/2002	Lynn
6,996,427 B2	2/2006	Ali et al.	2002/0198442 A1	12/2002	Rantala et al.
7,003,338 B2	2/2006	Weber et al.	2003/0018243 A1	1/2003	Gerhardt et al.
7,003,339 B2	2/2006	Diab et al.	2003/0036690 A1	2/2003	Geddes et al.
7,006,855 B1	2/2006	Sarussi	2003/0045785 A1	3/2003	Diab et al.
7,006,856 B2	2/2006	Baker, Jr. et al.	2003/0073889 A1	4/2003	Keilbach et al.
7,016,715 B2	3/2006	Stetson	2003/0073890 A1	4/2003	Hanna
7,020,507 B2	3/2006	Scharf et al.	2003/0100840 A1	5/2003	Sugiura et al.
7,024,233 B2	4/2006	Ali et al.	2003/0132495 A1	7/2003	Mills et al.
7,024,235 B2	4/2006	Melker et al.	2003/0135099 A1	7/2003	Al-Ali
7,025,728 B2	4/2006	Ito et al.	2003/0162414 A1	8/2003	Schulz et al.
7,027,849 B2	4/2006	Al-Ali et al.	2003/0171662 A1	9/2003	O'Connor et al.
7,027,850 B2	4/2006	Wasserman	2003/0176776 A1	9/2003	Huiku
7,035,697 B1	4/2006	Brown	2003/0181799 A1	9/2003	Lindekugel et al.
7,039,449 B2	5/2006	Al-Ali	2003/0187337 A1	10/2003	Tarassenko et al.
7,043,289 B2	5/2006	Fine et al.	2003/0195402 A1	10/2003	Fein et al.
7,047,055 B2	5/2006	Boas et al.	2003/0197679 A1	10/2003	Ali et al.
7,047,056 B2	5/2006	Hannula et al.	2003/0212316 A1	11/2003	Leiden et al.
7,060,035 B2	6/2006	Wasserman et al.	2003/0225323 A1	12/2003	Kiani et al.
7,062,306 B2	6/2006	Benaron et al.	2003/0225337 A1	12/2003	Scharf et al.
7,062,307 B2	6/2006	Norris et al.	2003/0236452 A1	12/2003	Melker et al.
7,065,392 B2*	6/2006	Kato 600/323	2003/0236647 A1	12/2003	Yoon et al.
7,067,893 B2	6/2006	Mills et al.	2004/0006261 A1	1/2004	Swedlow et al.
			2004/0010188 A1	1/2004	Wasserman et al.
			2004/0024297 A1	2/2004	Chen et al.
			2004/0024326 A1	2/2004	Yeo et al.
			2004/0034293 A1	2/2004	Kimball

(56)

References Cited

U.S. PATENT DOCUMENTS

2004/0039272 A1 2/2004 Abdul-Hafiz et al.
 2004/0039273 A1 2/2004 Terry
 2004/0054269 A1 3/2004 Rantala et al.
 2004/0054291 A1 3/2004 Schulz et al.
 2004/0059209 A1 3/2004 Al-Ali et al.
 2004/0059210 A1 3/2004 Stetson
 2004/0064020 A1 4/2004 Diab et al.
 2004/0068164 A1 4/2004 Diab et al.
 2004/0087846 A1 5/2004 Wasserman
 2004/0092805 A1 5/2004 Yarita
 2004/0097797 A1 5/2004 Porges et al.
 2004/0098009 A1 5/2004 Boecker et al.
 2004/0107065 A1 6/2004 Al-Ali et al.
 2004/0116788 A1 6/2004 Chernoguz et al.
 2004/0116789 A1 6/2004 Boaz et al.
 2004/0117891 A1 6/2004 Hannula et al.
 2004/0122300 A1 6/2004 Boas et al.
 2004/0122302 A1 6/2004 Mason et al.
 2004/0133087 A1 7/2004 Ali et al.
 2004/0133088 A1 7/2004 Al-Ali et al.
 2004/0138538 A1 7/2004 Stetson
 2004/0138540 A1 7/2004 Baker, Jr. et al.
 2004/0143172 A1 7/2004 Fudge et al.
 2004/0147821 A1 7/2004 Al-Ali et al.
 2004/0147822 A1 7/2004 Al-Ali et al.
 2004/0147823 A1 7/2004 Kiani et al.
 2004/0147824 A1 7/2004 Diab et al.
 2004/0152965 A1 8/2004 Diab et al.
 2004/0158134 A1 8/2004 Diab et al.
 2004/0158135 A1 8/2004 Baker, Jr. et al.
 2004/0162472 A1 8/2004 Berson et al.
 2004/0171920 A1 9/2004 Mannheimer et al.
 2004/0171948 A1 9/2004 Terry
 2004/0176671 A1 9/2004 Fine et al.
 2004/0181133 A1 9/2004 Al-Ali et al.
 2004/0181134 A1 9/2004 Baker, Jr. et al.
 2004/0186358 A1 9/2004 Chernow et al.
 2004/0199063 A1 10/2004 O'Neil et al.
 2004/0204636 A1 10/2004 Diab et al.
 2004/0204637 A1 10/2004 Diab et al.
 2004/0204638 A1 10/2004 Diab et al.
 2004/0204639 A1 10/2004 Casciani et al.
 2004/0204865 A1 10/2004 Lee et al.
 2004/0210146 A1 10/2004 Diab et al.
 2004/0215069 A1 10/2004 Mannheimer
 2004/0230107 A1 11/2004 Asada et al.
 2004/0230108 A1 11/2004 Melker et al.
 2004/0236196 A1 11/2004 Diab et al.
 2004/0242980 A1 12/2004 Kiani et al.
 2004/0249252 A1 12/2004 Fine et al.
 2004/0257557 A1 12/2004 Block et al.
 2004/0260161 A1 12/2004 Melker et al.
 2004/0267103 A1 12/2004 Li et al.
 2004/0267104 A1 12/2004 Hannula et al.
 2004/0267140 A1 12/2004 Ito et al.
 2005/0004479 A1 1/2005 Townsend et al.
 2005/0010092 A1 1/2005 Weber et al.
 2005/0020887 A1 1/2005 Goldberg
 2005/0020894 A1 1/2005 Norris et al.
 2005/0033128 A1 2/2005 Ali et al.
 2005/0033129 A1 2/2005 Edgar, Jr. et al.
 2005/0043599 A1 2/2005 O'Mara
 2005/0043600 A1 2/2005 Diab et al.
 2005/0049470 A1 3/2005 Terry
 2005/0049471 A1 3/2005 Aceti
 2005/0075550 A1 4/2005 Lindekugel
 2005/0113651 A1 5/2005 Wood et al.
 2005/0177034 A1 8/2005 Beaumont
 2005/0197548 A1 9/2005 Dietiker

2005/0228248 A1 10/2005 Dietiker
 2005/0254992 A1 11/2005 Jenkins et al.
 2005/0267346 A1 12/2005 Faber et al.
 2005/0277819 A1 12/2005 Kiani et al.
 2005/0283059 A1 12/2005 Iyer et al.
 2006/0058594 A1 3/2006 Ishizuka et al.
 2006/0084852 A1 4/2006 Mason et al.
 2006/0089547 A1 4/2006 Sarussi
 2006/0106294 A1 5/2006 Maser et al.
 2006/0195028 A1 8/2006 Hannula et al.
 2006/0224058 A1 10/2006 Mannheimer
 2006/0229509 A1 10/2006 Al-Ali et al.
 2006/0247501 A1 11/2006 Ali
 2006/0258921 A1 11/2006 Addison et al.
 2007/0032710 A1 2/2007 Raridan et al.
 2007/0032712 A1 2/2007 Raridan et al.
 2007/0032715 A1 2/2007 Eghbal et al.
 2007/0073126 A1 3/2007 Raridan, Jr.
 2007/0129613 A1 6/2007 Rochester et al.
 2008/0316488 A1 12/2008 Mao et al.

FOREIGN PATENT DOCUMENTS

FR	2685865	1/1992
JP	3245042	10/1991
JP	6269430	9/1994
JP	7001273	1/1995
JP	2004261364	9/2004
WO	WO8909566	10/1989
WO	WO9001293	2/1990
WO	WO9309711	5/1993
WO	WO9502358	1/1995

OTHER PUBLICATIONS

Cubeddu, Rinaldo, et al.; "Portable 8-channel time-resolved optical imager for functional studies of biological tissues," *Photon Migration, Optical Coherence Tomography, and Microscopy, Proceedings of SPIE*, vol. 4431, pp. 260-265 (2001).

Lopez-Silva, Sonia Maria Lopez, et al.; "NIR transmittance pulse oximetry system with laser diodes," *Clinical Diagnostic Systems, Proceedings of SPIE*, vol. 4255, pp. 80-87 (2001).

Maletas, Francois-Xavier, et al.; "Construction and calibration of a new design of Fiber Optic Respiratory Plethysmograph (FORP)," *Optomechanical Design and Engineering, Proceedings of SPIE*, vol. 4444, pp. 285-293 (2001).

Liu, Ying, et al.; "Sensor design of new type reflectance pulse oximetry," *Optics in Health Care and Biomedical Optics: Diagnostics and Treatment, Proceedings of SPIE*, vol. 4916, pp. 98-102 (2002).

Lopez-Silva, Sonia Maria Lopez, et al.; "Near-infrared transmittance pulse oximetry with laser diodes," *Journal of Biomedical Optics*, vol. 8, No. 3, pp. 525-533 (Jul. 2003).

Mendelson, Y., et al.; "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," *Proceedings of the 25th Annual International conference of the IEEE EMBS*, Cancun, Mexico, Sep. 1.

Pujary, C., et al.; "Photodetector Size Considerations in the Design of a Noninvasive Reflectance Pulse Oximeter for Telemedicine Applications," *IEEE*, pp. 148-149 (2003).

Lopez-Silva, S.M., et al.; "Transmittance Photoplethysmography and Pulse Oximetry With Near Infrared Laser Diodes," *IMTC 2004—Instrumentation and Measurement Technology Conference*, Como, Italy, May 18-20, 2004; pp. 718-723.

Odagiri, Y.; "Pulse Wave Measuring Device," *Micromechatronics*, vol. 42, No. 3, pp. 6-11 (undated) (Article in Japanese—contains English summary of article).

* cited by examiner

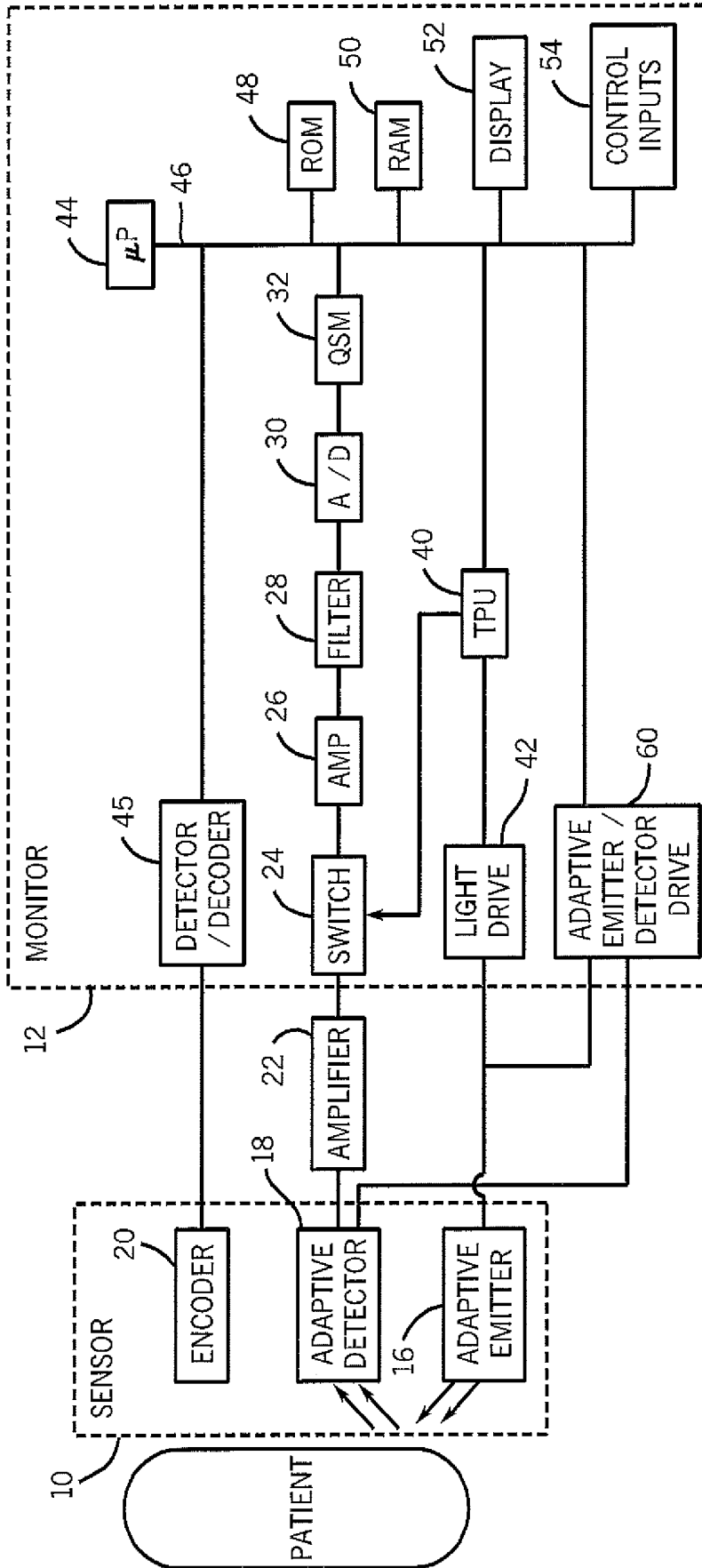


FIG. 1

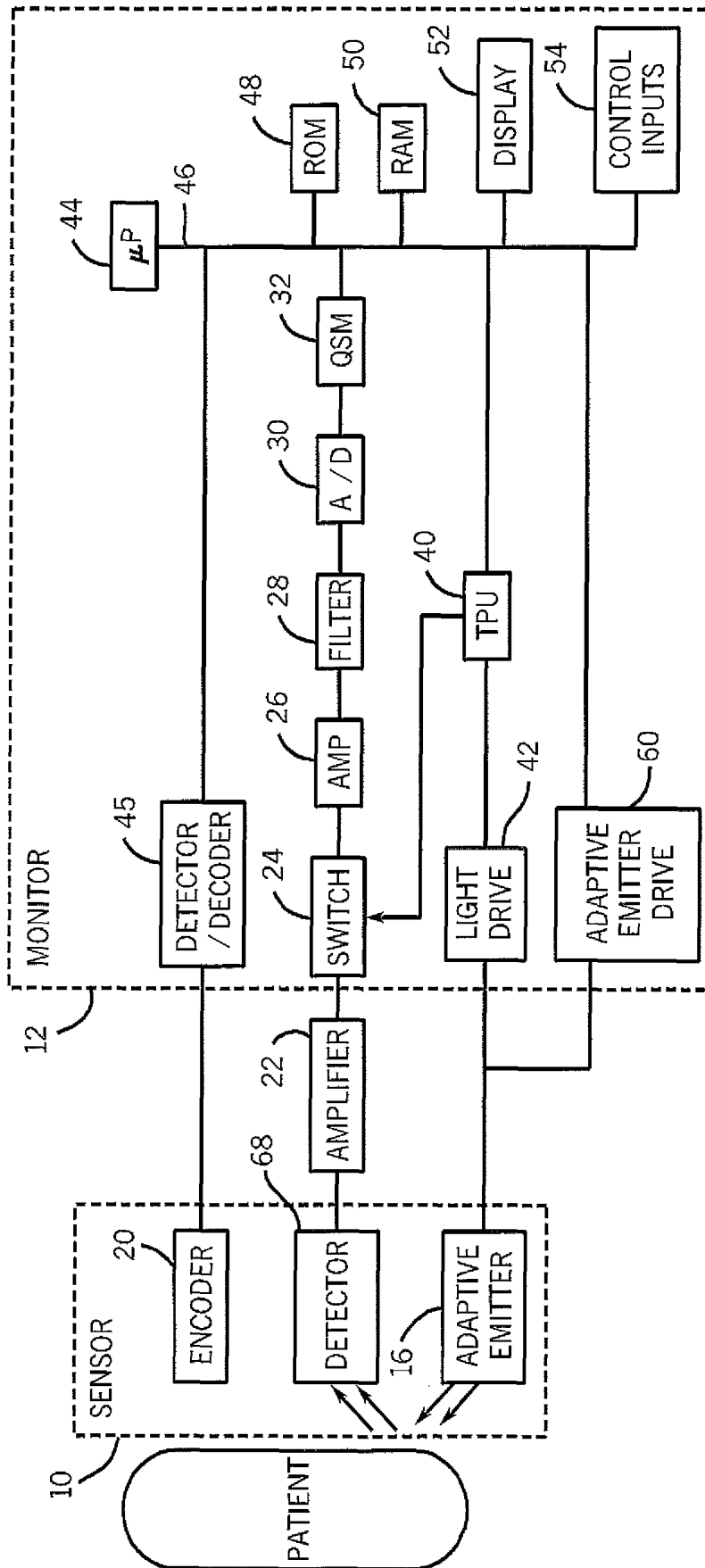


FIG. 2

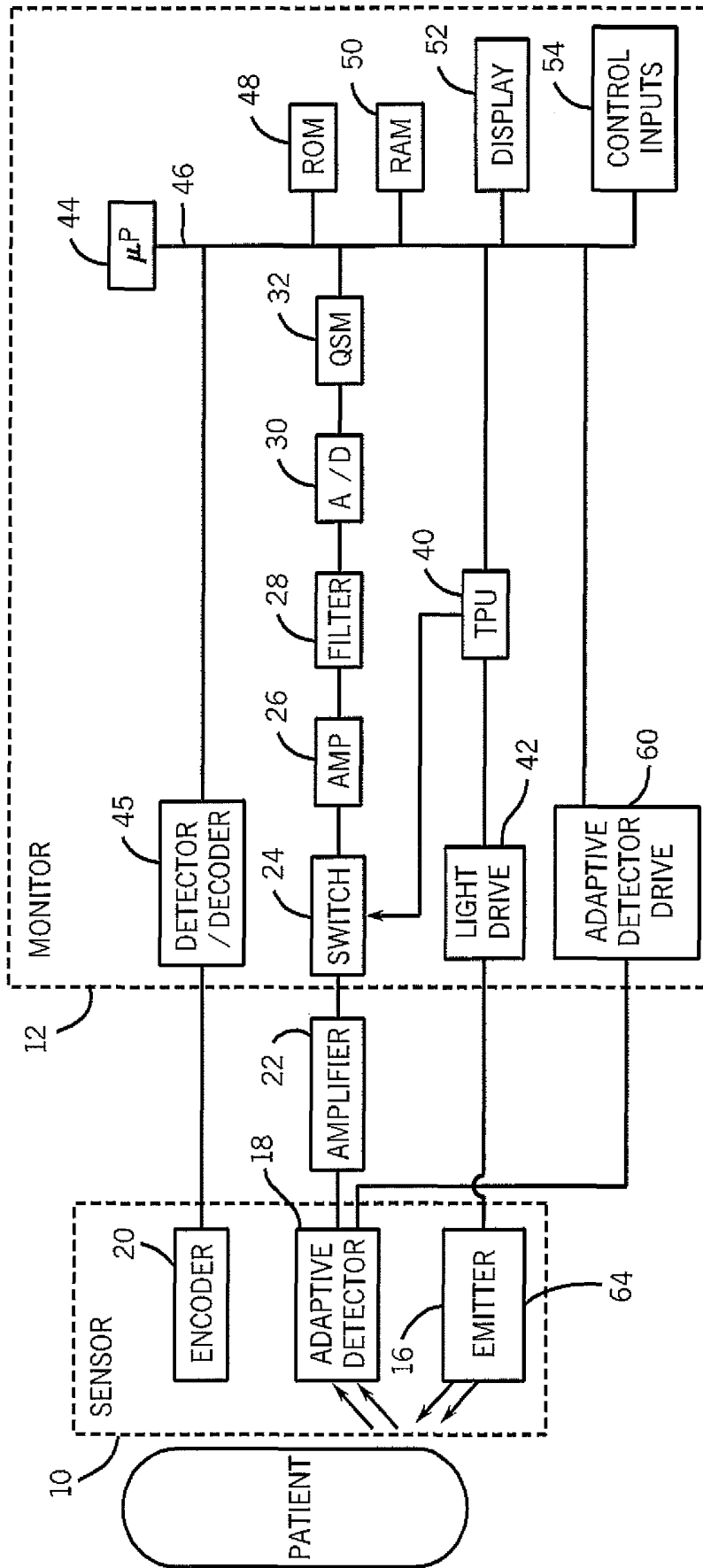


FIG. 3

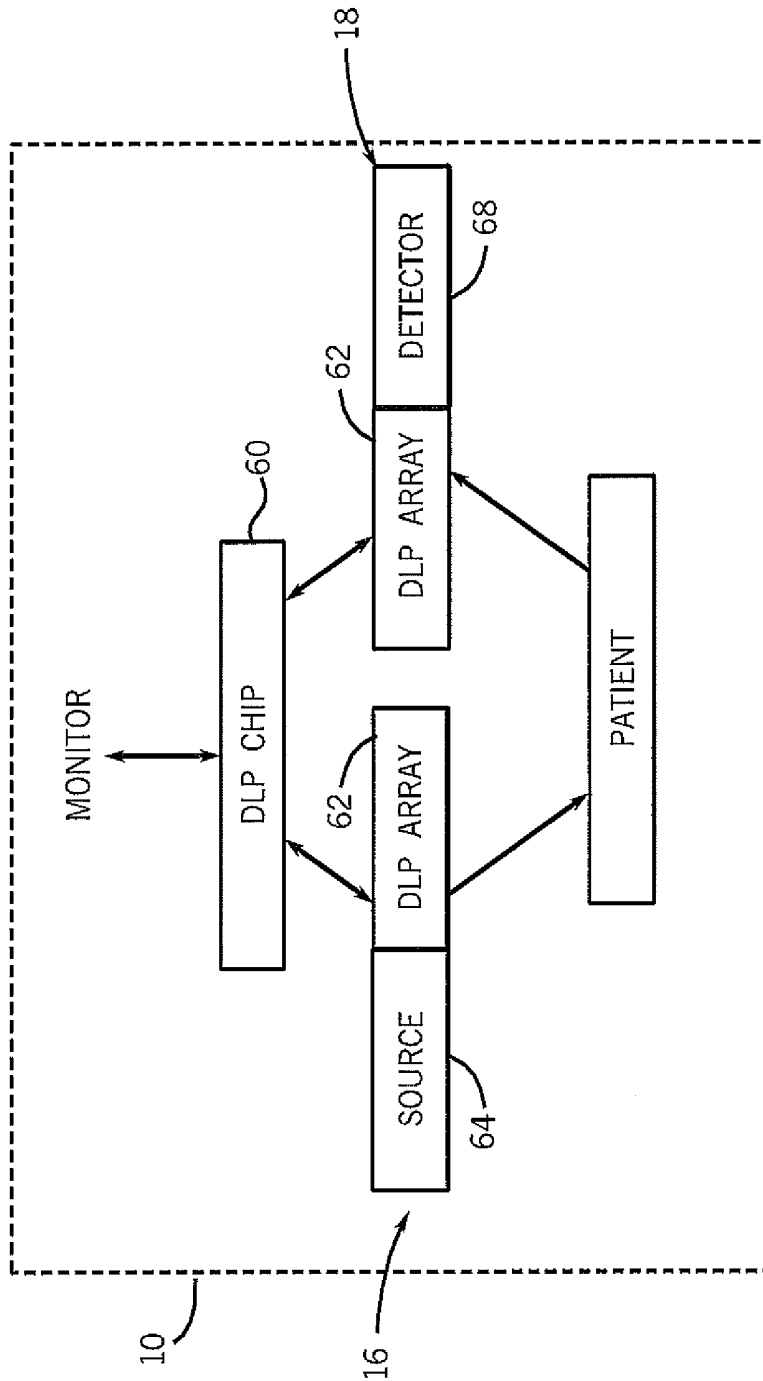


FIG. 4

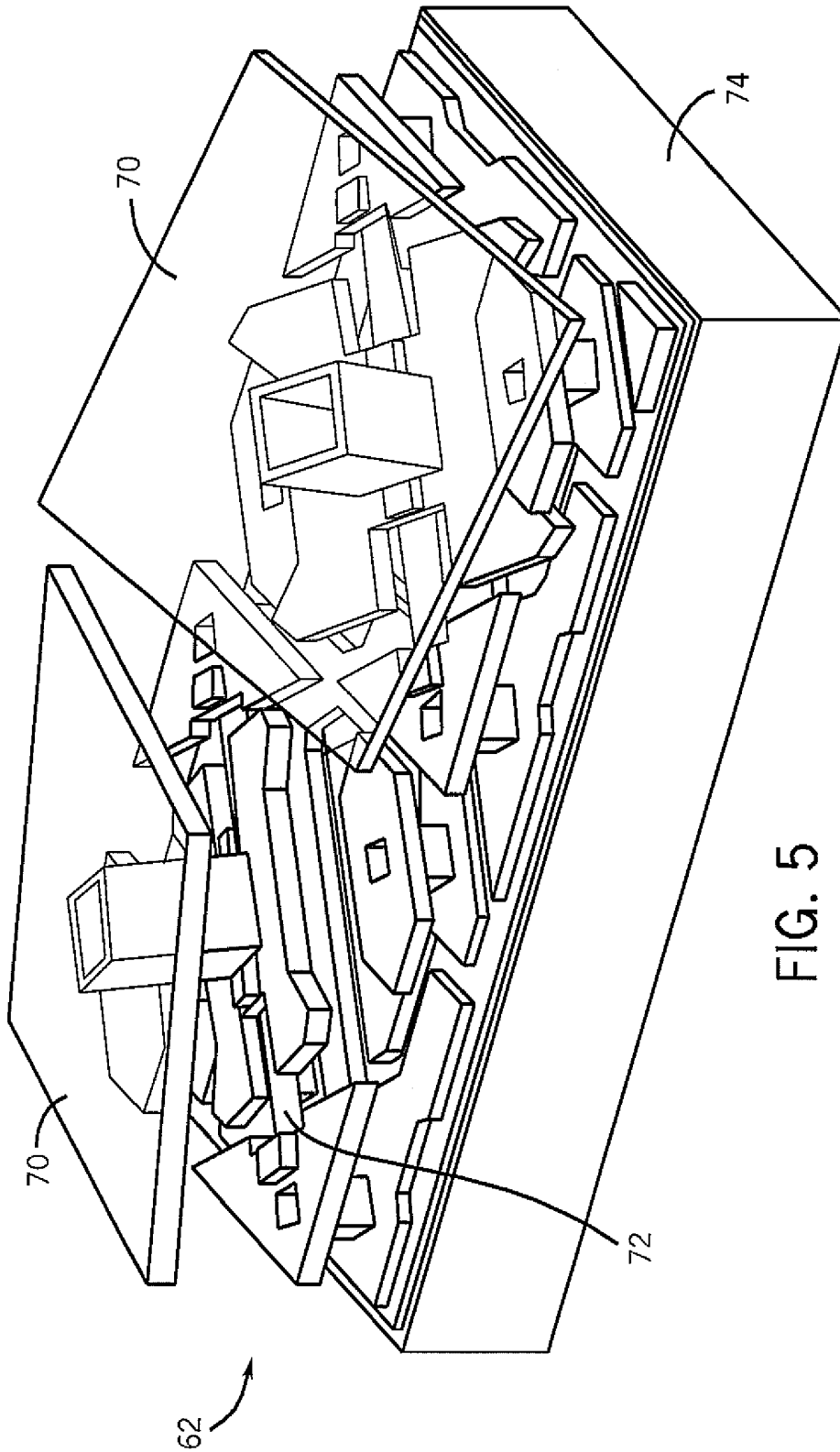


FIG. 5

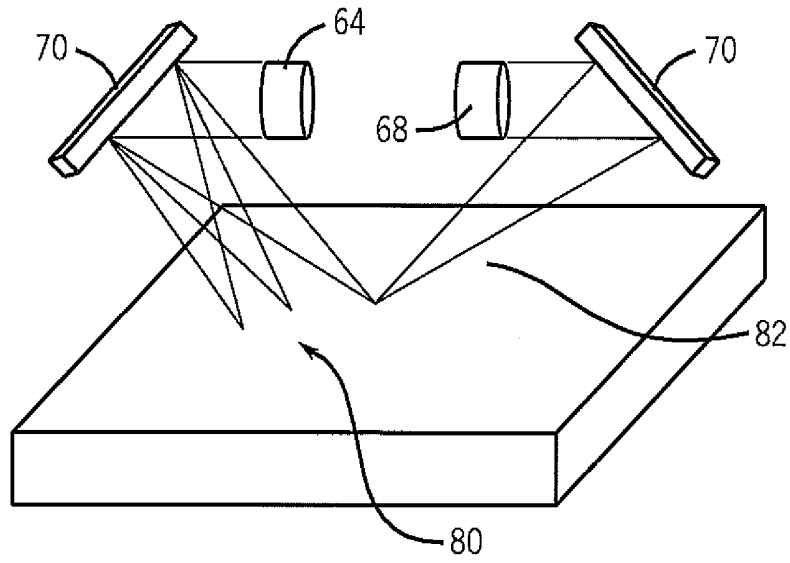


FIG. 6

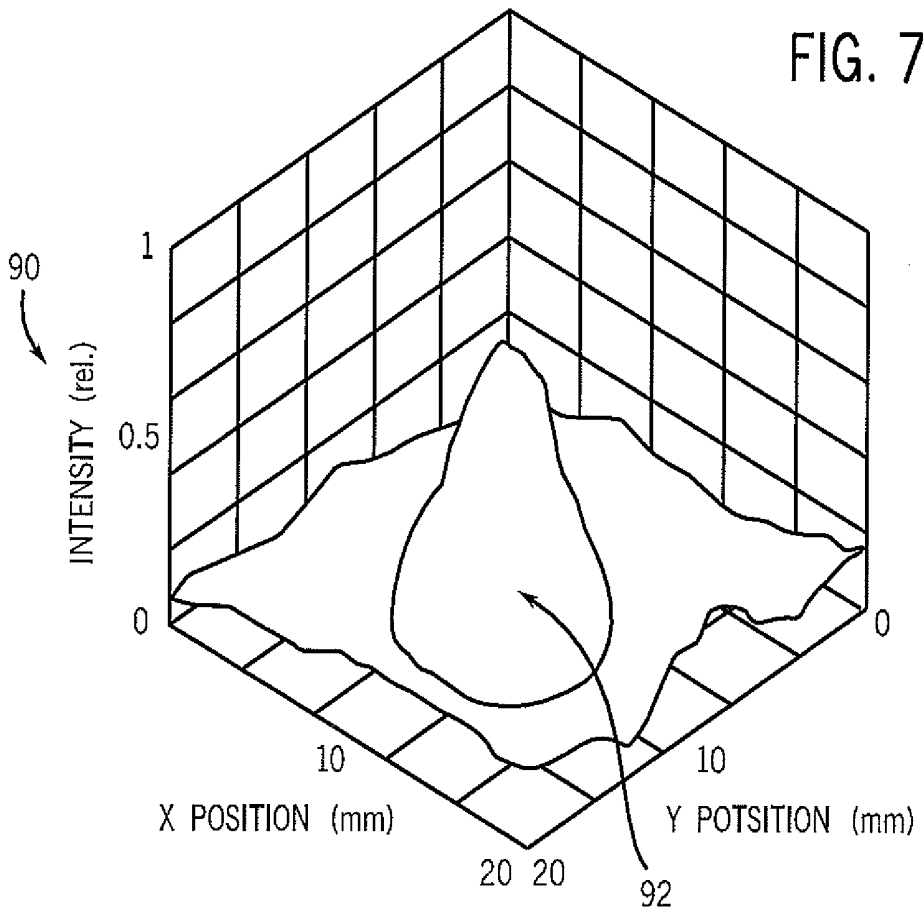


FIG. 7

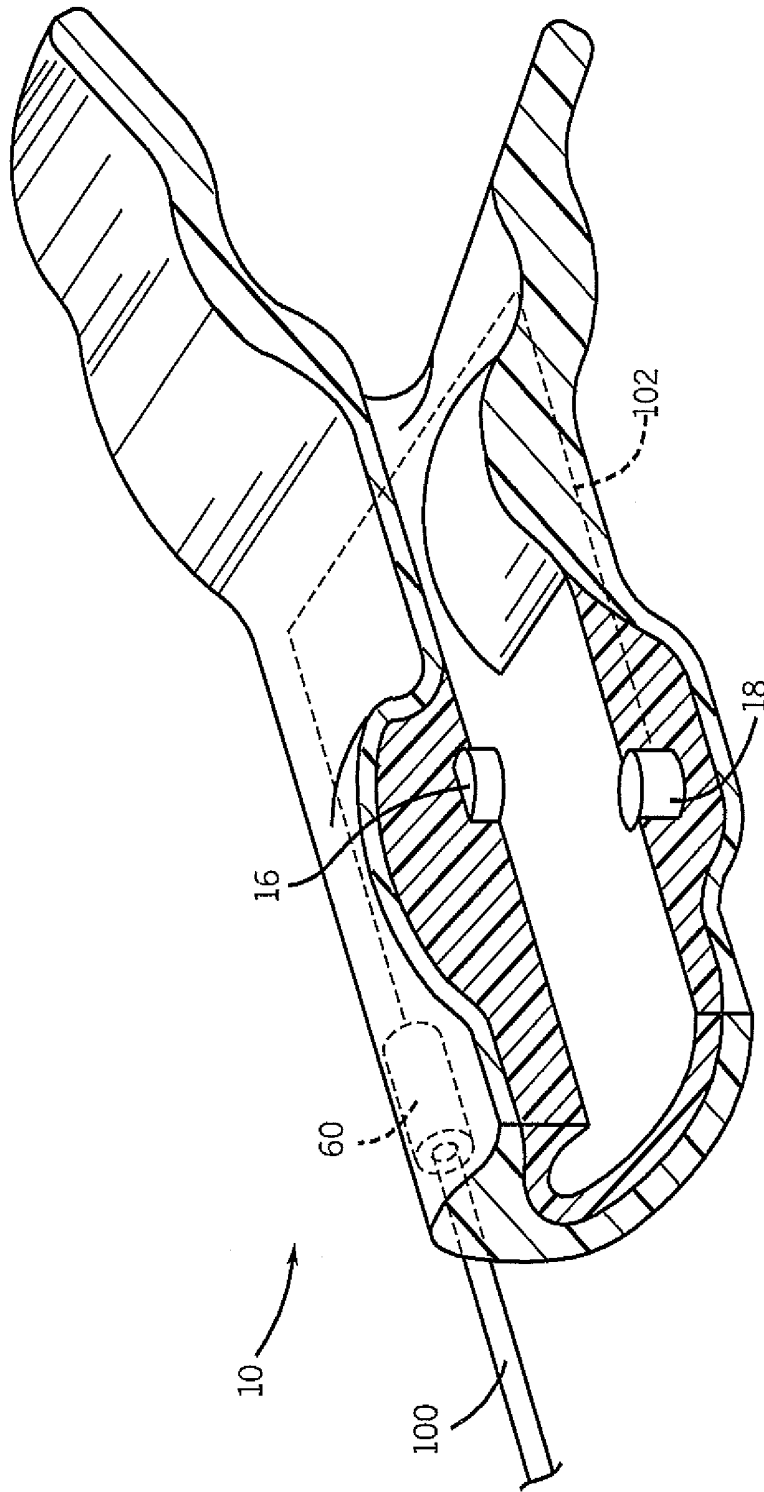


FIG. 8

MEDICAL SENSOR AND TECHNIQUE FOR USING THE SAME

BACKGROUND

The present disclosure relates generally to medical devices and, more particularly, to sensors used for sensing physiological parameters of a patient.

In the field of medicine, doctors often desire to monitor certain physiological characteristics of their patients. Accordingly, a wide variety of devices have been developed for monitoring many such physiological characteristics. Such devices provide doctors and other healthcare personnel with the information they need to provide the best possible healthcare for their patients. As a result, such monitoring devices have become an indispensable part of modern medicine.

One technique for monitoring certain physiological characteristics of a patient is commonly referred to as pulse oximetry, and the devices built based upon pulse oximetry techniques are commonly referred to as pulse oximeters. Pulse oximetry may be used to measure various blood flow characteristics, such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient. In fact, the "pulse" in pulse oximetry refers to the time varying amount of arterial blood in the tissue during each cardiac cycle.

Pulse oximeters typically utilize a non-invasive sensor that transmits light through a patient's tissue and that photoelectrically detects the absorption and/or scattering of the transmitted light in such tissue. One or more of the above physiological characteristics may then be calculated based upon the amount of light absorbed or scattered. More specifically, the light passed through the tissue is typically selected to be of one or more wavelengths that may be absorbed or scattered by the blood in an amount correlative to the amount of the blood constituent present in the blood. The amount of light absorbed and/or scattered may then be used to estimate the amount of blood constituent in the tissue using various algorithms.

The quality of the pulse oximetry measurement depends in part on the concentration of arterial blood relative to other tissue structures in the portion of the tissue illuminated by the sensor and in part on the magnitude of the pulsatile changes in the blood. Patient tissue variability and sensor placement variability can cause interference in the resulting pulse oximeter measurements. This variability stems, in part, from the heterogeneity of the tissue structure and vasculature within any specific sample of tissue and, in particular, the moving and pulsing structures, e.g., the arteries, within the tissue that non-linearly contribute to the optical density of the probed tissue bed.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the disclosure may become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. 1 is a block diagram of an exemplary medical sensor system;

FIG. 2 is a block diagram of an exemplary medical sensor system;

FIG. 3 is a block diagram of an exemplary medical sensor system;

FIG. 4 illustrates a block diagram of an exemplary medical sensor;

FIG. 5 is a schematic view of an exemplary microelectromechanical assembly for digital light projection that may be incorporated into a sensor as provided herein;

FIG. 6 is a schematic view of an exemplary optical source and adaptive detector interacting with a digital light projection assembly to shine light on a patient's tissue and detect the emitted light;

FIG. 7 is an exemplary photon intensity distribution that may be emitted by an adaptive emitter as provided herein; and

FIG. 8 is a cross-sectional view of an exemplary medical sensor.

DETAILED DESCRIPTION

One or more embodiments of the present disclosure will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

Typically, a pulse oximetry sensor employs a light source that shines photons of light on the tissue. The photons travel through the tissue and are variously transmitted, scattered, reflected, or absorbed. The photon distribution of the light depends in part on the physical structures of the tissue, including the pulsatile components, and may vary significantly within a single patient's tissue. Accordingly, simply shifting the placement of a sensor on the tissue by as little as a few millimeters, and therefore changing the paths by which the photons travel, can result in changes in the measured blood oxygen saturation of a few percent.

To address these concerns, it would be desirable to provide sensors and systems for pulse oximetry or other applications utilizing spectrophotometry that are capable of changing or adapting the optical components of the sensor to achieve improved signal strength and decreased interference from tissue variability. Sensors with adaptive optical components may provide improved measurements by adapting the emitted light to a light intensity profile that is associated with signal optimization. For example, an adaptive light emitter may be capable of emitting an increased intensity of light into a particular tissue region that has better perfusion and may be associated with an improved signal. Similarly, such an adaptive emitter may direct light away from regions of the tissue with surface discoloration or anatomical structures that may absorb light and result in decreased signal strength. In addition, sensors with adaptive optical components may also adapt the light detecting elements of the sensor to detect only light within certain wavelength or within a certain distribution profile associated with improved signals.

A sensor including one or more adaptive emitters and/or adaptive detectors as provided herein and illustrated generically as a sensor **10**, may be used in conjunction with a medical monitor **12**, as illustrated in FIG. 1. A block diagram of an embodiment of a medical monitor **12** that may be configured to implement embodiments of the present disclosure. In an embodiment, the sensor **10** may be connected a pulse oximetry monitor, such as those available from Nellcor Puritan Bennett LLC. Light from adaptive emitter **16** may

pass into a blood perfused tissue, and may be scattered, and then detected by adaptive detector 18. A sensor 10 containing an adaptive emitter 16 and an adaptive detector 18 may also contain an encoder 20, which may be capable of providing signals indicative of the wavelength(s) of emitter 16 to allow the oximeter to select appropriate calibration coefficients for calculating oxygen saturation. The encoder 20 may, in an embodiment, be a resistor.

In an embodiment, the monitor 12 may include a microprocessor 44 coupled to an internal bus 46. Also connected to the bus may be a RAM memory 50 and a display 52. A time processing unit (TPU) 40 may provide timing control signals to light drive circuitry 42, which controls when the adaptive emitter 16 is activated, and if multiple light sources are used, the multiplexed timing for the different light sources. TPU 40 may also control the gating-in of signals from adaptive detector 18 through an amplifier 22 and a switching circuit 24. These signals are sampled at the proper time, depending at least in part upon which of multiple light sources is activated, if multiple light sources are used. The received signal from the adaptive detector 18 may be passed through an amplifier 26, a low pass filter 28, and/or an analog-to-digital converter 30. The digital data may then be stored in a queued serial module (QSM) 32, for later downloading to RAM 50 as QSM 32 fills up. In an embodiment, there may be multiple parallel paths of separate amplifier, filter, and A/D converters for multiple light wavelengths or spectra received.

In an embodiment of a two-wavelength system, the particular set of coefficients chosen for any pair of wavelength spectra may be determined by a value indicated by the encoder 20 corresponding to a particular light source in a particular sensor 10. In one embodiment, multiple resistor values may be assigned to select different sets of coefficients. In another embodiment, the same resistors are used to select from among the coefficients appropriate for an infrared source paired with either a near red source or far red source. The selection between whether the near red or far red set will be chosen can be selected with a control input from control inputs 54. Control inputs 54 may be, for instance, a switch on the pulse oximeter, a keyboard, or a port providing instructions from a remote host computer. Furthermore, any number of methods or algorithms may be used to determine a patient's pulse rate, oxygen saturation or any other desired physiological parameter. In an embodiment, based at least in part upon the received signals corresponding to the light received by adaptive detector 18, microprocessor 44 may calculate the oxygen saturation using various algorithms. These algorithms may require coefficients, which may be empirically determined, and may correspond to the wavelengths of light used. The algorithms may be stored in a ROM 48 and accessed and operated according to microprocessor 44 instructions.

In one embodiment, the monitor 12 includes a separate drive 60 for the adaptive components of the adaptive emitter 16 and/or adaptive detector 18. While the light drive 42 may control a light source portion of the adaptive emitter 16, such as a light emitting diode, the adaptive drive 60 may control microelectromechanical portions of the adaptive optical components. In one embodiment, the adaptive drive 60 may direct certain microelectromechanical portions of a digital light processing array to independently orient in specified directions to control the directions and/or focus of emitted light and thereby direct the adaptive emitter 16 to produce a certain light intensity profile on the patient's tissue. In another embodiment, the adaptive drive 60 may direct application of voltage across portions of a liquid lens to change the curvature, and thus the optical properties, of the lens. In an embodi-

ment, such a device may include a code or other identification parameter that may allow the monitor 12 to select an appropriate software or hardware instruction set for processing the signal and/or instructions for handling the adaptive emitter 16 and/or the adaptive detector 18. In an embodiment, the adaptive drive 60 may also be located on the sensor 10 or may be located in a sensor's electrical connector, such as a cable.

In an embodiment, the microprocessor 44 may provide instructions for calibrating a sensor 10 based on signals from the adaptive detector 18. For example, after a sensor is applied to a patient's tissue, a monitor 12 may initiate a calibration sweep of the optical components by directing the adaptive emitter 16 and/or the adaptive detector 18 to run through various configurations. The detected signals may be then processed or subjected to quality metrics (such as those provided in U.S. Pat. No. 7,194,293, to Baker, which is incorporated by reference in its entirety herein for all purposes) to determine which configuration has improved signal to noise ratios in the detected signal. For example, the signal from each configuration may be subjected to quality metrics to determine the best adapted configuration of the adaptive emitter 16, adaptive detector, 18, or a combination of both. In an embodiment, the calibration includes a sweep through a pre-programmed set of optical configurations. A "best quality" configuration may be determined, and the sensor 10 may be directed to improve upon the best quality configuration by adaptive learning routines that initiate iterative improvements of the best quality configuration. In such a manner, a monitor and/or sensor may adapt an emitter 16 and a detector 18 to each individual patient. In one embodiment, the calibration sweep may be repeated periodically to update the calibration and account for subtle movements of the sensor on the patient's skin and/or clinical changes in the patient's condition that may affect tissue hydration, which in turn may influence the photon distribution.

In an embodiment, certain configurations of the adaptive optical components may be associated with certain patient characteristics and/or tissue sites. For example, certain configurations of the adaptive optical components may show empirical improvements in signal quality when a sensor 10 is associated with an ear, digit, or forehead. A user may select the tissue site of the sensor placement, and the adaptive drive 60 may adjust the configuration of the adaptive optical components accordingly. In another embodiment, specific configurations of the adaptive optical components may be associated with patients certain skin colors as determined by, for example, Fitzpatrick skin color types. A monitor 12 may be adapted to allow a user to select a patient skin color and may subsequently provide instructions through the adaptive drive 60 to the adaptive optical elements.

In an embodiment, the adaptive optical components may be used to map the tissue structure to provide an indication to a healthcare provider about tissue structures that may be associated with signal quality changes. For example, a sensor 10 may "sweep" a tissue area by changing the configuration of the adaptive optical components and processing the detected signal. Signals characteristic of large anatomic structures, such as bone or tissue masses, may be indicated to a healthcare provider. In addition, the information from the "sweeps" of the tissue may be used to reconstruct a tomographic image of the tissue properties below the surface using a variety of wavelengths and configurations of the source and receiver adaptive optical elements. These tomographic techniques are typically referred to as Diffuse Optical Tomography or Photon Migration Imaging.

In certain embodiments, such as those illustrated in FIG. 2 and FIG. 3, a sensor 10 may include a combination of adaptive

and nonadaptive optical components. For example, FIG. 2 shows a sensor 10 with an adaptive emitter 16 coupled to a standard detector 68, such as a photodetector. In such an embodiment, the adaptive drive 60 may be coupled to the emitter 16. Alternatively, FIG. 3 shows an embodiment in which a light emitter 64 may be coupled to an adaptive detector 18. In the depicted embodiment, the adaptive drive 60 is coupled to the detector 18.

FIG. 4 shows a block diagram of a sensor 10 that includes an adaptive emitter 16 and an adaptive detector 18, according to an embodiment. As depicted, the adaptive components of the emitter 16 and detector 18 may include digital light processing arrays 62 coupled to either a light source 64 and/or a light detector 68. The sensor 10 may include a digital light processing chip 60 with functionality to respond to processor instructions from a downstream monitor to control the micro-electromechanical portions of the digital light processing arrays 62. In other embodiments, the digital light processing chip 60 may be provided on a monitor 20 and a control signal transmitted from the digital light processing chip 60 to the digital light processing arrays 62.

In an embodiment, the adaptive emitter 16 includes a light source 64, and the adaptive detector includes a light detector 68. The light source 64 may be adapted to be coupled with the digital light processing array 62 to allow the digital light processing array 62 to direct the path of the emitted light onto the tissue. The light detector may be adapted to be coupled with the digital light processing array 62 to allow the digital light processing array 62 to direct the path of the light that has passed through the tissue to impinge the light detector 68.

In an embodiment, light source 64 may be one or more light emitting diodes adapted to transmit one or more wavelengths of light in the red to infrared range, and the light detector 68 may include one or more detectors selected to receive light in the range or ranges emitted from the adaptive emitter 16. Alternatively, the light source 64 may also be a laser diode or a vertical cavity surface emitting laser (VCSEL). A light source 64 may also include optical fiber sensing elements. The light source 64 may include a broadband or "white light" source, in which case the adaptive detector could include any of a variety of elements for selecting specific wavelengths, such as reflective or refractive elements or interferometers. Alternatively, a sensor 10 may sense light detected from the tissue is at a different wavelength from the light emitted into the tissue. Such sensors may be adapted to sense fluorescence, phosphorescence, Raman scattering, Rayleigh scattering and multi-photon events or photoacoustic effects.

In an embodiment of a pulse oximetry applications using either transmission or reflectance type sensors the oxygen saturation of the patient's arterial blood may be determined using two or more wavelengths of light, most commonly red and near infrared wavelengths. Similarly, in other applications, a tissue water fraction (or other body fluid related metric) or a concentration of one or more biochemical components in an aqueous environment may be measured using two or more wavelengths of light, most commonly near infrared wavelengths between about 1,000 nm to about 2,500 nm. It should be understood that, as used herein, the term "elight" may refer to one or more of radio, microwave, millimeter wave, infrared, visible, ultraviolet, gamma ray or X-ray, and/or electromagnetic radiation, and may also include any wavelength within the radio, microwave, infrared, visible, ultraviolet, or X-ray spectra.

In an embodiment, the digital light processing array 62 may include a digital micromirrors disposed on a substrate (see FIG. 5), and any suitable focusing and/or collimating optics. For example, the digital light processing array 62 may

include a lens or series of lenses designed to direct light from the light source 64 to digital micromirrors.

The digital light processing array 62 may also include a lens or series of lenses designed to focus light from the digital micromirrors onto a patient's tissue.

FIG. 5 is a schematic view of an embodiment of a portion of a digital light processing array 62, such as the digital light processing systems available from Texas Instruments (Dallas, Tex.) that may be incorporated into an adaptive emitter 16 or an adaptive detector 18. Such an array 62 may include thousands of micromirrors 70. The array 62 may also include a controlling substrate 74, such as a CMOS substrate, and a torsion hinge 72 that controls the motion of the micromirrors 70.

In one embodiment, each mirror portion 70 is able to move into two states, +10 degrees for "on" or -10 degrees for "off," and thereby control the direction of light hitting the mirror 70. Essentially, when a mirror 70 rotates via the hinge 72 to its on state, light from a light source is projected through the focusing optics and when the mirror 70 rotates via the hinge 72 to its off state, light from a light source 64 may be projected away from the focusing optics. A digital signal may address the controlling substrate 74 below each mirror portion 70 of the digital micromirror device. Responding to this electrical signal, each mirror 70 interacts with incident light from the light source as described above, with the input signal controlling how long each mirror stays in either the on or off state.

In an embodiment, as shown in FIG. 6, in operation, a sensor 10 with an adaptive emitter 16 and an adaptive detector 18 may control the light emitted from the light source 64 by directing the light into particular distributions onto the tissue 82. For example, emitted light 80 may be directed by the mirror 70 to certain portions of the tissue 82 and cancelled out in other portions. In addition, the adaptive detector 18 may be configured to only detect certain wavelengths of light, or light reflected back from certain portions of the tissue. By changing configurations, the adaptive detector 18 may act as a light filter or grating. In this manner, the sensor 10 may utilize a broadband light source 64 and employ the adaptive detector 18 to filter out the undesirable wavelength ranges. In such an embodiment, a sensor 10 may be able to change from a pulse oximetry sensor to a water fraction sensor by driving the adaptive detector 18 to change configurations as appropriate to filter out different wavelength ranges.

In one embodiment, the configured photon intensity distributions of the adaptive optical components may also be achieved by employing liquid lens technology in the adaptive optical components, see for example, U.S. Pat. No. 6,369,954 to Berge et al. and U.S. Pat. No. 6,665,127 to Bao et al., the specifications of which are hereby incorporated by reference herein for all purposes. By applying an external voltage to the liquid, the surface profile of the liquid may be tuned because of the contact angle change. As a result, the focal length of the liquid lens may be varied. In one embodiment, a tunable-focus liquid lens may be used that employs pressure induced liquid redistribution. The liquid lens may be composed of a flat cell and a liquid. The rigid flat cell has two non-overlapping holes that are sealed with elastic membranes. One membrane is adhered on the outer surface of a substrate and the other is adhered on the inner surface of another substrate. The liquid is fully filled in the cell chamber and sealed. Initially the two membranes are flat, so no focusing effect takes place. Squeezing the outside membrane inward by an actuator or other electromechanical means will redistribute the liquid rapidly, thus the inside membrane will swell outward and change the focus of the lens.

FIG. 7 shows an exemplary photon intensity distribution 92 that may be emitted by an adaptive emitter 16 onto a patient's tissue, according to an embodiment. Once the sensor 10 is suitably applied to the tissue, the adaptive emitter 16 transmits the selected wavelength(s) of light onto and into the tissue. The intensity 90 with which the photons of light impact the tissue at various locations along the tissue surface may be mapped to represent the photon intensity distribution. The exemplary distribution 92, with a central peak fading at a substantially equal rate at all sides, may be similar to the effect of a light source shining straight down on the tissue. The adaptive emitter 16 may replicate the effect of other types of light sources, or may create photon intensity distributions with complex patterns that are difficult to achieve with conventional light sources. In other embodiments, the photon intensity distribution may have several peaks and valleys or may be substantially flat, i.e., uniform, over the area of exposure.

In the embodiment shown in FIG. 8, the adaptive emitter 16 and the adaptive detector 18 may be disposed on a sensor body 102, which may be made of any suitable material, such as plastic, foam, woven material, or paper. In certain embodiments, the sensor body 102 may be in the form of a bandage-style structure or a clip-style structure. In one embodiment, the sensor body 102 may be a molded reusable structure with recesses into which the adaptive emitter 16 and the adaptive detector 18 may be mounted. In the depicted embodiments, the sensor 10 is coupled to a cable 100 that is responsible for transmitting signals to and from the adaptive emitter 16 and adaptive detector 18 of the sensor 10 to the monitor 12.

In an embodiment) the sensor 10 may include a "transmission type" sensor, as shown in FIG. 8. Transmission type sensors may include an emitter and detector, such as an adaptive emitter 16 and/or adaptive detector 18, that are typically placed on opposing sides of the sensor site. If the sensor site is a fingertip, for example, the sensor 10 is positioned over the patient's fingertip such that the adaptive emitter 16 and adaptive detector 18 lie on either side of the patient's nail bed. In other words, the sensor 10 is positioned so that the adaptive emitter 16 is located on the patient's fingernail and the adaptive detector 18 is located 180° opposite the adaptive emitter 16 on the patient's finger pad. During operation, the adaptive emitter 16 shines one or more wavelengths of light through the patient's fingertip and the light received by the adaptive detector 18 is processed to determine various physiological characteristics of the patient. In each of the embodiments discussed herein, it should be understood that the locations of the adaptive emitter 16 and the adaptive detector 18 may be exchanged. For example, the adaptive detector 18 may be located at the top of the finger and the adaptive emitter 16 may be located underneath the finger. In either arrangement, the sensor 10 will perform in substantially the same manner.

In an embodiment, reflectance type sensors also operate by emitting light into the tissue and detecting the light that is transmitted and scattered by the tissue. However, reflectance type sensors may include an adaptive emitter 16 and adaptive detector 18 that are typically placed on the same side of the sensor site. For example, a reflectance type sensor may be placed on a patient's fingertip or forehead such that the adaptive emitter 16 and adaptive detector 18 lie side-by-side. Reflectance type sensors detect light photons that are scattered back to the adaptive detector 18. A sensor 10 may also be a "transflectance" sensor, such as a sensor that may subtend a portion of a baby's heel.

While the disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been

described in detail herein. However, it should be understood that the embodiments provided herein are not intended to be limited to the particular forms disclosed. Indeed, the disclosed embodiments may not only be applied to measurements of blood oxygen saturation, but these techniques may also be utilized for the measurement and/or analysis of other blood constituents. For example, using the same, different, or additional wavelengths, the present techniques may be utilized for the measurement and/or analysis of carboxyhemoglobin, met-hemoglobin, total hemoglobin, fractional hemoglobin, intravascular dyes, and/or water content. Rather, the various embodiments may cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure as defined by the following appended claims.

What is claimed is:

1. A monitoring system comprising:

a sensor capable of being operatively coupled to a medical monitor, the sensor comprising:

a sensor body capable of being applied to a patient's tissue;

an adaptive light emitting structure disposed on the sensor body and configured to emit light at a first wavelength, wherein the adaptive light emitting structure comprises a plurality of configurable elements configured to be independently addressed to change a path of the emitted light from at least one of the configurable elements relative to at least one other configurable element of the plurality of configurable elements and to change an intensity profile of light at the first wavelength emitted by the adaptive light emitting structure; and

a detector disposed on the sensor body and spaced apart from the adaptive light emitting structure, wherein the detector is capable of detecting at least a portion of the emitted light; and

a medical monitor comprising a processor, wherein the processor is configured to independently address the configurable elements of the adaptive light emitting element to change the path and the intensity profile of the emitted light.

2. The system, as set forth in claim 1, wherein the detector comprises an adaptive light detecting structure comprising a second plurality of configurable elements that can be independently addressed to change a location from which light is detected.

3. The system, as set forth in claim 1, wherein the configurable elements comprise micro electromechanical elements of a digital light processor array or a liquid lens assembly.

4. The system, as set forth in claim 1, comprising a processing chip or processing driver for the adaptive light emitting structure disposed in or on the sensor body, in or on an electrical connector extending from the sensor body, or in the monitor.

5. The system, as set forth in claim 1, wherein the sensor comprises a pulse oximetry sensor and the monitor comprises a pulse oximetry monitor.

6. The system, as set forth in claim 1, wherein a user may provide input to the processor that may be used to independently address the configurable elements of the adaptive light emitting element to change an orientation of the configurable elements relative to one another.

7. The system, as set forth in claim 1, wherein the processor is capable of changing a configuration of the configurable elements of the adaptive light emitting element relative to one another one or more times to calibrate the sensor.

8. The system, as set forth in claim 1, comprising a second adaptive light emitting structure disposed on the sensor body and configured to emit light at a second wavelength, wherein the second adaptive light emitting structure comprises a plu-

ality of configurable elements that can be independently addressed to change an intensity profile of light at the second wavelength emitted by the plurality of configurable elements of the second adaptive light emitting structure.

9. The system, as set forth in claim 8, wherein the first wavelength is in a red wavelength range and the second wavelength is in the infrared wavelength range.

* * * * *

专利名称(译)	医疗传感器及其使用技术		
公开(公告)号	US8914088	公开(公告)日	2014-12-16
申请号	US12/241260	申请日	2008-09-30
[标]申请(专利权)人(译)	内尔科尔普里坦贝内特公司		
申请(专利权)人(译)	NELLCOR PURITAN BENNETT LLC		
当前申请(专利权)人(译)	COVIDIEN LP		
[标]发明人	BUICE CARL MCKENNA EDWARD		
发明人	BUICE, CARL MCKENNA, EDWARD		
IPC分类号	A61B5/1455 A61B5/00		
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其他公开文献	US20100081901A1		
外部链接	Espacenet USPTO		

摘要(译)

根据实施例，用于医学光谱学的传感器和系统可以包括自适应光学组件，例如数字光处理组件。自适应发光元件可以允许这样的传感器改变发射的光子的强度分布，以改变光子通过组织的分布或扫描组织的区域，以确定某些区域是否可以与改进的测量相关联。另外，具有所提供的自适应光检测元件的传感器可适于选择性地检测某些波长的光或来自组织的某些区域。

