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(54) **A SYSTEM FOR VEHICLE SECURITY, PERSONALIZATION AND CARDIAC ACTIVITY MONITORING OF A DRIVER**

FAHRZEUG-ZUGANGS-, -PERSONALISIERUNGS- UND HERZTÄTIGKEITSÜBERWACHUNGS-SYSTEM FÜR EINEN FAHRER

SYSTEME DE SECURITE VEHICULAIRE, DE PERSONNALISATION ET DE SURVEILLANCE CARDIAQUE D'UN CONDUCTEUR

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(56) References cited:
EP-A2- 1 477 370
WO-A1-01/24700
WO-A2-2006/048701
DE-A1- 10 310 719
US-A- 4 706 072
US-A1- 2003 097 047

- **CHAIKOWSKI I ET AL: "Value of the single-lead ECG in comparison with 12-lead ECG", 20080101, vol. 6, no. 1, 1 January 2008 (2008-01-01) , pages 25-27, XP007917364, cited in the application**
- **ANDREAS RIENER ET AL: "Heart on the road: HRV analysis for monitoring a driver s affective state", PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON AUTOMOTIVE USER INTERFACES AND INTERACTIVE VEHICULAR APPLICATIONS (AUTOMOTIVEUI 2009), SEPTEMBER, 21-22 2009, ESSEN, GERMANY, ACM, ASSOCIATION FOR COMPUTING MACHINERY, 21 September 2009 (2009-09-21), pages 99-106, XP007917365, ISBN: 978-1-61738-615-2 cited in the application**

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(Cont. next page)

- JOHN M IRVINE AND STEVEN A ISRAEL: "A Sequential Procedure for Individual Identity Verification Using ECG", EURASIP JOURNAL ON ADVANCES IN SIGNAL PROCESSING, HINDAWI PUBLISHING CORP, US, vol. 2009, 1 January 2009 (2009-01-01), pages 243215/1-13, XP007917366, ISSN: 1687-6172, DOI: DOI:10.1155/2009/243215 cited in the application
- HEE-SOO PARK ET AL: "ECG Pattern Classification Based on Generic Feature Extraction", PROCEEDINGS OF THE WSEAS (WORLD SCIENTIFIC AND ENGINEERING ACADEMY AND SOCIETY) INTERNATIONAL CONFERENCE, WORLD SCIENTIFIC AND ENGINEERING ACADEMY AND SOCIETY, US, 1 January 2009 (2009-01-01), pages 21-24, XP007917368, ISSN: 1790-5117

Description

FIELD OF INVENTION:

[0001] The present invention relates to a system for vehicle security, personalization and monitoring cardiac activity of a driver. More particularly the invention relates to a use of integrated ECG (electrocardiography) device in vehicles for recording and storing electrical signals generated by cardiac muscles of driver and to monitor the cardiac condition of the driver. In addition to this, the present invention also relates to a means for person identification and associating a person with a particular vehicle using acquired ECG signal to actuate personalization of vehicle, and act as person identification basis, to prevent the unauthorized access to the vehicle.

BACKGROUND OF THE INVENTION:

[0002] Cardiac diseases are one of the leading causes of death in the western countries and due to stressful lifestyle are alarmingly increasing in Asian and South Asian counties as well. The majority of cardiac deaths are sudden, and nearly half of the cardiac deaths occur outside hospitals. Staggeringly, 63.4% of heart disease deaths that occurred fall into the category of sudden cardiac death. In addition, 46.9% of heart disease patients who died, did so before reaching the hospital, while another 16.5% were pronounced dead on arrival or died immediately upon arrival in the emergency room. In fact, cardiac disease is the leading cause of death in the developed countries as well as in most of the emerging nation. Studies indicate that approximately 70% of the people who die of cardiac diseases are not diagnosed until their death. These studies demonstrate that all patients with diagnosed cardiac disease and people with high risk of cardiac disease would benefit by being monitored for early detection of cardiac abnormalities. Interstingly, most of the cardiac abnormalities, in many cases are transient and can be avoided if detected at an early stage. (CHAIKOWSKI I ET AL: "Value of the single-lead ECG in comparison with 12-lead ECG", journal Ukr. z. telemed. med. telemat. 20080101, vol. 6, no.1, 1 January 2008 (2008-01-01), pages 25-27, XP007917364; http://www.nbuv.gov.ua/portal/chem_biol/Ujtm/2008_1/2008_1_5.pdt).

[0003] Vehical driving is affected by an increasing number and complexity of Driver Assistance Systems (DAS), resulting in a raised cognitive load of a driver. Consequently, these DASs add to the distraction from the main activity of driving (ANDREAS RIENER ET AL: "Heart on the road: HRV analysis for monitoring a drivers affective state", PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON AUTOMOTIVE USER INTERFACES AND INTERACTIVE VEHICULAR APPLICATIONS (AUTOMOTIVEUI 2009), SEPTEMBER, 21-22 2009, ESSEN, GERMANY, ACM, ASSOCIATION FOR COMPUTING MACHINERY, 21 September 2009 (2009-09-21), pages 99-106, XP007917365, IBSN: 978-1-61738-615-2). A number of potential solutions have been proposed so far, however, these techniques broaden the perception horizon of a driver e. g. the introduction of the sense of touch as additional information modality or the utilization of multimodal instead of unimodal interfaces. These solutiuons demand attention of the driver. In order to cope with the issues of workload and/or distraction, it is essential to find a non-distracting and noninvasive solution for generation of significant sensory information about the driver's awareness and health condition.

[0004] For many of the above stress monitoring systems it is also expected to confirm the identity of the driver to avoid an unauthorized access to a vehicle and thus enable decision making for alert generation. There are biometric techniques for disclosing the identity of the driver to the car. Fingerprint is one of the most popular methods. Recently it has been shown that ECG can be used as a biometric input for person identification. The work in (JOHN M IRVINE AND STEVEN A ISRAEL: "A Sequential Procedure for Individual Identity Verification Using ECG", EURASIP JOURNAL ON ADVANCES IN SIGNAL PROCESSING, HINDAWI PUBLISHING CORP, US, vol. 2009, 1 January 2009 (2009-01-01), pages 243215/1-13, XP007917366, ISSN: 1687-6172, DOI: DOI:10.1155/2009/243215) describes the results of such an experimentation of using ECG as a biometric.

[0005] Some of the inventions which deal in cardiac monitoring in vehicle are as follows:
DE10310719A1 describes an adaptive cruise control system (1) control unit (5) which stores (11) driver chosen settings that can be activated by a current driver identification (7) transponder key, contactless chip card, fingerprint or iris pattern to select dynamics, speed display and acoustic warnings (18). The procedure used by the unit is also described. In particular, the closest prior-art document DE10310719A1 discloses a non-distracting and non-invasive, in-vehicle system for identification, personalization, wherein the system comprises;

a. plurality of probing means, each means being a sensor mounted on one or more parts of the vehicle for acquiring in real-time an electric signal;
b. a means for extracting features from a signal;
c. a means for detecting and allowing entry of the driver into the vehicle wherein the extracted feature is matched with registered binary code; and
d. a means for storing driver's preferences for personalization in vehicle wherein the triggering of personalization

occurs after matching the driver's features and binary code with registered binary code.

[0006] US20070265540 discloses a heart-rhythm monitoring device for a vehicle which determines whether a driver has an arrhythmia while driving the vehicle or not.

[0007] US5574641 discloses an apparatus and method to monitor heartbeat pulse information for improving the awareness of vehicle drivers by prompting the vehicle driver when it is determined that the awareness of the vehicle driver is decreasing due to the driver falling asleep. However, it failed to disclose the ECG monitoring and secure biometric identification of the driver with display of ECG waveform along with heart rate.

[0008] US4706072 discloses a human condition and security controlling apparatus on road-vehicles for detecting the condition of a driver by measuring fluctuation in heart rate and taking a given security action in accordance with the detected result but it failed to disclose ECG monitoring and biometric identification of driver.

[0009] US6599243 discloses a system for advising or averting potentially dangerous driving situations based on an analysis of driver stress but it failed to disclose display of health status or ECG waveform and generation of alert with the facility of making E-call in case of emergency.

[0010] US5783997 discloses a cardiac rate measuring apparatus which measures the cardiac rate of a driver without restraining motions of the driver and US6575902 discloses a system for monitoring, recording and/or analyzing vigilance, alertness or wakefulness and/or a stressed state of an operator of equipment or machinery but both failed to disclose ECG monitoring and biometric identification of the driver with display of ECG waveform along with heart rate and also facility of making emergency call.

[0011] However, all the above mentioned inventions do not provide personalization of vehicle and identification of driver by using Electrocardiography.

[0012] In order to overcome the above mentioned drawbacks in the prior art, the present invention provides an integrated the ECG sensing device in vehicle for vehicle security, personalization and monitoring the heart status.

OBJECT OF INVENTION:

[0013] The principle object of the present invention is to provide a system for vehicle security, personalization and monitoring cardiac activity of a driver in a vehicle.

[0014] Another object of the present invention is to monitor cardiac status of driver in a continuous and real-time fashion.

[0015] Yet another object of the invention is to provide a solution for person identification using ECG trace recorded by cardiac device installed in vehicle.

[0016] Still another object of the invention is to provide a device to display the ECG trace, Heart rate, Sound track.

[0017] Further object of the present invention is to provide automatic personalization of the vehicle on the basis of the registered biometric profile of the drivers wherein the personalization scheme comprises re-setting of the rear view mirrors, active play list of songs, video and FM /TV stations, speaker volume, sound level of horn, dashboard display, perfume fragrance, seat height, tilt, climate control settings, speed limit, security settings, navigation display settings, engine response etc.

[0018] Another object of the invention is to provide real-time diagnosis of cardiac activity of vehicle driver wherein in case of an emergency an automatic emergency call or alert can be generated by the system.

[0019] Another object of the present invention is to provide vehicle security by preventing unauthorized access of the vehicle.

[0020] Yet another object of the invention the cardiac activity is monitored using non intrusive biosensors.

[0021] Yet another object of the invention is to use the ECG based driver identity as information to assign responsibility or to ensure identity of the driver in case of accidents.

[0022] Another object of the invention is to provide a scheme for privacy enabled handling of ECG data captured.

SUMMARY OF THE INVENTION

[0023] The present invention relates to a system for identification, personalization and monitoring cardiac activity of a driver according to claim 1. The system comprises non intrusive biosensors placed inside the vehicle for monitoring the real time electrical signal generated by cardiac muscles of the driver. The system conceptualized by the inventors of this invention may also in case of an emergency generate an automatic emergency call or alert in case of abnormal cardiac condition. The present invention also discloses the use of acquired ECG signal (from the biosensors placed either inside or outside of the vehicle) as a secure biometric system for person identification so that person identification information can be used for authentication and personalization of in-vehicle security and infotainment services.

BRIEF DESCRIPTION OF DRAWINGS

[0024] The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

Fig. 1 illustrates the block diagram of Bio-Sensor Vehicle system setup with ECG device, Electrode and display.

Fig. 2 illustrates a schematic block diagram of an embodiment of Bio-Sensor Vehicle system for recording and optionally displaying the cardiac signal or ECG Signal.

Fig. 3 shows a schematic block diagram of an embodiment of Bio-Sensor Vehicle system for person identification or biometric.

Fig. 4 shows an exemplary Bio-Sensor Vehicle system setup with ECG device, Electrode and display.

Fig. 5 illustrates the flowchart algorithm of secure person identification system of the Bio-Sensor Vehicle system.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The words "comprising," "having," "containing," and "including," and other forms thereof, are intended to be equivalent in meaning and be open ended in that an item or items following any one of these words is not meant to be an exhaustive listing of such item or items, or meant to be limited to only the listed item or items.

[0026] It must also be noted that as used herein and in the appended claims, the singular forms "a," "an," and "the" include plural references unless the context clearly dictates otherwise. Although any methods or system or equivalent to those described herein can be used in the practice or testing of embodiments of the present invention, the preferred methods and system are now described. The invention is further described in detail in the following paragraphs, which are given by way of illustration. The scope of the present invention is intended to be limited by only by the claims and its equivalents.

[0027] The following paragraphs describe a few illustrative embodiments of the invention that exemplify some of its aspects and features. They are not exhaustive in illustrating its many aspects and embodiments, and thus are not in any way limitative of the invention. Many other aspects, features, and embodiments of the invention are described herein. Many other aspects and embodiments will be readily apparent to those skilled in the art upon reading the application and giving it due consideration in the full light of the prior art and knowledge in the field.

[0028] The present invention provides a non-distracting and non-invasive, in-vehicle system for identification, personalization, and monitoring cardiac activity of a driver in a vehicle based on ECG data wherein the system comprises:

a. plurality of ECG trace probing means, each means being a sensor mounted on one or more parts of the vehicle for acquiring in real-time an electric signal generated by cardiac muscles of driver;
b. a means for extracting ECG features and one time enrolling of ECG trace as binary code sequence using processor implemented binary sequence code book generation algorithm in a binary code book based on the ECG data of the driver captured from the said probing means;
c. a means for detecting and allowing the entry of the driver in the vehicle wherein the binary code of the driver's ECG trace is matched with the registered binary code book sequence using processor implemented steps of nearest neighbor classifier algorithm;
d. a means for storing driver's preferences for personalization in vehicle wherein the triggering of personalization occurs after matching the driver's ECG features and binary code with registered binary code book sequence;

[0029] The present invention also provides a system for vehicle security to detect unauthorized access of the vehicle wherein the system comprises:

a means for extracting ECG features and one time enrolling of ECG trace as binary code sequence using processor implemented binary sequence code book generation algorithm in a binary code book based on the ECG data of the driver captured from the said probing means;
a means for detecting and allowing the entry of the driver in the vehicle wherein the binary code of the driver's ECG trace is matched with the registered binary code book sequence using processor implemented steps of nearest neighbor classifier algorithm

[0030] According to one of the embodiments of the present invention, a vehicle biosense cardiac monitoring device is a miniature device which measures the single lead 1 lead electrocardiogram (ECG) signal which can be integrated to various vehicular parts where a non intrusive personal access is possible to acquire signal ECG like steering wheel, seat, gear shift lever etc. Lead is an electrical picture of the heart. ECG recorder compares the electrical activity detected in the different electrodes and the electrical picture so obtained is called lead.

[0031] According to one of the preferred embodiments of the invention there is a means for registering one time the driver's biometric profile which includes ECG waveform, heart rate etc which detects the unauthorized entry of a person in a vehicle.

[0032] In one embodiment of the invention the secured biometric system has been achieved by storing the individual's data as binary code sequence. Binary code sequences were generated from the extracted feature of the ECG trace based on Binary code book rules which accounts for feature variance.

[0033] In a preferred embodiment of the invention the system generates appropriate alerts (50) if person's profile does not match with the registered profile. This can be used as one of the features for intruder detection towards vehicle security for which the deployment of the ECG can be placed on door handle or steering wheel.

[0034] According one preferred embodiment of the present invention there is also a means for storing the driver's preferences for personalization of vehicle which includes but is not limited to the following: Re-setting of the rear view mirrors, active play list of songs, video and fm /television stations, speaker volume, sound level of horn, dashboard display, perfume fragrance, seat height, tilt, climate control settings, speed limit, security settings, navigation display settings, engine response etc. This is not an exhaustive list and the invention need not be bound by limitations set forth herein, and the invention can include all automatically configurable settings in the vehicle as per user preferences.
Still in another embodiment of the present invention, identification of the person or driver inside the vehicle triggers personalization of the vehicle through automatic re-configuration guided by user profile or preferences which are being already set by driver/user.

[0035] In an another embodiment of the invention the biometric profile and personalization settings of different driver can be stored, and system will detect the identity and personalization scheme by matching already registered profile with the ECG and biometric profile of the person entering in the vehicle. If profile does not match, the system will generate an alert to a concerned person and thereby the system as proposed in this invention also acts as intruder detector towards vehicle security.

[0036] Now referring to figure 1 and 4 which illustrates the bio-sense vehicle system setup, wherein a ECG device (90), electrode (10) and display (40) are disposed therein the vehicle. As illustrated in figure 1 and 4, the In-Vehicle biosensor according to one of the exemplary embodiment comprises of a ECG device (90) is mounted at vehicle's steering wheel (70), Electrode (10) is mounted on a side bar of the steering wheel and a display (40) is disposed at the center and on top of the steering wheel of vehicle to display the ECG trace, heart rate calculated from ECG trace, and sound track played in the vehicle etc.

[0037] Referring to figure 2 the Electrode (10) lead is placed on the side bar of the steering wheel which measures a low voltage signal approximately 1mV. The system of present invention adapts a single lead ECG system. Due to low voltage property of signal, the acquired ECG signal is amplified using a differential amplifier (20). Amplified signal are filtered (20) to reject the noise present in the ECG signal and to collect the decided frequencies of signal. Filtered ECG signal were passed to Digital section (30). ECG signal which is passed to the microcontroller is an input signal to ADC and is sampled at 250Hz. Sampled ECG signals are preprocessed and feature parameter are acquired and stored for future processing. Extracted features were processed and used for two applications.

[0038] In an another embodiment of the present invention, the In-Vehicle Biosensor device is used as a single lead ECG monitoring device, which acquires single lead ECG and extract the features therefrom. The extracted features are used to calculate the heart rate and display the same. In addition to this, if any arrhythmia occurs, the digital section detected and set on the Alarm/indication as shown in figure 2. In addition to the status indication, it also enables the e-call to emergency unit.

[0039] Now referring to figure 5 which depicts steps for person identification in biosensor vehicle system (80), in one of the exemplary embodiments, the Electrode (10) is placed on the side bar of the steering wheel measures a low voltage signal approximately 1 mV and registers the profile of driver(s). The individual data is stored as binary code sequence which is generated from the extracted features of the ECG trace based on binary code book rules which accounts for feature variance. Whenever a driver or any person enters the vehicle the biosensors generates a binary code which is matched from the profiles already stored in the Binary code book; If profile matches then system allows entry of person in vehicle if profile does not matches system rejects the ECG signals and generates appropriate alert (50) to the concern person.

[0040] According to one of the preferred embodiments of the invention, the extracted features were used for biometric system as shown in figure 3 and 5. Extracted features were converted to binary sequence using binary sequence code book generation algorithm for privacy enabled storage of the ECG. Here the original raw ECG waveform of the user is never stored in the memory. This prevents anyone from retrieving the ECG data from the vehicle electronics and using

it for any other application including replay attack. In replay attack the raw ECG waveform is replayed and applied to the ECG sensor as if it is coming from a live person.

Binary Sequence Code Book Generation Algorithm:

[0041] Based on key observation of feature space a Binary code book is designed for each user which consists of variances of extracted features of the ECG trace for a particular user.

[0042] Let,

Number of users is '**U**'

Number of trails for one users is '**T**' and

Feature '*F*' of ECG trace is of length '**N**'.

$$Fmin_i(j) = \begin{cases} \frac{\min(F_i(k,j))}{10}, & if(\min(F_i(k,j)) > 9) \\ \min(F_i(k,j)), & else \end{cases}$$

$$B_{min}(i,j) = Fmin_i(j)$$

$$Fmax_i(k,j) = \begin{cases} \frac{\max(F_i(k,j))}{10}, & if(\max(F_i(k,j)) > 9) \\ \max(F_i(k,j)), & else \end{cases}$$

$$B_{max}(i,j) = Fmax_i(j)$$

where,

= 1, 2.....U

= 1, 2.....N

= 1, 2.....T

B_{min}, B_{max} are Binary code book.

[0043] Here all the numbers are represented in 2^4 binary format.

If the test feature vector satisfies the lower bound and upper bound of users then we classify the test data feature vector accordingly. It is experimentally found that, test feature vector satisfying the boundary conditions of users will yield in a sub set of total number of users.

[0044] This method of binary code book reduce the computational time of Nearest Neighbor Classifier (NNC) when there are large number of users and hence, Binary code book is used as a first stage classifier followed by NNC at second stage.

Nearest Neighbor Classifier Algorithm:

[0045] We have used Non parametric nearest neighbor classifier as a second stage classifier which is simple yet powerful classifier. Binary code book generator (first stage classifier) resulting in subset of users is fed to the NNC to choose the closest matching user to the probe. The NNC methodology is simple and as follows, given a new test query q, we try to find the k closest training queries to it in terms of Euclidean distance.

[0046] The present invention addresses the approach of integrating the ECG sensing device in car (in-vehicle biosensor device) for monitoring the heart status and secure person identification of a driver. Therefore, the foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention. In as much as the present disclosure includes that contained in the appended claims as well as that of the foregoing description. Although this invention has been described in its preferred forms with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and numerous changes in the details of construction and combination and arrangement of parts may be resorted to without

departing from the scope of the invention.

WORKING EXAMPLE

Step 1

[0047] The Raw ECG data of mV signal is acquired through surface electrode and amplified to Voltage signal X (n). Raw ECG signals were pre-processed and feature parameters F(X) were extracted as shown in Table 1.
where, F(X) = {F1, F2....F9}

Table 1 ECG Features for user 1 and user 2

User	F1	F2	F3	F4	F5	F6	F7	F8	F9
1	0.038	0.814	39.042	93.222	44.861	27.556	44.861	39.042	138.806
2	0.288	0.811	25.223	87.16	31.532	27.532	31.532	25.223	119.17

Step 2

[0048] Extracted features parameter F(x) were converted to binary sequence B (F(x)) using binary sequence code book generation algorithm as shown in Table 2

Table 2 Binary codes for user 1 and user 2

User	Binary codes								
1	0000	0000	0111	1001	1001	0010	1001	0111	0111
2	0000	0000	0101	1000	0101	0101	0101	0101	0100

[0049] Similarly binary codes are generated for all the training set of users and a database is created.
[0050] Once we get the probe data, step 1 and 2 are performed. Later, the binary code generated from the probe is matched to the trained binary codes database using classifier or matching techniques.
[0051] For example two cases were considered, which deals with authorized and unauthorized person.

Case 1

[0052] In case-1 an authorized person, i.e. user-1 trail and the corresponding extracted features and binary codes are presented in table 3. Classifier or matching technique tries to match the binary code of probe data with trained binary codes database presented in table 2 and yields a closest matching output as user-1.

Table 3 Feature F(x) and Binary code B(F(x)) for authorized user

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Feature	0.026	0.805	39.653	93.028	45.431	27.361	45.431	39.653	139.16 7
Binary code	0000	0000	0111	1001	1001	0010	1001	0111	0111

Case 2

[0053] In case-2 an unauthorized person (whose data is not present in the trained database) and his/her corresponding feature and binary code are presented in table 4. Classifier or matching technique tries to match the binary code of probe data with trained binary codes database presented in table 2. The matching/classification algorithm compares the probe data and rejects the user.

Table 4 Feature F(x) and Binary code B(F(x)) for unauthorized user

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Feature	0.013	0.774	22.829	133.855	57.513	28.211	57.513	22.829	191.934

(continued)

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Binary codes	0000	0000	0100	0100	1001	0101	1001	0100	0100

ADVANTAGES OF THE INVENTION:

[0054]

1. The present invention monitors the cardiac status of driver in a real time fashion.
2. The present invention provides person/driver identification using ECG trace recorded by cardiac device.
3. The present invention displays the ECG trace, Heart rate, sound track to provide insights of cardiac condition.
4. The present invention also monitors other health conditions including blood pressure, skin temperature etc.
5. The present invention enables to make emergency call by providing real time diagnosis.
6. The present invention generates alerts to the subject person to an external contact point for required assistance in case of emergency.
7. The present invention automatically personalizes the vehicle based on user preferences/profile.
8. The present invention detects the entry of person/driver in the vehicle thereby prevents unauthorized entry in the vehicle.
9. The present invention provides intruder detection towards vehicle security.
10. The present invention biosensors are non intrusive and monitors the cardiac activity in a non distracting manner.
11. The present invention stores a converted binary sequence code of ECG data for biometrics.

Claims

1. A non-distracting and non-invasive, in-vehicle system (80) for identification, personalization, and monitoring cardiac activity of a driver in a vehicle based on ECG data wherein the system (80) comprises:

a. plurality of ECG trace probing means (10), each means (10) being a sensor mounted on one or more parts of the vehicle for acquiring in real-time an electric signal generated by cardiac muscles of driver;
b. a means (30) for extracting ECG features and one time enrolling of ECG trace as binary code sequence using processor implemented binary sequence code book generation algorithm in a binary code book based on the ECG data of the driver captured from the said probing means (10);
c. a means (30) for detecting and allowing entry of the driver into the vehicle wherein the binary code of the driver's ECG trace is matched with the registered binary code book sequence using processor implemented steps of nearest neighbor classifier algorithm; and
d. a means for storing driver's preferences for personalization in vehicle wherein the triggering of personalization occurs after matching the driver's ECG features and binary code with registered binary code book sequence.

2. The system (80) of claim 1, wherein the ECG trace probing means (10) are enabled to measure 1 Lead ECG signal.

3. The system (80) of claim 1, further comprising a means (40) for displaying the cardiac activity of the driver.

4. The system (80) of claim 3, wherein the display means (40) is mounted on one of:

at the center and on the top of the steering wheel (70), and;
the dash board.

5. The system (80) of claim 1, wherein the system (80) further comprises means (50) to alert the driver in case the driver is detected with abnormal cardiac activity.

6. The system (80) as claimed in claim 5 further comprising a means for making automatic emergency call in case at least one of the alerts is so generated.

7. The system (80) of claim 6, wherein the alert is signaled to one of a subject, person, and an external contact point for assistance as an emergency call.

8. The system (80) of claim 1, wherein one or more sites for mounting the detecting means (30) are selected from steering wheel (70), seat, and gear shift lever.

9. The system (80) of claim 1, wherein cardiac activities are monitored in the form of electrocardiogram waveform and heart rate.

10. The system (80) of claim 1, wherein the system (80) further comprises probing means to determine skin temperature, respiration, stress, and blood pressure of the driver.

11. The system (80) of claim 1, wherein the personalization comprising of re-setting of plurality of user preferences including the rear view mirrors, active play list of songs, video and FM /TV stations, speaker volume, sound level of horn, dashboard display, perfume fragrance, seat height, tilt, climate control settings, speed limit, security settings, navigation display settings, and engine response.

Patentansprüche

1. Nicht ablenkendes und nicht invasives bordeigenes System (80) zur Erkennung, Personalisierung und Überwachung von Herzaktivität eines Fahrers in einem Fahrzeug basierend auf EKG-Daten, wobei das System (80) Folgendes umfasst:

   a. mehrere EKG-Kurvenprüfmittel (10), wobei jedes Mittel (10) ein Sensor ist, der auf einem oder mehreren Teilen des Fahrzeugs gelagert ist, um ein elektrisches Signal, das durch die Herzmuskeln des Fahrers erzeugt wird, in Echtzeit zu erhalten;
   b. ein Mittel (30) zum Extrahieren von EKG-Merkmalen und einmaligen Eintragen von EKG-Kurven als Binärcodefolge unter Verwendung eines Prozessor-implementierten Algorithmus zum Erzeugen eines Binärfolgencodebuchs in einem Binärcodebuch basierend auf den EKG-Daten des Fahrers, die von den Prüfmitteln (10) aufgenommen wurden;
   c. ein Mittel (30) zum Erfassen eines Fahrer und Ermöglichen, dass er das Fahrzeug betritt, wobei der Binärcode der EKG-Kurve des Fahrers mit der registrierten Binärcodebuchfolge unter Verwendung von Prozessor-implementierten Schritte des Nearest-Neighbor-Algorithmus abgeglichen wird; und
   d. ein Mittel zum Speichern von Einstellungen des Fahrers für die Personalisierung im Fahrzeug, wobei das Auslösen der Personalisierung auftritt, nachdem die EKG-Merkmale des Fahrers und der Binärcode mit der registrierten Binärcodebuchfolge abgeglichen wurden.

2. System (80) nach Anspruch 1, wobei die EKG-Kurvenprüfmittel (10) aktiviert sind, um ein 1-Kanal-EKG-Signal zu messen.

3. System (80) nach Anspruch 1, das ferner ein Mittel (40) zum Anzeigen der Herzaktivität des Fahrers umfasst.

4. System (80) nach Anspruch 3, wobei das Anzeigemittel (40) auf Folgendem gelagert ist:

   in der Mitte und auf der Oberseite des Lenkrads (70) oder;
   auf dem Armaturenbrett.

5. System (80) nach Anspruch 1, wobei das System (80) ferner Mittel (50) umfasst, um den Fahrer zu benachrichtigen, wenn bei dem Fahrer eine ungewöhnliche Herzaktivität erfasst wird.

6. System (80) nach Anspruch 5, das ferner ein Mittel zum Tätigen eines automatischen Notrufs umfasst, wenn wenigstens eine der Warnungen entsprechend erzeugt wurde.

7. System (80) nach Anspruch 6, wobei die Warnung an ein Subjekt, eine Person oder einen externen Kontaktpunkt gemeldet wird, um in einem Notfall Hilfe zu leisten.

8. System (80) nach Anspruch 1, wobei eine oder mehrere Stellen zum Lagern des Erfassungsmittels (30) aus dem Lenkrad (70), dem Sitz und dem Schalthebel ausgewählt sind.

9. System (80) nach Anspruch 1, wobei Herzaktivitäten in der Form von Elektrokardiogramm-Wellenform und Herz-

frequenz überwacht werden.

10. System (80) nach Anspruch 1, wobei das System (80) ferner Prüfmittel zum Bestimmen von Hauttemperatur, Atmung, Belastung und Blutdruck des Fahrers umfasst.

11. System (80) nach Anspruch 1, wobei die Personalisierung das erneute Einstellen mehrerer Benutzereinstellungen, einschließlich der Rückspiegel, der aktiven Wiedergabeliste von Liedern, Videos und FM-/TV-Sendern, der Lautsprecherlautstärke, des Schallpegels der Hupe, der Armaturenbrettanzeige, des Parfümdufts, der Sitzhöhe, des Neigungswinkels, der Klimaregelungseinstellungen, der Geschwindigkeitsbegrenzung, der Sicherheitseinstellungen, der Navigationsanzeigeeinstellungen und der Motorreaktionsleistung, umfasst.

Revendications

1. Système embarqué dans un véhicule ne gênant pas la concentration et non invasif (80) pour l'identification, la personnalisation et la surveillance d'activité cardiaque d'un conducteur dans un véhicule d'après des données ECG, dans lequel le système (80) comprend :

a. une pluralité de moyens de sondage de tracé ECG (10), chaque moyen (10) étant un capteur monté sur une ou plusieurs pièces du véhicule pour acquérir en temps réel un signal électrique généré par des muscles cardiaques du conducteur ;
b. un moyen (30) d'extraction de particularités ECG et d'enrôlement unique de tracé ECG sous forme de séquence de code binaire à l'aide d'un algorithme de génération de livre de code de séquence binaire implémenté par processeur dans un livre de code binaire d'après les données ECG du conducteur capturées à partir desdits moyen de sondage (10) ;
c. un moyen (30) de détection et d'autorisation d'entrée du conducteur dans le véhicule, dans lequel le code binaire du tracé ECG du conducteur est mis en concordance avec la séquence de livre de codes binaires enregistrée à l'aide d'étapes implémentées par processeur d'un algorithme classificateur du plus proche voisin ; et
d. un moyen de stockage des préférences du conducteur pour une personnalisation dans le véhicule, dans lequel le déclenchement de la personnalisation se produit après mise en concordance des particularités ECG du conducteur et du code binaire avec la séquence de livre de codes binaires enregistrée.

2. Système (80) selon la revendication 1, dans lequel les moyens de sondage de tracé ECG (10) sont activés pour mesurer un signal ECG de dérivation 1.

3. Système (80) selon la revendication 1, comprenant en outre un moyen (40) d'affichage d'activité cardiaque du conducteur.

4. Système (80) selon la revendication 3, dans lequel le moyen d'affichage (40) est monté sur l'un parmi :

au centre et sur le dessus du volant de direction (70), et ;
le tableau de bord.

5. Système (80) selon la revendication 1, dans lequel le système (80) comprend en outre des moyens (50) pour alerter le conducteur dans le cas où une activité cardiaque anormale du conducteur est détectée.

6. Système (80) selon la revendication 5, comprenant en outre un moyen pour passer un appel d'urgence automatique dans le cas où au moins l'une des alertes est ainsi générée.

7. Système (80) selon la revendication 6, dans lequel l'alerte est signalée à l'un d'un sujet, d'une personne et d'un point de contact externe d'aide sous forme d'appel d'urgence.

8. Système (80) selon la revendication 1, dans lequel un ou plusieurs sites pour monter le moyen de détection (30) sont choisis parmi le volant de direction (70), le siège et le levier de changement de vitesse.

9. Système (80) selon la revendication 1, dans lequel les activités cardiaques sont surveillées sous la forme d'une forme d'onde d'électrocardiogramme et d'une fréquence cardiaque.

10. Système (80) selon la revendication 1, dans lequel le système (80) comprend en outre des moyens de sondage pour déterminer la température de la peau, la respiration, le stress et la pression artérielle du conducteur.

11. Système (80) selon la revendication 1, dans lequel la personnalisation comprend la réinitialisation d'une pluralité de préférences de l'utilisateur, incluant les rétroviseurs, une liste de lecture active de chansons, de vidéo et de stations FM/TV, un volume des haut-parleurs, un niveau sonore du klaxon, un affichage du tableau de bord, une fragrance de parfum, une hauteur de siège, une inclinaison, des réglages de climatisation, une limite de vitesse, des réglages de sécurité, des réglages d'affichage de navigation et une réponse moteur.

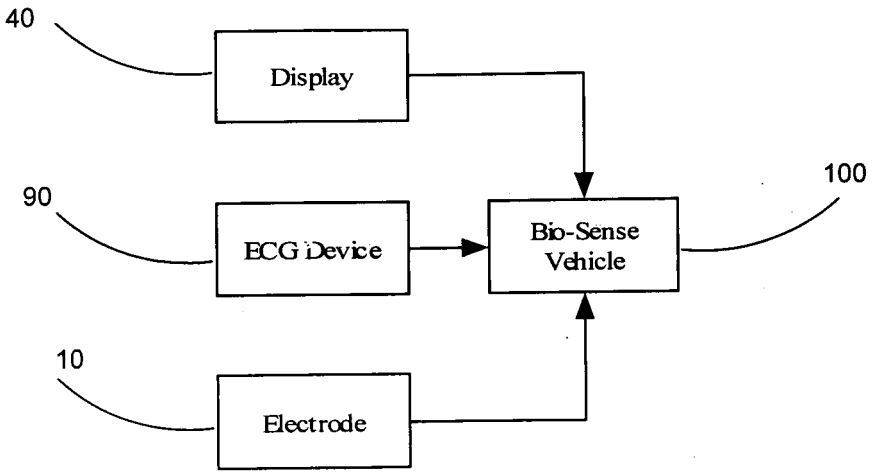

Fig. 1

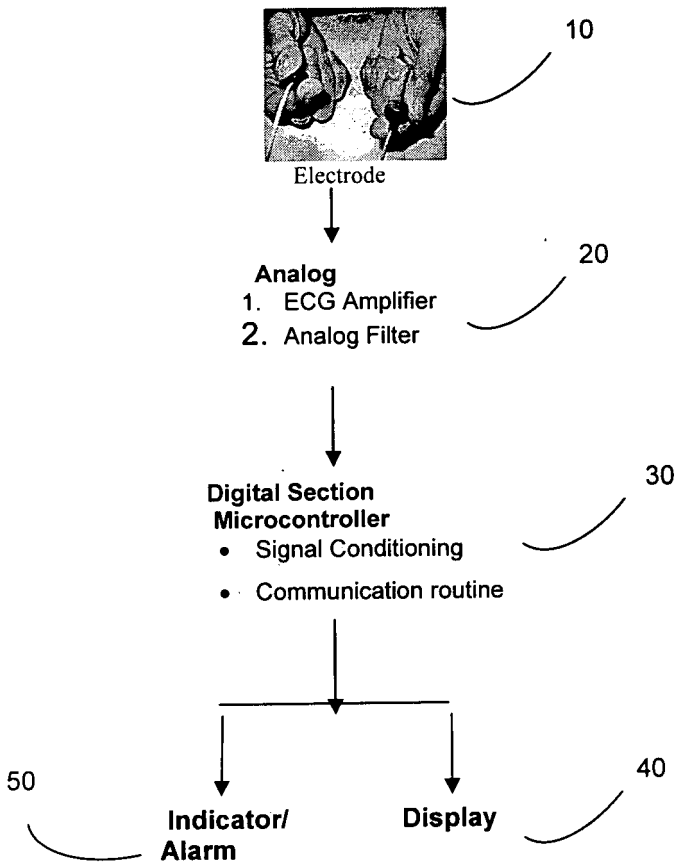
10
Electrode
20
Analog
1. ECG Amplifier
2. Analog Filter
30
Digital Section
Microcontroller
• Signal Conditioning
• Communication routine
50
Indicator/
Alarm
Display
40

Fig. 2

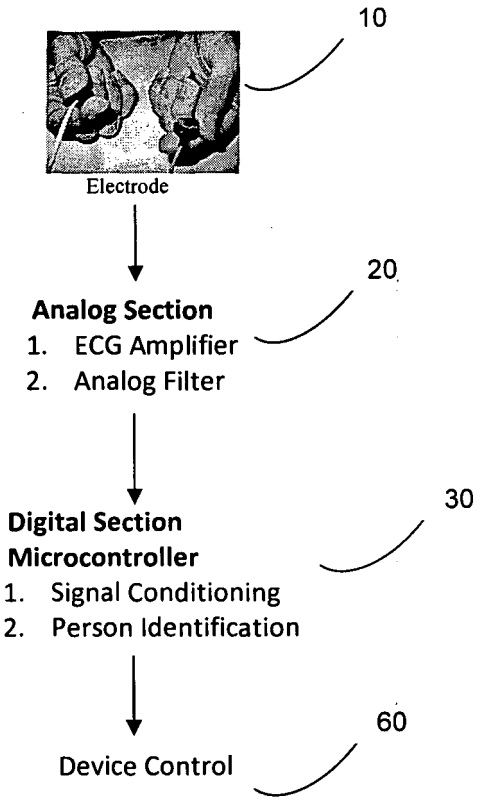
10
Electrode
20
Analog Section
1. ECG Amplifier
2. Analog Filter
30
Digital Section
Microcontroller
1. Signal Conditioning
2. Person Identification
60
Device Control

Fig. 3

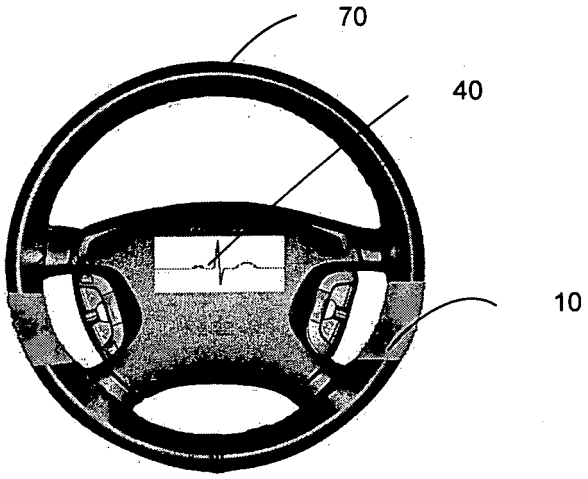

Fig. 4

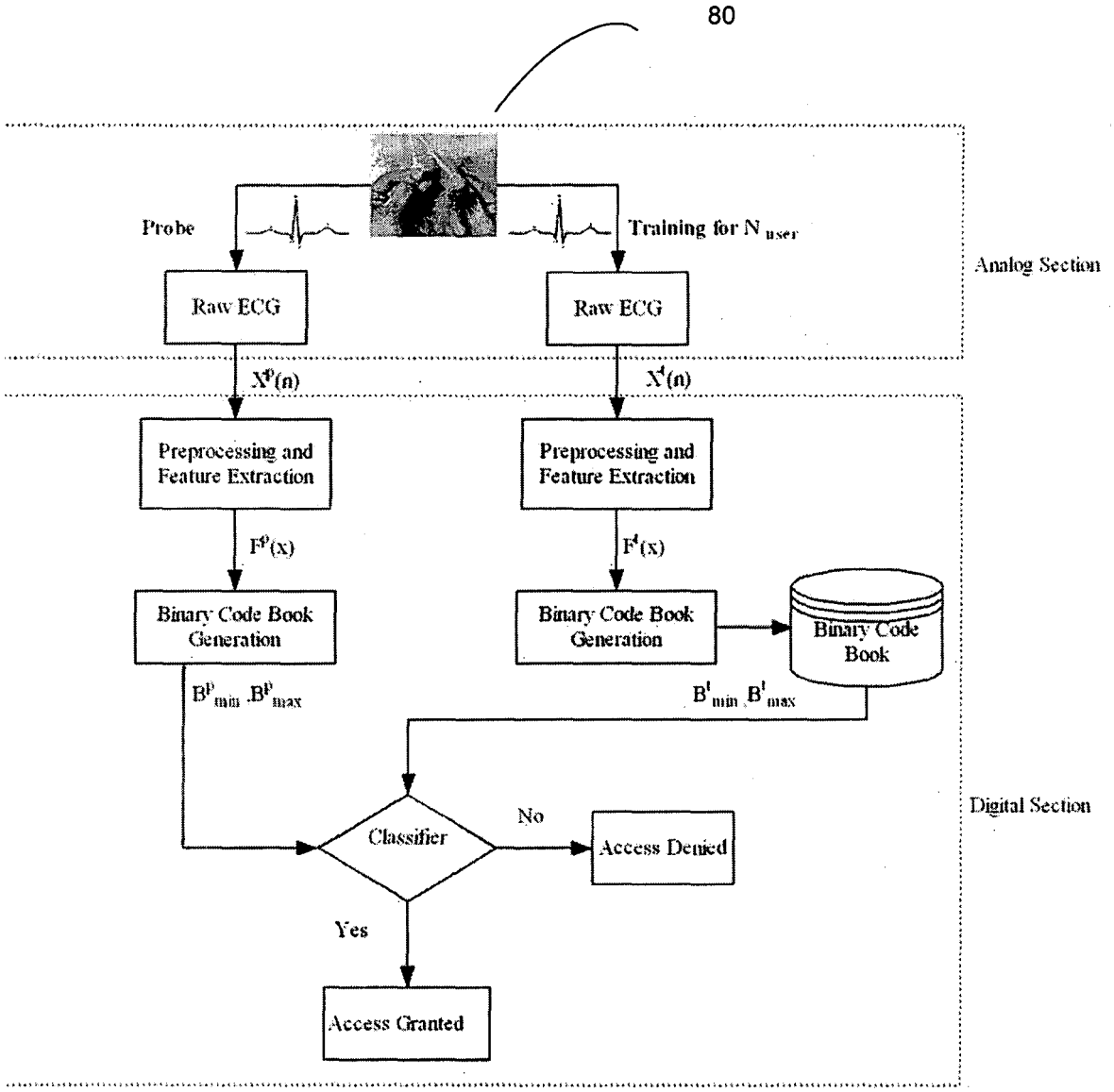
80
Probe
Trainning for N user
Analog Section
Raw ECG
Raw ECG
X^p(n)
X^t(n)
Preprocessing and Feature Extraction
Preprocessing and Feature Extraction
F^p(x)
F^t(x)
Binary Code Book Generation
Binary Code Book Generation
Binary Code Book
B^p min ,B^p max
B^t min ,B^t max
Classifier
No
Access Denied
Yes
Access Granted
Digital Section

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 10310719 A1 **[0005]**
- US 20070265540 A **[0006]**
- US 5574641 A **[0007]**
- US 4706072 A **[0008]**
- US 6599243 B **[0009]**
- US 5783997 A **[0010]**
- US 6575902 B **[0010]**

Non-patent literature cited in the description

- **CHAIKOWSKI I et al.** Value of the single-lead ECG in comparison with 12-lead ECG. *journal Ukr. z. telemed. med. telemat.,* 01 January 2008, vol. 6 (1), 25-27, http://www.nbuv.gov.ua/portal/chem_biol/Ujtm/2008_1/2008_1_5.pdt **[0002]**
- Heart on the road: HRV analysis for monitoring a drivers affective state. **ANDREAS RIENER et al.** PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON AUTOMOTIVE USER INTERFACES AND INTERACTIVE VEHICULAR APPLICATIONS (AUTOMOTIVEUI 2009). ACM, ASSOCIATION FOR COMPUTING MACHINERY, 21 September 2009, 99-106 **[0003]**
- A Sequential Procedure for Individual Identity Verification Using ECG. **JOHN M IRVINE ; STEVEN A ISRAEL.** EURASIP JOURNAL ON ADVANCES IN SIGNAL PROCESSING. HINDAWI PUBLISHING CORP, 01 January 2009, vol. 2009, 243215, , 1-13 **[0004]**

专利名称(译)	一种用于驾驶员的车辆安全性，个性化和心脏活动监测的系统		
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发明人	JAYARAMAN, SRINIVASAN NARASIMHA MURTHY,VENKATESH PURUSHOTHAMAN, BALAMURALIDHAR		
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CPC分类号	A61B5/0408 A61B5/6887 B60W2040/0872 B60W2540/043 B60W2540/22 B60W2540/221 G07C9/00563		
优先权	658MUM2010 2010-03-12 IN		
其他公开文献	EP2544914B1		
外部链接	Espacenet		

摘要(译)

本发明提供一种用于驾驶员的车辆安全性，个性化和心脏活动监测的系统，其中监视和登记驾驶员的心电图，其用于基于用户偏好识别进入车辆的人和车辆的个性化，从而行动作为入侵者对车辆安全的检测。除了登记之外，本发明还以连续和实时的方式监视驾驶员的心脏活动，而没有任何对驾驶员的干扰，具有产生警报和进行紧急呼叫的便利。