US 20190357856A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2019/0357856 A1**

(43) **Pub. Date: Nov. 28, 2019**

Goloubev et al.

(54) **PERSONAL DEVICE FOR DIAGNOSING AND MONITORING INDIVIDUAL ACTIVITY, CONDITIONS, AND DIET**

(71) Applicants: **Mikhail Goloubev**, Baltimore, MD (US); **Lethia Jackson**, Ellicott City, MD (US); **Julisha Patten**, Apollo Beach, FL (US)

(72) Inventors: **Mikhail Goloubev**, Baltimore, MD (US); **Lethia Jackson**, Ellicott City, MD (US); **Julisha Patten**, Apollo Beach, FL (US)

(21) Appl. No.: **15/990,574**

(22) Filed: **May 25, 2018**

Publication Classification

(51) **Int. Cl.**

A61B 5/00	(2006.01)
A61B 5/0205	(2006.01)
A61B 5/11	(2006.01)
G16H 40/63	(2006.01)

(52) **U.S. Cl.**

CPC *A61B 5/7282* (2013.01); *A61B 5/0205* (2013.01); *A61B 5/1118* (2013.01); *A61B 5/746* (2013.01); *A61B 5/742* (2013.01); *A61B 5/021* (2013.01); *A61B 5/0002* (2013.01); *A61B 5/7275* (2013.01); *A61B 5/7225* (2013.01); *G16H 40/63* (2018.01); *A61B 5/4866* (2013.01)

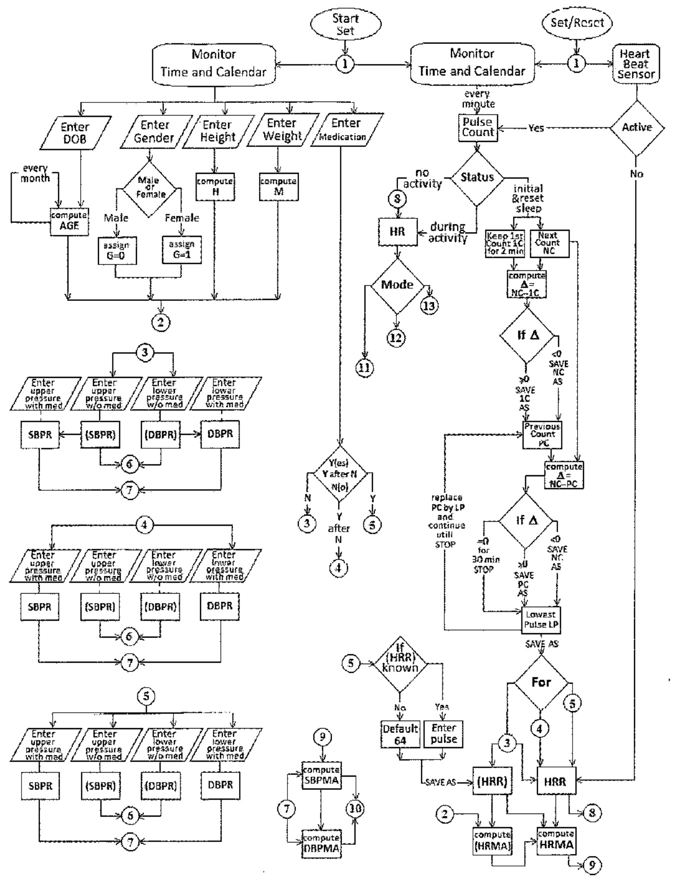
(57) **ABSTRACT**

Vigorous exercise might produce great health benefits but is not recommended for everyone and has to be performed under professional trainer/doctor supervision. That requires preliminary lab tests which are usually avoided due to the lack of time or finances. Personalized wrist electronic device allows avoiding the above complications particularly for non-athletes.

The principle of design for such device was achieved through rigorous mathematical analysis of approved medical research facts linking personal heart rate to individual's blood pressure and metabolic rate depending on person's weight, height, age, gender, medical treatment, and blood pressure together with heart rate at rest.

It allowed significantly personalize and upgrade the process of dynamical diagnosing and monitoring of user activity, health conditions, and diet incorporating them into a new technologically advanced individual electronic device capable of simultaneously functioning in multiple modes ran from automatically or manually updated personal input as well as providing with the warnings on both physical or mental stressful situations, effects of prescribed medications, and dieting progress.

Have not been offered before together these three the most important health features along with the proposed options of data transferring to an authorized party make this device unique and the most desirable for both users and their physicians.



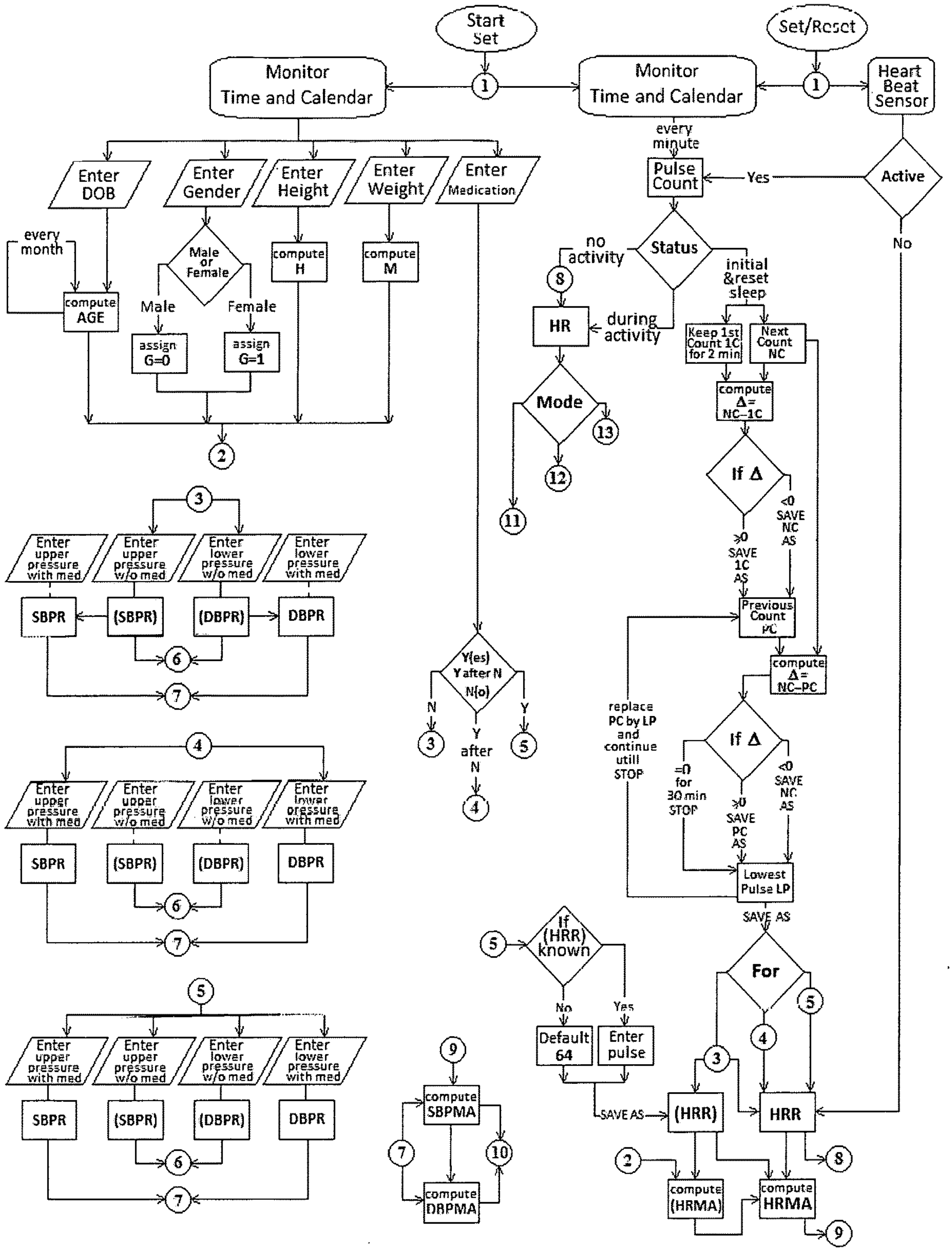

Start Set
Set/Reset
Monitor Time and Calendar
Monitor Time and Calendar
Heart Beat Sensor
every minute
Pulse Count
Yes
Active
No
Enter DOB
Enter Gender
Enter Height
Enter Weight
Enter Medication
every month
compute AGE
Male or Female
Male
Female
assign G=0
assign G=1
compute H
compute M
no activity
Status
initial &reset sleep
HR
during activity
Keep 1st Count 1C for 2 min
Next Count NC
compute Δ= NC−1C
Mode
If Δ
≥0 SAVE 1C AS
<0 SAVE NC AS
Previous Count PC
compute Δ= NC−PC
replace PC by LP and continue utill STOP
If Δ
=0 for 30 min STOP
≥0 SAVE PC AS
<0 SAVE NC AS
Lowest Pulse LP
SAVE AS
For
Enter upper pressure with med
Enter upper pressure w/o med
Enter lower pressure w/o med
Enter lower pressure with med
SBPR
(SBPR)
(DBPR)
DBPR
Y(es) Y after N N(o)
N
Y after N
Y
If (HRR) known
No
Yes
Default 64
Enter pulse
SAVE AS
(HRR)
HRR
compute SBPMA
compute DBPMA
compute (HRMA)
compute HRMA

Figure 1A

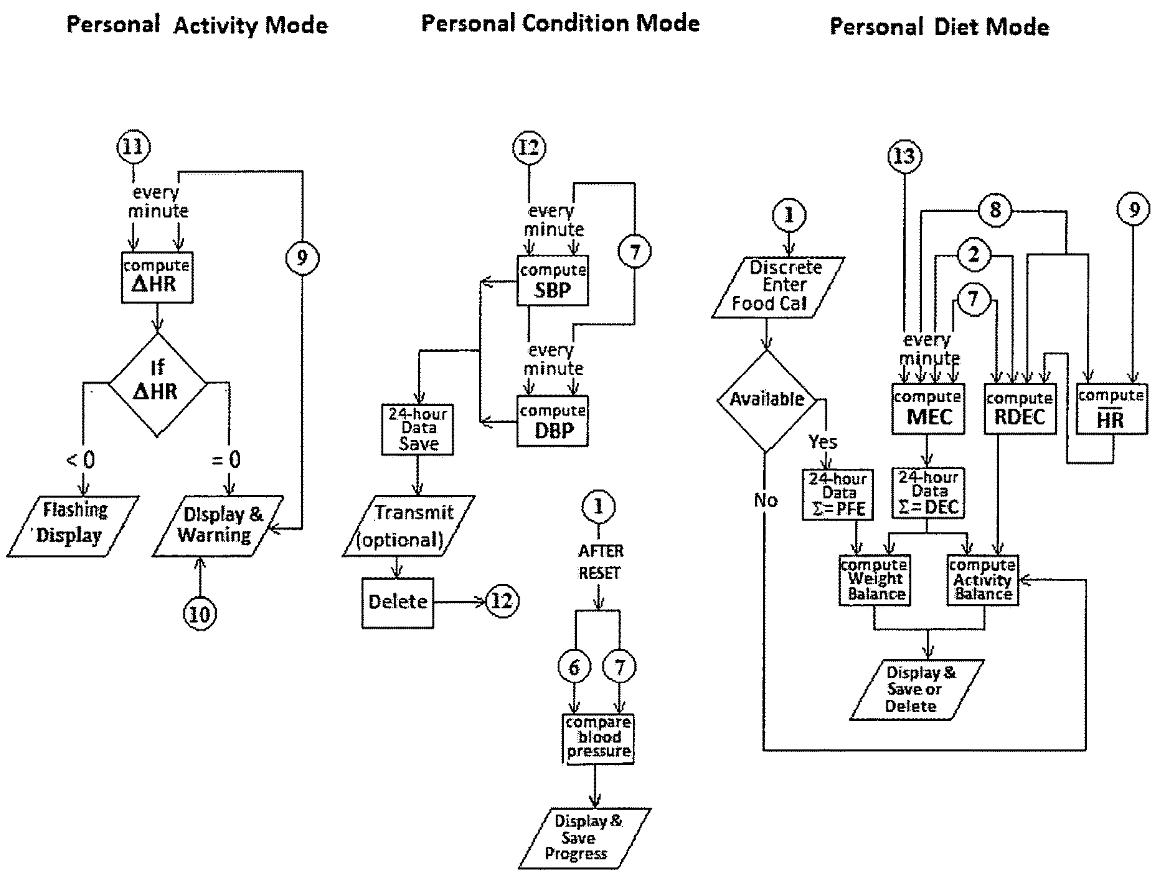

Personal Activity Mode
Personal Condition Mode
Personal Diet Mode
11
every minute
compute ΔHR
If ΔHR
< 0
= 0
Flashing Display
Display & Warning
9
10
12
every minute
compute SBP
7
every minute
compute DBP
24-hour Data Save
Transmit (optional)
Delete
12
1
AFTER RESET
6
7
compare blood pressure
Display & Save Progress
13
1
Discrete Enter Food Cal
Available
Yes
No
8
2
7
9
every minute
compute MEC
compute RDEC
compute HR
24-hour Data Σ=PFE
24-hour Data Σ=DEC
compute Weight Balance
compute Activity Balance
Display & Save or Delete

Figure 1B

PERSONAL DEVICE FOR DIAGNOSING AND MONITORING INDIVIDUAL ACTIVITY, CONDITIONS, AND DIET

U.S. PATENT DOCUMENT

[0001]

5,810,736 B1	September 1998	Pail	600/500
5,807,267 D1	September 1998	Bryars et al.	600/500
6,095,984 B1	August 2000	Amano et al.	600/500
9,597,004 B2	March 2017	Hughes et al.	A61B 5/0468 (20130101)
6,580,942 B1	June 2003	Willshire	600/509
9,566,007 B2	February 2017	McCombie et al.	A61B 5/0205 (20130101)
6,042,549 B1	March 2000	Amano et al.	600/500
9,566,010 B2	February 2017	Chu	A61B 5/02438 (20130101)
9,430,615 B2	August 2016	Michaelis et al.	A61B 5/02438 (20130101)

OTHER PUBLICATIONS

[0002] "Cardiac Output", Wikipedia, https://en.wikipedia.org/wiki/Cardiac_output

[0003] "Mean Arterial Pressure", Wikipedia, https://en.wikipedia.org/wiki/Mean_arterial_pressure

[0004] "Metabolic Equivalent", Wikipedia, https://en.wikipedia.org/wiki/Metabolic_equivalent

[0005] James L. Holly, MD "Aging Well. Part III: Basal Metabolism Rates", Southeast Texas Medical Associates, L.L.P., http://www.setma.com/Your-Life-Your-Health/pdfs/Aging-Well-Part-III.pdf

[0006] "Basal Metabolic Rate", Wikipedia, https://en.wikipedia.org/wiki/Basal_metabolic_rate

[0007] Mifflin, M D; St Jeor, S T; Hill, L A; Scott, B J; Daugherty, S A; Koh, Y O (1990). "A new predictive equation for resting energy expenditure in healthy individuals". The American journal of clinical nutrition 51 (2): 241-7.

[0008] "Human Body Weight", Wikipedia, https://en.wikipedia.org/wiki/Human_body_weight

BACKGROUND OF INVENTION

[0009] Accurate diagnosis of a personal level of overload activity is required besides obvious sports and medical applications in stressful situations in order to prevent them. Activity estimation is based on the heart rate and there are two major currently existing heart rate monitors HRM: wrist-based and chest-strap. The very earliest technical solutions for placed over the carpal tunnel wrist pulse monitor with infra-red sensor to pick up the flow of blood therein and radio frequency transmitter to transfer data to a display unit which processes it and displays pulse is cited in U.S. Pat. No. 5,810,736 B1. Quite elegant assembly of wrist pulse monitor with additional piezoelectric sensing elements to eliminate power drain from light emitting diode (LED) and thus more complete noise reduction resulting in reading accuracy is proposed in U.S. Pat. No. 5,807,267 B1.

[0010] More sophisticated digital apparatus for detecting arrhythmia by analyzing the continuity of change in pulse waveform is suggested in U.S. Pat. No. 6,095,984 B1. Incorporated into device body motion detection means allow accurate arrhythmia monitoring. This device is developed to a higher degree in U.S. Pat. No. 9,597,004 B2 where advanced technological solution allows two-way communication with a server configured and monitored by a cardiologist in case the user initiated the trigger. Device configuration aims constant heart rate and EKG data collection mostly for diagnostic or intense care purposes. Change of patient condition due to aging or new medication prescription requires new appointments and server update. Moreover, amount of volunteers wishing to be monitored by same cardiologist is limited, while provided service could be expensive.

[0011] In U.S. Pat. No. 6,580,942 B1 a chest apparatus for detecting an activity of a human heart operates on proposed circuit which analyzes signals received from the sensors and upon determination that such signals are of electrographic nature, i.e. derived from heart beats, generates an alert. This invention is fitting best patient monitoring before during and after surgical or medical treatment at the hospital. Such approach is further advanced in U.S. Pat. No. 9,566,007 B2 proposing a method and based on it a wearable device for continuously and accurately monitoring ECG and photoplethysmograph waveform to determine a patient's vital signs. Wrist and chest detectors comprised with an analyzer module and blood pressure measuring by pulse transmit time technique require multiple electrodes attached to the patient's chest. This ultimately restricts the movement capability of the user but makes the device a valuable addition to an operation room.

[0012] U.S. Pat. No. 6,042,549 B1 is disclosing a personal device for measuring exercise intensity and quantity based on the user pulse which limits are computed and set up from preliminary test of maximum oxygen consumption rate. This method and device is rather for professional athletes undergoing intense training and being observed by qualified medical personnel. A method for monitoring a cardiac status during intense exercise is suggested in U.S. Pat. No. 9,566,010 B2 where proposed algorithm is based on related to cardiac output cardio force index normalized to cardiac force index at walking. Such training (or self-training) apparatus functionality fully depends on measured acceleration during walking, input weight of the user, and preset maximum activity level. Unfortunately, definitions of neither acceleration during walking with constant speed, nor individual maximum activity level are specified.

[0013] U.S. Pat. No. 9,430,615 B2 depicts a device that goes beyond the scope of a wearable monitor. It is a personal phone, playing music, or watching videos device configured to utilize measured by two electrodes EKG signals and monitoring method for detecting heart rate anomalies in the background during use and alerting proper authorities in case irregularity occurs. The shortcoming of the device is that it does not take into account the distinctiveness of each user heart rate based on upon their medical history. Therefore, the definition of "anomaly" is not personal and could result in many false positives.

[0014] In general, none of the existing heart rate monitoring devices is capable of predicting personal level of dangerous activity and alarm the user of its approach. Moreover, closely related to pulse issues such as continuous blood pressure and metabolic rate estimations have never been a features of any heart rate monitoring device.

SUMMARY OF INVENTION

[0015] Proposed new personal device allowing continuous monitoring and diagnosing user activity accompanied by estimation of blood pressure and metabolism.

[0016] The working principle of this device is based on developed unique and efficient method to accurately evaluate personal heart rate and blood pressure at over stressed, or maximum allowed physical or mental activity for an individual of a given build, fit, age, and gender with certain health conditions and heart rate at rest.

[0017] Based on personal input (automatically updated or manually reset) and instantaneous heart rate device is constantly

- [0018] compares it with the individual heart rate at maximum activity (over stressed zone) and issues warnings in order to avoid dangerous unhealthy situation;
- [0019] estimates and saves blood pressure data with the option of transferring it to an authorized party;
- [0020] computes user energy consumption and estimates amount of daily weight loss or gain;

thus, monitoring three the most crucial health issues—individual activity, medical conditions, and dieting never been presented together in one device suitable for any adult and surely helpful for any physician.

BRIEF DESCRIPTION OF THE DRAWING

[0021] FIG. **1**A to **1**B. Flow Chart Diagram for continuous diagnosing dangerous and monitoring personal heart rate (activity mode) and blood pressure (personal condition mode) along with the warnings of approaching overstress zone and metabolic rate evaluation (diet mode).

DETAILED DESCRIPTION

A: Definitions

[0022] The following definitions are useful in understanding the process of metabolism and its relation to instantaneous heart rate.

- [0023] HRR is heart rate at rest measured in beat/min;
- [0024] HRMA is heart rate at maximum allowed activity measured in beat/min;
- [0025] HR is heart rate at some activity measured in beats/min;
- [0026] PHRI is percentage of heart rate increase compared to heart rate at rest;
- [0027] M is mass (weight) of an individual measured in Kg;
- [0028] IW is ideal weight of an individual measured in Kg;
- [0029] H is height of the individual measured in m(eters);
- [0030] AGE is the age of individual measured in y(ears);
- [0031] MRMA is metabolic rate at maximum allowed activity measured in MET;
- [0032] PMRMA is personal mean metabolic rate at maximum activity measured in MET;
- [0033] BMRS is basal metabolic rate standard, measured in Kcal/day;
- [0034] BMR is individual metabolic rate measure in MET;
- [0035] SBPR is systolic blood pressure at rest measured in mm Hg;
- [0036] DBPR is diastolic blood pressure at rest measure in mm Hg;
- [0037] MAP is mean arterial pressure measured in mm Hg;
- [0038] CO is cardiac output measured in Liter/min;
- [0039] R is total peripheral resistance of pulmonary system measured in (mm Hg)*min/Liter;
- [0040] SV is stroke volume measured in Liter/beat;
- [0041] G is gender equal +5 for adult male and −161 for an adult female;
- [0042] A is ideal weight constant equal 50 for male and 45.4 for a female;
- [0043] PIMR is personal instantaneous metabolic rate measured in Kcal/min
- [0044] RDEC is required daily energy consumption measured in Kcal/day
- [0045] PFE is provided by food (and alcohol) energy during the day measured in Kcal/day

B: Development of Relevant Solutions

[0046] In order to function body needs energy which is coming from oxygen delivered by blood flow called cardiac output CO. Hence, energy consumption has to be proportional to cardiac output. There are two basic equations involving CO:
and

$$CO = SV * HR \quad \text{(Eq. 1)}$$

$$CO = \frac{MAP}{R} \quad \text{(Eq. 2)}$$

[0047] Since individual stroke volume SV is a constant parameter and different activities definitely require different cardiac output, energy consumption (or metabolic rate at maximum activity MRMA) according to Eq.1 has to obey proportion

$$\frac{MRMA}{PMRMA} = \frac{HRMA}{HRR} \quad \text{(Eq. 3)}$$

[0048] Metabolic rate is measured in Metabolic Equivalent of Task (MET) which is a physiological measure expressing the energy cost of physical activities:

$$1\ MET = 1\ \frac{\text{Kcal}}{\text{kg} \cdot hr}$$

Physical activity	MET
Light intensity activities	<3
Sleeping	0.9
watching television	1.0
writing, desk work, typing	1.5
walking, 1.7 mph (2.7 km/h), level ground, strolling, very slow	2.3
walking, 2.5 mph (4 km/h)	2.9
Moderate intensity activities	3 to 6

-continued

Physical activity	MET
bicycling, stationary, 50 watts, very light effort	3.0
walking 3.0 mph (4.8 km/h)	3.3
calisthenics, home exercise, light or moderate effort, general	3.5
walking 3.4 mph (5.5 km/h)	3.6
bicycling, <10 mph (16 km/h), leisure, to work or for pleasure	4.0
bicycling, stationary, 100 watts, light effort	5.5
sexual activity	5.8
Vigorous intensity activities	>6
jogging, general	7.0
calisthenics (e.g. pushups, situps, pullups, jumping jacks), heavy, vigorous effort	8.0
running jogging, in place	8.0
rope jumping	10.0

Conservative Estimate of Dangerous Activity MRMA-6 MET.

[0049] According to James L. Holly, MD the best metabolic rate is observed for an adults at the age of 20 with its average reduction by 4% every decade for males and 3% for females for who metabolic rate is 13% lower than for males. Further analysis of presented in this publication data reveals the following expression for metabolic rate at maximum activity:

$$MRMA(MET) = \begin{cases} 6 * 0.96^{\frac{AGE-20}{10}} & \text{for male} \\ 5.2 * 0.97^{\frac{AGE-20}{10}} & \text{for female} \end{cases} \quad \text{(Eq. 4)}$$

[0050] Personal Metabolic Rate of an individual PMRMA is the amount of energy the body needs to function at a maximum activity with resting heart rate HRR. PMRMA can be defined from individual metabolic rate BMR which is number of Kcal required by a given body to support vital functions for the entire day while at rest. Currently accepted standard for basal metabolic rate BMRS of a healthy individual of ideal weight IW is Mufflin-St.Jeor equation:

$$BMRS\left(\frac{\text{Kcal}}{\text{day}}\right) = 10 * IW + 625 * H - 4.92 * \text{AGE} + G \quad \text{(Eq. 5)}$$

Ideal weight divine equation $IW\ (\text{Kg}) = A + 90.55 \cdot (H - 1.524)$ (Eq.6)

where constant

$$A = \begin{cases} 50.0 \text{ for men} \\ 45.5 \text{ for women} \end{cases} \text{ while gender } G = \begin{cases} +5 & \text{for men} \\ -161 & \text{for women} \end{cases}$$

[0051] Conversion into metabolic equivalent of task MET reveals expression

$$BMRS\ (MET) = \frac{10 \cdot [A + 90.55 \cdot (H - 1.524)] + 625 \cdot H - 4.92 \cdot \text{AGE} + G}{24 \cdot [A + 90.55 \cdot (H - 1.524)]} \quad \text{(Eq. 7)}$$

[0052] Normalization of individual metabolic rate BMR to the standard one BMRS (the same person would have in case of being in a perfect health) requires two corrections for:

[0053] actual weight M (Kg) leading to coefficient

$$\frac{BMR}{DMRS} = \frac{M}{A + 90.55 - (\text{II} - 1.524)}$$

and

[0054] blood pressure (mean arterial blood pressure MAP) which, in assumption of constant peripheral resistance of pulmonary system R and in accordance with Eq.2 provides with

$$\frac{BMR}{BMRS} = \frac{MAP_{actual}}{MAP_{desired}}$$

[0055] In general, mean arterial pressure can be defined as

$$MAP = DBPR + 0.01(SBPR - DBPR)\exp\left(4.14 - \frac{40.74}{HR}\right) \quad \text{(Eq. 8)}$$

[0056] For desired blood pressure at 120×80 mm Hg, the second correction coefficient can be defined as

$$\frac{BMR}{BMRS} = \frac{DBPR + 0.01(SBPR - DBPR) * \exp\left(4.14 - \frac{40.74}{HRR}\right)}{80 + 0.01(120 - 80) * \exp\left(4.14 - \frac{40.74}{HRR}\right)} \quad \text{(Eq. 9)}$$

[0057] Thus, equation for BMR measured in MET becomes:

$$BMR = M * \frac{10 \cdot [A + 90.55 \cdot (H - 1.524)] + 625 \cdot H - 4.92 \cdot \text{AGE} + G}{24 \cdot [A + 90.55 \cdot (H - 1.524)]^2} * \frac{\left[DBPR + 0.01(SBRP - DBPR) \cdot \exp\left(4.14 - \frac{40.74}{HRR}\right)\right]}{\left[80 + 0.01(120 - 80) \cdot \exp\left(4.14 - \frac{40.74}{HRR}\right)\right]} \quad \text{(Eq. 10)}$$

[0058] Mean metabolic rate for above average physical work/exercise (PMRMA) is usually 2.4 times higher than BMR, or measured in MET

$$PMRMA = M * \frac{A + 90.55 \cdot (H - 1.524) + 62.5 \cdot H - 0.492 \cdot \text{AGE} + 0.1 \cdot G}{[A + 90.55 \cdot (H - 1.524)]^2} * \frac{DBPR + 0.01(SBPR - DBPR) * \exp\left(4.14 - \frac{40.74}{HRR}\right)}{80 + 0.01(120 - 80) * \exp\left(4.14 - \frac{40.74}{HRR}\right)} \quad \text{(Eq. 11)}$$

[0059] Hence, as it follows from Eq.3 dangerous (maximum allowable) heart rate can be evaluated as:

$$HRMA=\frac{6*0.96^{\frac{AGE-20}{10}}*HRR*[80+0.01(120-80)\cdot\exp\left(4.14-\frac{40.74}{HRR}\right)]*[50+90.55\cdot(H-1.524)]^2}{\left[DBPR+0.01(SBPR-DPBR)\cdot\exp\left(4.14-\frac{40.74}{HRR}\right)\right]*[50+90.55\cdot(H-1.524)+62.5\cdot H-0.492\cdot\mathrm{AGE}+0.1\cdot5]\cdot M} \tag{Eq. 12a}$$

for men and

$$HRMA=\frac{5.2*0.97^{\frac{AGE-20}{10}}*HRR*[80+0.01(120-80)\cdot\exp\left(4.14-\frac{40.74}{HRR}\right)]*[45.5+90.55\cdot(H-1.524)]^2}{\left[DBPR+0.01(SBPR-DPBR)\cdot\exp\left(4.14-\frac{40.74}{HRR}\right)\right]*[45.5+90.55\cdot(H-1.524)+62.5\cdot H-0.492\cdot\mathrm{AGE}-0.1\cdot161]\cdot M} \tag{12b}$$

for women

[0060] This equation allows to define percentage of heart rate increase at maximum activity for a person taking no medications for changing blood pressure and pulse

$$PHRI=\frac{HRMA-HRR}{HRR} \tag{Eq. 13}$$

[0061] In case medication sets up different heart rate at rest, the limit of dangerous activity should be computed as

$$HRMA_{with\ medication}=HRR_{with\ medication}\cdot\left[1+\left(\frac{HRMA-HRR}{HRR}\right)_{without\ medication}\right] \tag{Eq. 14}$$

[0062] Based on the fact that systolic cycle is two times shorter the diastolic one there is another expression for mean arterial blood pressure:

$$MAP=DBP+\frac{SBP-DBP}{3} \tag{Eq. 15}$$

where DBP and SBP are current diastolic and systolic blood pressure respectively.

[0063] Hence, Eq.8 and Eq.15 reveal equation

$$DBP+\frac{SBP-DBP}{3}= \tag{Eq. 16}$$

-continued

$$DBPR+0.01\cdot(SBPR-DBPR)\cdot\exp\left(4.14-\frac{40.74}{HR}\right)$$

where HR is heart rate at given activity

[0064] Under the assumption that the ratio of systolic blood pressure to diastolic blood pressure remains the same under any activity

$$\frac{SBPR}{DBPR}=\frac{SBP}{DBP}$$

solution of Eq.16 is:

$$SBP=SBPR\cdot\frac{3+0.03\cdot\left(\frac{SBPR}{DBPR}-1\right)\cdot\exp\left(4.14-\frac{40.74}{HR}\right)}{\frac{SBPR}{DBPR}+2} \tag{Eq. 17}$$

$$DBP=DBPR\cdot\frac{3+0.03\cdot\left(\frac{SBPR}{DBPR}-1\right)\cdot\exp\left(4.14-\frac{40.74}{HR}\right)}{\frac{SBPR}{DBPR}+2}$$

with three related to discussed subject consequences:

[0065] State of rest (SBP=SBPR and HR=HRR) does not depend on blood pressure and can be defined as heart rate

$$HRR=\frac{40.74}{4.14+\ln 0.03}\cong 64\ \text{beats/min.}$$

This number, in case no-medication-heart-rate is known or recalled, can be used for computing heart rate at maximum activity in Eqs.12a and 12b and further in Eq.14 for computing maximum allowed heart rate HRMA for a user taken prescription drug;

[0066] Pulse is an indicator of blood pressure which dangerous level could be estimated as

$$SBPMA=SBPR\cdot\frac{3+0.03\left(\frac{SBPR}{DBPR}-1\right)\cdot\exp\left(4.14-\frac{40.74}{HRMA}\right)}{\frac{SBPR}{DBPR}+2} \tag{Eq. 18}$$

$$DBPMA=SBPMA\cdot\frac{DBPR}{SBPR}$$

[0067] personal instantaneous metabolic rate (PIMR), or measured in Kcal per minute required for current activity energy, can be estimated by continuously (every minute) monitored heart rate in accordance with modified Eq.10 as follows

$$PIMR=M^2*\frac{A-138+153.05\cdot H-0.492\cdot\mathrm{AGE}+0.1\cdot G}{144\cdot[A+90.55\cdot(H-1.524)]^2}* \tag{Eq. 19}$$

-continued

$$\frac{\left[DBPR + 0.01(SBPR - DBPR) * \exp\left(4.14 - \frac{40.74}{HR}\right)\right]}{\left[80 + 0.01(120 - 80) * \exp\left(4.14 - \frac{40.74}{HRR}\right)\right]}$$

[0068] Replacement of instantaneous heart rate (HR) in the above equation by daily (average) heart rate

$$\overline{HR} = \frac{HRR + HRMA}{2}$$

leads to evaluation of required daily energy consumption (RDEC) as

$$RDEC = 10 * M^2 * \frac{A - 138 + 153.05 \cdot H - 0.492 \cdot \mathrm{AGE} + 0.1 \cdot G}{[A + 90.55 \cdot (H - 1.524)]^2} * \quad \text{(Eq. 20)}$$

-continued

$$\frac{\left[DBPR + 0.01(SBPR - DBPR) * \exp\left(4.14 - \frac{40.74}{HR}\right)\right]}{\left[80 + 0.01(120 - 80) * \exp\left(4.14 - \frac{40.74}{HRR}\right)\right]}$$

[0069] Further comparison of its value with actually provided by food during the day energy (PFE) allows to watch over or improve personal diet. On average, carbohydrates (sugars and starches) and proteins provide approximately 4 Kcal/g, lipids (fats) produce 9 Kcal/g, and the oxidation of alcohol produces 7 Kcal/g. Thus, daily balance evaluation could be in favor of gain, loss, or stable weight:

$$\begin{cases} PFE > RDEC & \text{means gaining } \left(\frac{PFE - RDEC}{9}\right) \text{ gramms of fat} \\ RDEC > PFE & \text{means loosing } \left(\frac{RDEC - PFE}{9}\right) \text{ gramms of fat} \\ PFE = RDEC & \text{means breaking even} \end{cases}$$

TABLE

Flow Chart Diagram for Personal Activity, Conditions, and Diet Diagnosing and Monitoring

Personal Input

1. Start and Set
2. Input of user:

birth date DOB (month, year) converted into

$$\mathrm{AGE} = \text{current year } \frac{\text{number of current month}}{12} - DOB \text{ year } \frac{\text{number of } DOB \text{ year month}}{12}$$

automatically updated monthly by adding $\frac{1}{12}$ to the latest age estimate;

gender (male – female) defined as $G = \begin{cases} 0 & \text{for a male} \\ 1 & \text{for a female} \end{cases}$;

height (Feet – Inches) computed as $H = \frac{\text{Inches} + \text{Feet} * 12}{2.54}$;

weigh (Pounds) computed as M = 0.453 · Pounds;

medical treatment (if medication capable to effect blood pressure is taken) and blood pressure:

3. If a choice is N(o)
4. If a Y(es) follows previous N(o)
5. If a choice is Y(es)
6. Input of user systolic (SBPR) and diastolic (DBPR) blood pressure at rest without medication in mm Hg
7. Input of user current systolic SBPR and diastolic DBPR blood pressure at rest in mm Hg:

if medication choice is N(o) then (SBPR) = SBPR and (DBPR) = DBPR;

if medication choice is Y(es) after N(o) then previously input numbers for (SBPR) and (DBPR) remain the same while new input for SBPR and DBPR is required;

if medication choice is Y(es), then all four numbers known to a user have to be input

8. Estimation of personal heart rate at rest and at maximum activity (overstressed zone):

The final step of device personalization is wearing it over the sleep time when heart beat sensor keeps the first count 1C and compares it with the next NC defining Δ = NC − 1C. If Δ is negative or zero then NC is saved as previous count PC, otherwise it is 1C. The whole process is repeated by comparing PC with NC until Δ = NC − PC remains zero for 30 minutes. Defined lowest pulse LP is user current heart rate at rest HRR. It is saved as heart rate at rest without medication (HRR) satisfying choices N(o) and Y(es) after N(o). In case of choice Y(es) either manual (if known) or automatic (default 64) input of (HRR) is required.

TABLE-continued

Flow Chart Diagram for Personal Activity, Conditions, and Diet Diagnosing and Monitoring

9. Heart rate at maximum activity without medication is computed as

$$(HRMA)=\frac{[6*(1-G)+5.2*G]*[0.96*(1-G)+0.97*G]^{\frac{AGE-20}{10}}*(HRR)*\left\{80+0.4*\exp\left[4.14-\frac{40.74}{(HRR)}\right]\right\}*[50*(1-G)+45.5*G+90.55\cdot(H-1.524)]^2}{\left\{(DBPR)+0.01*[(SBPR)-(DBPR)]*\exp\left[4.14-\frac{40.74}{(HRR)}\right]\right\}*[50*(1-G)+45.5*G+90.55\cdot(H-1.524)+62.5\cdot H-0.492\cdot\mathrm{AGE}+0.5*(1-G)-16.1*G]\cdot M}$$

while user current heart rate maximum activity is defined as $HRMA=HRR*\frac{(HRMA)}{(HRR)}$.

10. Calculation and storage of systolic blood pressure prediction at dangerous activity

$$SBPMA=SBPR\cdot\frac{3+0.03\cdot\left(\frac{SBPR}{DBPR}-1\right)\cdot\exp\left(4.14-\frac{40.74}{HRMA}\right)}{\frac{SBPR}{DBPR}+2}$$

Calculation and storage of diastolic blood pressure prediction at dangerous activity

$$DBPMA=SBPMA\cdot\frac{DBPR}{SBPR}$$

1. Reset can be generated automatically or manually with the option to keep or change information of any prompt. Each reset is followed by comparison of systolic and diastolic blood pressure before and after reset in order to evaluate user health progress.

Personal Output

Device constantly measures user instantaneous heart rate HR when it is in use. Otherwise, heart beat sensor is inactive, HR = HRR. This user instantaneous heart rate is simultaneously used in three personal output modes:

11. Activity: constant computation of $\Delta HR = HRMA - HR$. If ΔHR value becomes zero a sound and displayed values of SBPMA and DBPMA are activated. If ΔHR becomes negative screen is flashing as a warning.
12. Condition: constant computation of estimated values of instantaneous systolic and diastolic blood pressure

$$SBP=SBPR\cdot\frac{3+0.03\left(\frac{SBPR}{DBPR}-1\right)\cdot\exp\left(4.14-\frac{40.74}{HR}\right)}{\frac{SBPR}{DBPR}+2}$$

$$DBP=SBP\cdot\frac{DBPR}{SBPR}$$

Minutely computed blood pressure is stored in mode memory and accessible upon demand. Every 24 hours all stored data can be transmitted (optional) to a user or authorized party computer and is deleted from the memory.

13. Diet: Required Daily Energy Consumption is computed as

$$RDEC=10*M^2*\frac{50*(1-G)+45.5*G-138+153.05\cdot H-0.492\cdot\mathrm{AGE}+0.5*(1-G)-16.1*G}{[50*(1-G)+45.4*G+90.55\cdot(H-1.524)]^2}*\frac{\left[DBPR+0.01(SBPR-DBPR)*\exp\left(4.14-\frac{40.74}{\overline{HR}}\right)\right]}{\left[80+0.01(120-80)*\exp\left(4.14-\frac{40.74}{HRR}\right)\right]}$$

where daily mean heart rate is defined as $\overline{HR}=\frac{HRR+HRMA}{2}$

Minute Energy Consumption is computed as

$$MEC=M^2*\frac{50*(1-G)+45.5*G-138+153.05\cdot H-0.492\cdot\mathrm{AGE}+0.5*(1-G)-16.1*G}{144*[50*(1-G)+45.5*G+90.55\cdot(H-1.524)]^2}*\frac{\left[DBPR+0.01(SBPR-DBPR)*\exp\left(4.14-\frac{40.74}{HR}\right)\right]}{\left[80+0.01(120-80)*\exp\left(4.14-\frac{40.74}{HRR}\right)\right]}$$

for consequent 24 hours adding each new value to the previous ones revealing Daily Energy Consumption DEC.

TABLE-continued

Flow Chart Diagram for Personal Activity, Conditions, and Diet Diagnosing and Monitoring
The negative difference (RDEC − DEC) generates the warning of elevated activity on the previous day Optionally this mode might contain an extra input for Provided by Food Energy PFE (in Kcal). In case this option is initiated and used properly, daily weight balance is estimated at the beginning of next cycle as
$\frac{PFE - DEC}{4077}$ lbs when positive number means weight gain while negative one weight loss.
Each new value (positive or negative) has to be added to the previous ones providing with daily diet monitoring and overall result of desired or chosen dieting duration.

DISCUSSION

[0070] Derived equations for a personal overstressed level of heart beats allow proposing a new electronic device capable of:

- **[0071]** Estimating expected alarm conditions of dangerous activity by comparing heart rate at rest with the instantaneous one. For randomly selected individuals "static" analysis reveals trustworthy results.
- **[0072]** Automatically updating age information along with changing health conditions affecting heart rate at rest (see table below).
- **[0073]** Input new data regarding change of weight, medication taken, and blood pressure.
- **[0074]** Predict current and dangerous level of blood pressure.
- **[0075]** Monitor energy output (see table below) and compare it with the input (if known) resulting in weight loss or gain.
- **[0076]** Further modifications for wireless communications with authorized parties.

[0077] While illustrative embodiment of the invention has been shown and described, numerous variations and alternate embodiments, including eliminating one or more of the steps or elements presented herein, will occur to those skilled in the art. Such variations and alternate embodiments are contemplated and can be made without departing from the spirit and scope of the invention as mentioned in the appended claims.

Estimates of dangerous heart rate level and average daily energy output for randomly chosen individuals

	Individual										
	1	2	3		4		5		6	7	8
	w/o med.	w/o med.	w/o med.	with med	w/o med.	with med.	w/o med.	with med.	w/o med.	w/o med.	w/o med.
HRR, 1/min	60	70	(80)	71	(64)	80	(64)	75	60	65	65
SBPR, mm Hg	120	145	(150)	130	(160)	135	(150)	130	120	125	125
DBPR, mm Hg	80	80	(90)	75	(110)	85	(100)	80	70	85	80
Weight M, Kg	70	90	100		100		80		56	60	75
Height, H, m	1.75	1.74	1.80		1.90		1.68		1.64	1.70	1.74
AGE, years	25	60	65		70		55		60	30	35
Gender G	male	male	male		male		female		female	female	male
HRMA, 1/min	149	117	(122)	108	(97)	121	(88)	103	148	143	111
PHRI, %	—	—	52.50		51.56		37.5		—	—	—
High BP,	127	155	160	138	165	142	154	136	130	132	133
in mm Hg	85	86	96	80	113	89	103	84	76	90	85
Average heart rate HR = (HRR + HRMA)/2	104	94	(101)	90	(80)	101	(76)	89	104	104	104
PIMR, Kcal/min	1.21	1.96	(2.33)	1.98	2.29	1.85	(1.93)	1.60	0.77	0.99	1.38
Daily energy required Kcal	1,735	2,825	(3,355)	2,855	(3,298)	2,664	(2,775)	2,305	1,110	1,425	1,990

The invention claimed is:

1. A personal advanced electronic device computing user over stressed zone heart rate and blood pressure based on individual automatically processed input of age, weight, height, gender, systolic and diastolic blood pressure at rest, medical treatment, and accurately evaluated by wearing device over sleep time and individually processed heart rate at rest;

2. The personal advanced electronic device of claim **1** monitoring and displaying instantaneous heart rate, comparing it with the heart rate estimated for the user maximum activity, and generating warnings of approaching over stressed zone;

3. The personal advanced electronic device of claim **2** estimating and displaying upon request instantaneous blood pressure, saving the data, transmitting it to an authorized party, and generating the warnings of approaching over stressed zone;

4. The personal advanced electronic device of claim **3** computing, updating, and displaying upon request the value of user required daily energy consumption and estimating weight loss or gain upon amount of energy provided by food intake.

* * * * *

专利名称(译)	诊断和监视个人活动，状况和饮食的个人设备		
公开(公告)号	US20190357856A1	公开(公告)日	2019-11-28
申请号	US15/990574	申请日	2018-05-25
[标]申请(专利权)人(译)	GOLOUBEV MIKHAIL		
申请(专利权)人(译)	GOLOUBEV米哈伊尔·		
当前申请(专利权)人(译)	GOLOUBEV米哈伊尔·		
[标]发明人	GOLOUBEV MIKHAIL		
发明人	GOLOUBEV, MIKHAIL JACKSON, LETHIA PATTEN, JULISHA		
IPC分类号	A61B5/00 A61B5/0205 A61B5/11 G16H40/63		
CPC分类号	A61B5/0205 A61B5/7225 G16H40/63 A61B5/4866 A61B5/746 A61B5/02438 A61B5/1118 A61B5/7275 A61B5/7282 A61B5/021 A61B5/0002 A61B5/742 A61B5/024 G16H20/10 G16H50/30		
其他公开文献	US10646169		
外部链接	Espacenet USPTO		

摘要(译)

剧烈运动可能对健康有益，但不建议所有人都进行，必须在专业培训师/医生的监督下进行。这就需要进行初步的实验室测试，通常由于时间或经济原因而避免了这种测试。个性化的腕部电子设备可以避免上述并发症，特别是对于非运动员。 这种设备的设计原理是通过对批准的医学研究事实进行严格的数学分析而实现的，该医学研究事实将个人心率与个人血压和代谢率相关联，具体取决于个人的体重，身高，年龄，性别，医疗，血压以及心率在休息。 它允许对用户活动，健康状况和饮食进行动态诊断和监控的过程进行显着个性化和升级，将其整合到能够同时以多种模式运行的新技术先进的个人电子设备中，该设备既可以自动或手动更新个人输入，也可以提供有关身体或精神压力状况，处方药的效果以及节食进度的警告。 之前尚未提供这三个最重要的健康功能，以及将数据传输到授权方的建议选项，使得该设备是唯一的，对用户及其医生而言都是最理想的。