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[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR REAL TIME TELEMONITORING OF CARDIAC ACTIVITY

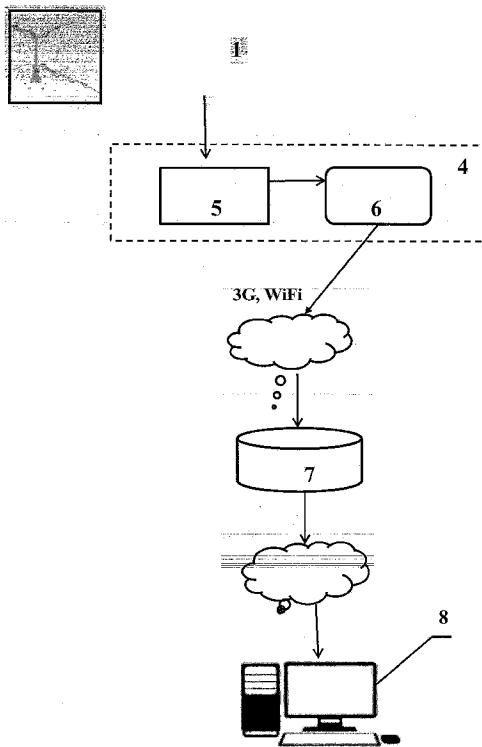


Fig. 1

(57) Abstract: This invention relates to a method and system for real time telemonitoring of cardiac activity, which has application in monitoring both the hospital bedridden patients and outpatients. The wide range of application includes monitoring in air transport, sea transport, fitness training, insurance and other risks. The system for real time telemonitoring of cardiac activity comprises successively arranged and functionally connected flexible printed circuit, formed as a reusable patch (1), patient device (4) connected through a wireless 3G or WiFi connection with a file server (7) and the telemonitoring centre (8), including a computer or mobile devices connected to the file server (7) over the Internet. The reusable patch (1) is equipped with removable electrodes (2) and with at least two microphones (3) and the patient device (4) is divided into two parts. One part of patient device is a medical device (5) located on the chest of the patient, and the second part is a communication device (6) which is placed on the belt or in a special case on the patient's arm. The medical device (5) and the communication device (6) are connected wirelessly and communication device (6) is a 3G or WiFi communication module for connecting to the file server.

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Published:

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METHOD AND SYSTEM FOR REAL TIME TELEMONITORING OF CARDIAC ACTIVITY

TECHNICAL FIELD

The present invention relates to a method and system for real time telemonitoring of cardiac activity and will find application in the monitoring of both the hospital bedridden patients and outpatients. The wide range of application includes monitoring in air transport, sea transport, fitness training, insurance risks and other.

BACKGROUND OF THE INVENTION

Known cardiac monitoring devices require the presence of the patient in a specialized room or hospital and are still static, large and offline. In practice there are also known various systems for online remote monitoring of cardiac activity. These systems consist of individual modules – sensors located on the body of the patient, taking into consideration the heart rate and other vital signs of the patient.

A method and system are also known including a flexible printed circuit, in the form of patch, on which 3, 5 or 12 fields are shaped that are in contact, by a porous material soaked with an electrolyte, with the human body in the region of the heart and transmit electrical signals. So accepted weak electrical signals enter the patient's device, where they are amplified and digitized by precision analogue-digital converters. After filtration, the signals are broadcast to the Internet via 3G or WiFi connection. File server via the Internet accepts these data and store them for further processing. After the necessary calculations and transformations, the information is available for visualization in a telemonitoring centre. The devices

through which doctors monitor patients reconnect through Internet to the file server and display the information in an appropriate graphic and text mode.

In the known methods and systems for remote monitoring of cardiac patients, the primary battery of the patient's device very quickly wear out, suggesting its charging every 4 hours and restricting the patient freedom of mobility. Electrodes are connected via heavy and uncomfortable cables which also interfere with normal life. On the other hand, replacing them with a single patch considerably increases the cost of the survey. Moreover, during the time when the patient is outside the scope of the mobile operator, the data are not stored. Information coming into the server is with much noise and artefacts and there are no means by which to notify the patient of a serious problem.

SUMMARY OF THE INVENTION

The problem of the invention is to create a method and system for real time telemonitoring of cardiac activity, leading to maximum accurate and precise results in surveys. The system is lightweight and compact while providing greater measurement precision, eliminating noise and artefacts.

~~This problem is solved by creating a method for real time telemonitoring of cardiac activity.~~

The created method comprises the steps of: transmitting electrical signals from the heart area to the patient device; amplification, digitizing and sending via wireless connection of these signals to the file server where the received data is stored for further processing; and visualization of data processed in telemonitoring centre. According to the invention, simultaneously with the transmission of electrical signals from cardiac activity, audio signals are transmitted from various

auscultatory points, whereupon the transmission of both types of signals to patient device is wireless. The processing of the received two types of signals in the file server is done in real time and it is a vector analysis in three planes, and the resultant vector is displayed in every frame of the 3D image on the telemonitoring centre devices.

This problem is solved by creating a system for real time telemonitoring of cardiac activity.

The system for real time telemonitoring of cardiac activity includes successively arranged and functionally connected flexible printed circuit, shaped as a patch, patient device connected via wireless 3G or WiFi connection to the file server and telemonitoring centre involving computer or mobile devices connected with the file server over the Internet.

The patch is reusable and is fitted with replaceable electrodes and at least two microphones, and the patient device is divided into two parts. One part of the patient device is a medical device located on the patient's chest, and the second part is a communication device that is placed on the patient's belt or in a special case on the patient's arm.

Medical device and communication device are connected wirelessly and the communication device is a 3G or WiFi communication module for connection to the file server.

The invention allows embodiments in which the removable electrodes are from two to twelve, and the medical device may be from a single-channel to twelve channels.

The method and system provide the following advantages:

- Mobility: monitoring is done in real time under normal conditions for the patient – when the patient works, travels, sports or rests, thanks to the use of small and light modules in the system;
- Security: at any time of the day the patient is monitored by a specialized team. In emergency cases, the telemonitoring centre responds with a call and instructions to the patient, his/her doctor or emergency centre if necessary;
- Prevention: by accumulating data, an artificial intelligence is created, with which through analysis, a number of heart diseases can be prognosticates and healed in time. Furthermore, the system can detect faults and conditions, which are precursors of serious diseases in the future – sudden cardiac death, myocardial infarction, stroke and the like.

With the so created system there are provided, as well:

- Long battery life of the medical device, which ensures continuity of data for more than 72 hours;
- Lower economic cost of surveys, due to the fact that the electrodes only are changed, not the entire patch;
- Much greater precision of the received signal due to the elimination of interference from muscles during movement;
- A tool in the medical device through which the signal is received at the server, if the patient does not feel well;
- The patient has a permanent audio contact with the medical team at the centre.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a block diagram of the system for real time telemonitoring of cardiac activity; and

Figure 2 is a diagram of reusable patch.

DETAILED DESCRIPTION OF EMBODIMENT OF THE INVENTION

The system for real time telemonitoring of cardiac activity is a system of medical modules that remotely transmit information about vital signs of the patient. The system includes successively arranged and functionally connected reusable patch 1, patient device 4, file server 7 and telemonitoring centre 8, including a computer or mobile device to display information – Figure 1.

The reusable patch 1 shown in Figure 2, is a flexible printed circuit board located in the region of the heart of the patient. The patch 1 is provided with replaceable electrodes 2, which may be from two to twelve units, and which electrodes 2 transmit electrical signals reflecting the electrical activity of the heart (ECG). The patch 1 is equipped with 3 microphones located in different auscultatory points that transmit audio to the patient device 4 without the need for additional cables. The patch 1 can be used repeatedly.

Patient device 4 is divided into two parts, one part is a medical device 5, which is located on the patient's chest, and the second part is a communication device 6, which can be placed on the belt or in a special case on the arm. The medical device 5 may be single-channel to twelve-channels. Electrical signals from removable electrodes 2 and microphones 3 simultaneously enter the medical device

5, which amplifies and digitizes them through precision analogue – digital converters. The dimensions and consumption of medical device 5 are very small, which ensures continuity of data for more than 72 hours. Communication device 6 is a 3G or WiFi communication module, which, after filtering signals received from the medical device 5, transmit data to the file server 7. The connection between the medical device 5 and communication device 6 takes place wirelessly, eliminating the hassle of extra cables and heavy chest device. The file server 7 via the Internet accepts data sent from the communication device 6 and stores them for further processing.

To achieve a greater precision of the signal and removing the interference from the muscles during the movement, at least two microphones 3 are placed over the reusable patch 1 so as to obtain the audio signal from the two opposite parts of the heart, related cardiac and non-cardiac acoustic phenomena in audio and graphics (phonocardiographic) mode. After filtering, amplification and digitization of these audio signals, a graph is obtained depicting the received audio data. The signal from removable electrodes 2, representing the ECG is detailed and dynamic with a lot of interference called artefacts, while the graph of the audio signals is round, but precise in maximum and minimum values. By appropriate mathematical models and filters a third graph is obtained representing a kind of fusion between the graphs of ECG and audio data. The thus obtained graph is as much detailed, but the interferences are removed and it has much more accurate signal amplitude.

Moreover, processing of the obtained two types of signals in the file server 7 is carried out in real time and it is a vector analysis in three planes, and the resultant vector is displayed in each frame of the 3D image on the devices of the telemonitoring centre 8. The devices on which the doctors monitor patients are

computers or mobile devices from the centre 8 connecting to the file server 7 over the Internet.

USE OF THE INVENTION

The system for real time telemonitoring of cardiac activity is a system of medical modules that remotely transmit information about vital signs of the patient. The information is transmitted continuously in real time via the Internet at a telemonitoring centre. Reported vital signs include heart rate, indicators of breathing, oxygen saturation, blood pressure, physical activity, body temperature, body position in space (standing, sitting, lying, fallen). In the telemonitoring centre, incoming information is analyzed and the actual cardiovascular and total risk calculated for the occurrence of serious diseases and/or critical situations. When registering critical conditions, emergency procedure will be initiated with calls to the patient, his relatives and/or supervising doctor. The system monitors the health of the patient in real time, and, via the GPS module in patient unit 4, a possibility is secured the patient to be localized and, in an emergency situation, a specialized team to be directed to him/her.

CLAIMS

1. A method for real time telemonitoring of cardiac activity, including the steps of: transmitting electrical signals from the heart area to the patient device; amplifying, digitizing and sending these signals via wireless connection to the file server where the received data is stored for further processing; and visualization of data processed in telemonitoring centre,

characterized in that

simultaneously with the transmission of electrical signals from the cardiac activity, also audio signals are transmitted from various auscultatory points, whereupon the transmission of both types of signals to the patient device (4) is effected wirelessly and the processing of the obtained two types of signals is performed in the file server (7) in real time and it is a vector analysis in three planes, and the resultant vector is displayed in every frame of a 3D image on the telemonitoring centre (8) devices.

2. A system for real time telemonitoring of cardiac activity, including successively arranged and functionally connected flexible printed circuit, shaped as patch, patient device connected via wireless 3G or WiFi connection to a file server and telemonitoring centre, including computer or mobile device, connecting with the file server over the Internet

characterized in that

the patch is reusable (1) and is equipped with removable electrodes (2) and at least two microphones (3) and the patient device (4) is divided into two parts, one part is a medical device (5), located on the chest of the patient, and the second part is a communication device (6) which is placed on the belt or in a special case on the

patient's arm, whereupon the medical device (5) and the communications device (6) are connected wirelessly, and the communication device (6) is a 3G or WiFi communication module.

3. A telemonitoring system according to the claim, **characterized in that** the removable electrodes (2) are from two to twelve.

4. A telemonitoring system according to the claim, **characterized in that** the medical device (5) may be from single channel to twelve channels.

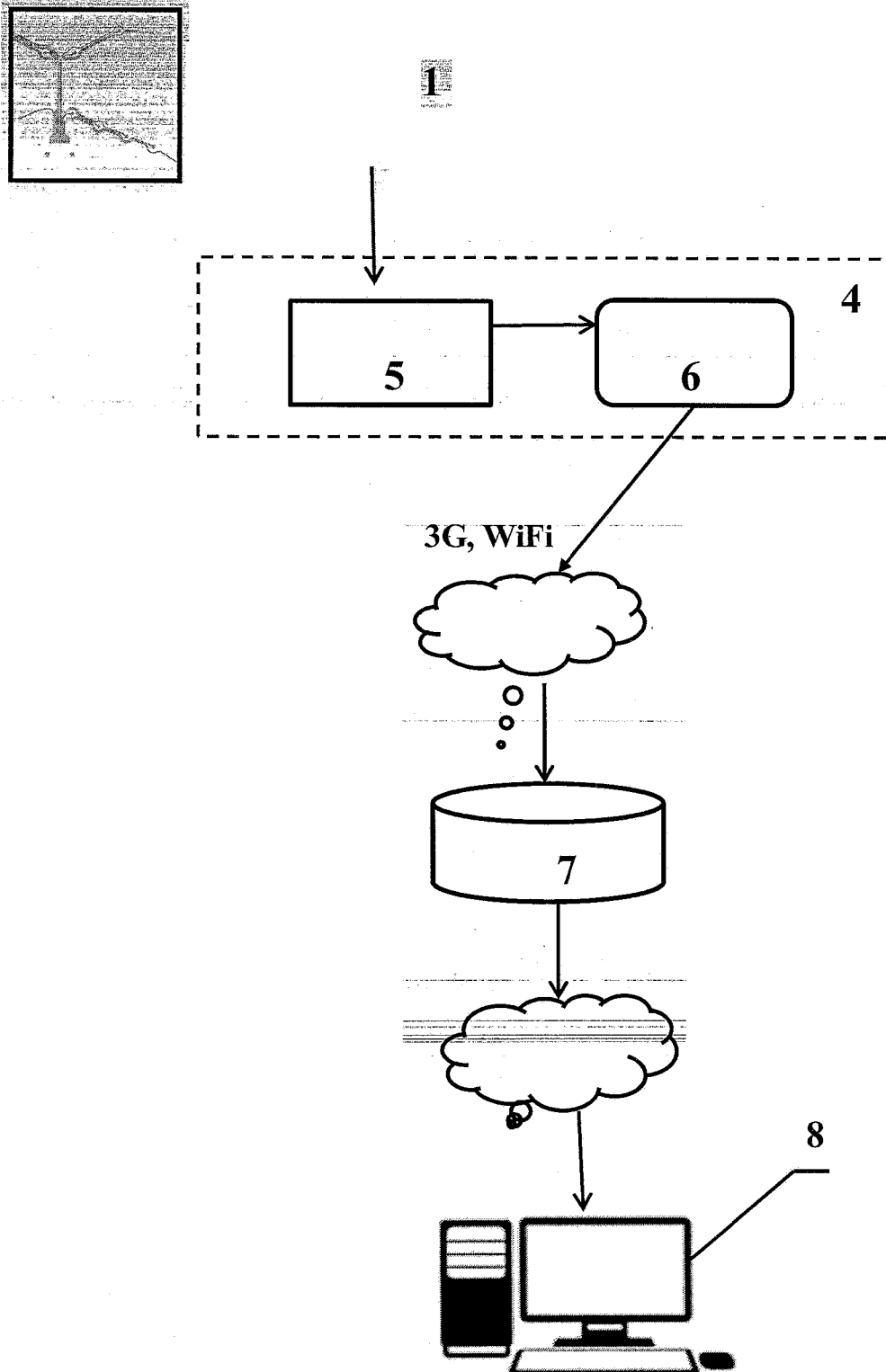


Fig. 1

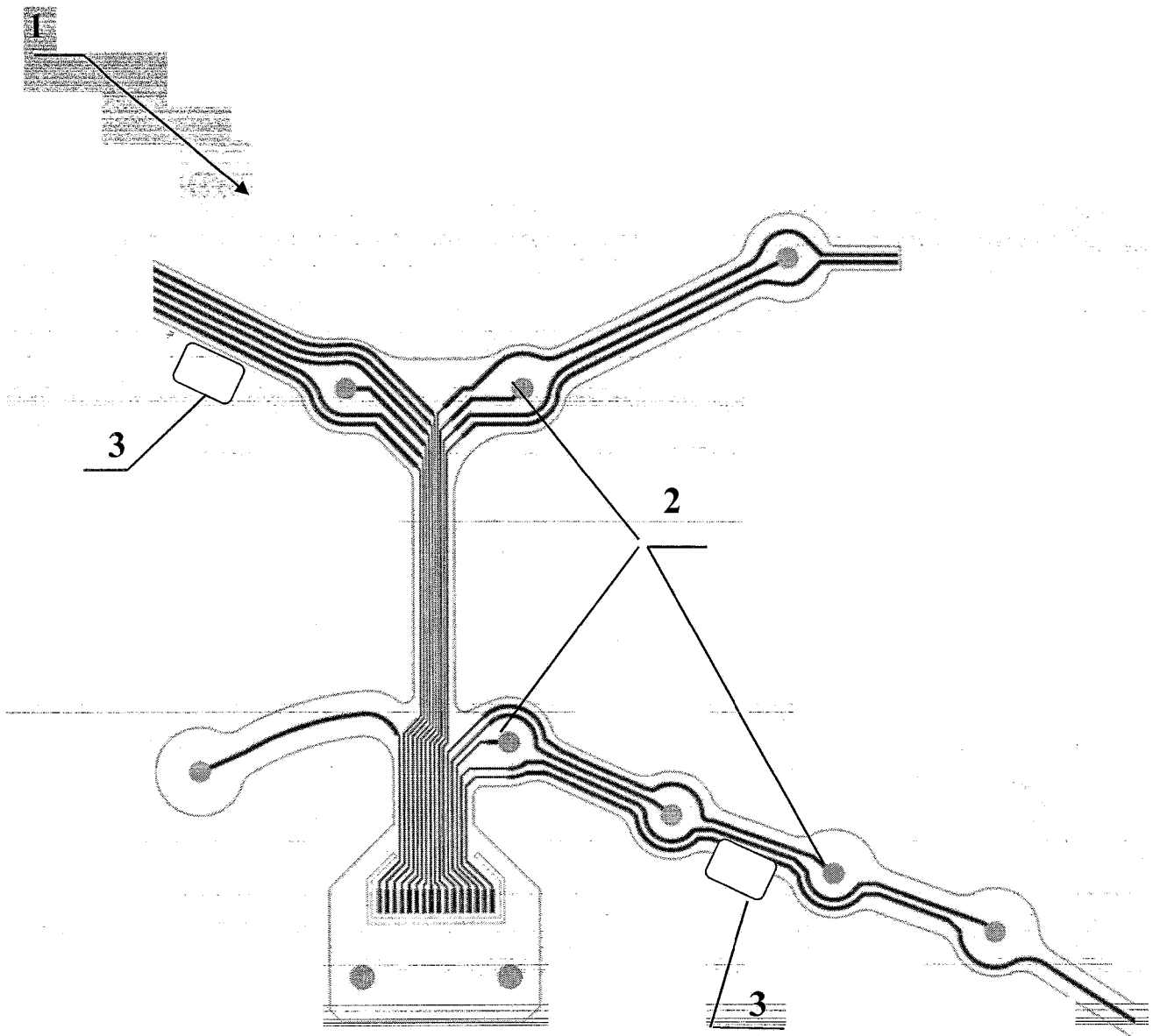


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/BG2017/000002

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00 A61B7/04 A61B5/04 A61B5/0408
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
A61B
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 24 May 2017	Date of mailing of the international search report 31/05/2017
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Knüpling, Moritz
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INTERNATIONAL SEARCH REPORT

International application No
PCT/BG2017/000002

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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专利名称(译)	用于心脏活动的实时远程监控的方法和系统		
公开(公告)号	EP3419506A1	公开(公告)日	2019-01-02
申请号	EP2017716442	申请日	2017-02-20
[标]发明人	KOLEV VENTSISLAV NIKOLAEV BOROV STOYAN PETKOV DIMITROV BORIS ANGELOV PEEV RADOSLAV PEEV BOYCHEV BOYCHO DENTCHEV DACHOV IVAYLO ZLATKOV		
发明人	KOLEV, VENTSISLAV NIKOLAEV BOROV, STOYAN PETKOV DIMITROV, BORIS ANGELOV PEEV, RADOSLAV PEEV BOYCHEV, BOYCHO DENTCHEV DACHOV, IVAYLO ZLATKOV		
IPC分类号	A61B5/00 A61B7/04 A61B5/04 A61B5/0408		
CPC分类号	A61B5/0006 A61B5/04011 A61B5/04085 A61B7/04		
优先权	112219 2016-02-23 BG		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于心脏活动的实时远程监视的方法和系统，该方法和系统已应用于监视卧床不起的患者和门诊患者。广泛的应用包括航空运输，海上运输，健身培训，保险和其他风险的监控。用于心脏活动的实时远程监视的系统包括：依次布置并功能连接的柔性印刷电路，形成为可重复使用的贴片（1）；通过无线3G或WiFi连接与文件服务器（7）连接的患者设备（4）；以及远程监视中心（8），包括通过Internet连接到文件服务器（7）的计算机或移动设备。可重复使用的贴片（1）配备有可移动电极（2）和至少两个麦克风（3），并且患者设备（4）分为两部分。患者设备的一部分是位于患者胸部的医疗设备（5），第二部分是通信设备（6），该通信设备放在皮带上或在特殊情况下位于患者的手臂上。医疗设备（5）和通信设备（6）无线连接，并且通信设备（6）是用于连接到文件服务器的3G或WiFi通信模块。