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(54) **METHOD FOR CONTROLLING A HVAC-APPARATUS, CONTROL UNIT AND USE OF A CONTROL UNIT**

(57) The invention relates to a method for controlling a heating- or cooling- and/or ventilation- and/or air-conditioning (HVAC)-apparatus, a corresponding control unit and possible uses of the control unit. The method for controlling the HVAC-apparatus is based on a control loop. The control loop starts off with calculating a quantity indicative of a thermal sensation of a user from at least one user-specific parameter and data from at least one sensor. Afterwards a deviation of this quantity from a value indicative of a target thermal sensation is computed. In the end the control loop outputs a control variable correlating with this deviation to the heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus. During this cycle the control loop utilizes at least a body fat ratio of a user as the at least one user-specific parameter and a room air temperature as data from the at least one sensor.

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Description

[0001] The invention relates to a method for controlling a heating- or cooling- and/or ventilation- and/or air-conditioning (HVAC)-apparatus, a corresponding control unit and possible uses of the control unit. The method for controlling the HVAC-apparatus is based on a control loop. The control loop starts off with calculating a quantity indicative of a thermal sensation of a user from at least one user-specific parameter and data from at least one sensor. Afterwards a deviation of this quantity from a value indicative of a target thermal sensation is computed. In the end the control loop outputs a control variable correlating with this deviation to the heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus. During this cycle the control loop utilizes at least a body fat ratio of a user as the at least one user-specific parameter and a room air temperature as data from the at least one sensor.

[0002] HVAC-systems are mounted in buildings and indoor spaces in order to create a thermally comfortable environment. Generally speaking, thermal comfort is defined as a condition of mind which expresses satisfaction with the thermal environment. However, this condition is difficult to reach since it is influenced by many parameters.

[0003] The mathematical formula according to which thermal comfort is determined in prior art is already quite elaborate and complex.

[0004] US 2015/0045981 A1 for instance describes a control system for an air conditioning apparatus in which thermal comfort is identified with a Predicted Mean Value (PMV) of 0. The PMV in this system is computed according to the formula in ISO 7730 which includes atmospheric temperature, mean radiant temperature, wind speed, relative humidity, clothing amount and metabolic amount. Among these parameters the metabolic amount is determined to be a measured quantity. Therefore a metabolic amount measurement device, such as a pedometer, is provided recording every step or movement of the user.

[0005] The drawback of this control system is that a constant monitoring of the user is required. Not every user, however, is willing to carry along a pedometer or another metabolic amount measurement device. Therefore the success of this control system depends on the compliance of the user.

[0006] Another approach to determine the thermal comfort of a user or occupant is known from US 2016/0363340 A1. This air conditioner control system operates with a metabolic amount which has been adjusted based on specific weight, height and age of a user. This may help some users to feel thermally more comfortable. However, if the user does not have a standard body shape and is rather muscular or fleshy, the adjusted metabolic amount is not appropriate and the HVAC-system causes under- or overheating/cooling. This does not only lead to a feeling of discomfort for the user. It also causes an increased energy consumption for the domestic technology in the cases of overheating and overcooling.

[0007] Considering these disadvantages it is the object of the current invention to provide an improved control unit and corresponding control method for a HVAC-system: On the one hand side the extent to which the user has to cooperate in this control method should be minimized. On the other hand side the control method should be able to regulate the indoor room temperature to a thermal comfort temperature of a user.

[0008] This object is achieved by the control unit according to claim 1, its use according to claim 15 and the method according to claim 8.

[0009] The inventive control unit for a heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus comprises a user interface via which at least one user-specific parameter can be entered and a generation unit which is configured to

- receive the at least one user-specific parameter and also data from at least one sensor,
- calculate a quantity indicative of a thermal sensation of a user based on the at least one user-specific parameter and the data from the at least one sensor,
- determine a deviation of this quantity from a value indicative of a target thermal sensation and
- output a control variable correlating with this deviation to the heating- or cooling- and/or ventilation- and/or air-conditioning- apparatus,

wherein the at least one user-specific parameter includes the body fat ratio of a user and wherein the at least one sensor includes a temperature sensor for room air.

[0010] The consideration of the body fat ratio of a user aims at making persons with a body shape that deviates from the average body shape feel thermally comfortable. The need for a special control unit arises from the fact, that two persons with the same body weight may have quite different thermal sensations and different comfort temperatures due to a different physique. A very athletic person with a low body fat ratio is likely to have a higher metabolic amount and will feel comfortable at lower room temperatures whereas an unathletic person with a high body fat ratio will feel more comfortable at higher room temperatures.

[0011] Since the body fat ratio of a person is a rather constant parameter it is sufficient if the user inputs it once during initialization of the HVAC-apparatus. An update may be necessary, but only if the body fat ratio of the user has changed by more than 0.5 %, preferably by more than 1.0 %.

[0012] The user interface preferably allows a user to input user-specific parameters in the form of number. In one embodiment, the user interface may be a touch user interface or a voice user interface. The touch user interface preferably includes a touch sensitive surface which can be mounted at a wall at eye level. The voice user interface preferably comprises a microphone.

[0013] The generation unit of the control unit can be a computational unit or a computer. The computational unit or the computer preferably comprises a timer, at least one input unit, at least one calculation unit and at least one output unit. In particular, the calculation unit is configured to calculate a quantity indicative of a thermal sensation of a user.

[0014] In a preferred embodiment the target thermal sensation is a neutral thermal sensation.

[0015] A neutral thermal sensation is reached in a situation in which the heat which is produced by the metabolism of the user is equal to the amount of heat lost from the body due to the temperature difference between the skin temperature and the temperature in the surrounding environment.

[0016] Preferably, the at least one user-specific parameter further includes a height, a weight, an activity level, an age, a clothing rate and/or a gender of a user.

[0017] By including height and weight in the calculation of a quantity indicative of a thermal sensation of a user it is possible to take into account if the user is slender or rather compact. The clothing rate can adopt different values depending on the textiles that a user is wearing and the insulation properties of these textiles. Usually the clothing rate strongly correlates with the outdoor temperature and the season. The activity level may be considered in order to distinguish between inside spaces in which persons are doing practical work and inside spaces in which persons sit rather motionless at a desk in front of a computer. The gender may also be a good indicator for the estimation of the thermal comfort temperature since women are said to have a more sensitive cooling feeling than men - they freeze faster and more violently, particularly at the extremities.

[0018] In a further preferred alternative of the control unit the at least one sensor further includes a sensor selected from the group consisting of a temperature sensor for ambient air, a sensor for measuring a temperature gradient, a temperature sensor for outdoor air, a sensor for relative humidity, a sensor for air velocity, a temperature sensor for radiant room temperature, a sensor for the status of a door or a window, a sensor for the number of users present in the room and combinations thereof, more preferably a thermocouple, a thermistor, a capacitive hygrometer, a resistive hygrometer, an infrared thermometer, a black-globe thermometer and/or a hot-wire anemometer.

[0019] Preferably, the sensor for measuring a temperature gradient is mounted indoor and is configured to measure a vertical temperature gradient (for example a gradient due to the rise of hot air) or a horizontal temperature gradient (due to airing or imperfect isolation in combination with the specific convection phenomena in the room).

[0020] The temperature sensor for room air, the sensor for relative humidity, the temperature sensor for radiant room temperature and the sensor for air velocity are preferably arranged inside a room. The temperature sensor for outdoor air is preferably located outdoor.

[0021] All data measured by the sensors may be transferred to the control unit. Therefore the at least one sensor may be coupled with the generation unit of the control unit via electric wires. Alternatively, the at least one sensor may also communicate with the generation unit wirelessly. A wireless communication is especially preferred for sensors that are mounted in outside spaces or at a great distance from the core generation unit of the control device.

[0022] Preferably the quantity indicative of the thermal sensation of a user is a Predicted Mean Vote (PMV) which is more preferably computed according to the following set of formulae (1)-(10):

$$\mathrm{PMV} = (0.303e^{-0.036M} + 0.028) \times L \ (1)$$

$$\begin{aligned}\mathrm{L} = \mathrm{M} &- 3.05 \times 10^{-3}(5733 - 6.99M - p_{\mathrm{a}}) - 0.42(M - 58.15) - 1.7 \\ &\times 10^{-5}M(5867 - p_{\mathrm{a}}) - 0.0014M(34 - t_{\mathrm{a}}) - 3.96 \\ &\times 10^{-8}f_{\mathrm{cl}} \times \{(t_{\mathrm{cl}} + 273)^4 - (t_{\mathrm{r}} + 273)^4\} \\ &- f_{\mathrm{cl}}h_{\mathrm{c}}(t_{\mathrm{cl}} - t_{\mathrm{a}}) \ (2)\end{aligned}$$

$$\begin{aligned}t_{\mathrm{cl}} = 35.7 &- 0.028M \\ &- I_{\mathrm{cl}}\{3.96 \times 10^{-8}f_{\mathrm{cl}} \times \{(t_{\mathrm{cl}} + 273)^4 - (t_{\mathrm{r}} + 273)^4\} \\ &+ f_{\mathrm{cl}}h_{\mathrm{c}}(t_{\mathrm{cl}} - t_{\mathrm{a}})\} \ (3)\end{aligned}$$

$$f_{\mathrm{cl}} = \begin{cases} 1.00 + 1.290 I_{\mathrm{cl}}\ for\ I_{\mathrm{cl}} \leq 0.078 m^2 K/W \\ 1.05 + 0.645 I_{\mathrm{cl}}\ for\ I_{\mathrm{cl}} > 0.078 m^2 K/W \end{cases} \quad (4)$$

$$h_{\mathrm{c}} = \begin{cases} 2.38 |t_{\mathrm{cl}} - t_{\mathrm{a}}|^{0.25}\ for\ 2.38 |t_{\mathrm{cl}} - t_{\mathrm{a}}|^{0.25} > 12.1\sqrt{v_{\mathrm{ar}}} \\ 12.1\sqrt{v_{\mathrm{ar}}}\ for\ 2.38 |t_{\mathrm{cl}} - t_{\mathrm{a}}|^{0.25} \leq 12.1\sqrt{v_{\mathrm{ar}}} \end{cases} \quad (5)$$

$$p_{\mathrm{a}} = 133.3 e^{18.6686 - \frac{4030.183}{235 + t_{\mathrm{a}}}} \times \frac{\mathrm{RH}}{100} \quad (6)$$

$$I_{\mathrm{cl}} = clo \cdot 0.155 \quad (7)$$

$$M = AL \cdot \frac{BMR}{58.2} \quad (8)$$

$$BMR = \frac{BM}{BSA} \quad (9)$$

$$BSA = W^a \cdot H^b \cdot c \quad (10)$$

wherein I_{cl} is a clothing insulation [m^{2}K/W], f_{cl} is a clothing surface area factor, *clo* is a clothing rate, t_a is an air temperature [°C], t_r is a mean radiant temperature [°C], v_{ar} is a relative air velocity [m/s], p_a is a water vapour partial pressure [Pa], h_c is a convective heat transfer coefficient [W/(m^{2}K)], t_{cl} is a clothing surface temperature [°C], *RH* is a relative humidity [%], *AL* is an activity level, *BSA* is a body surface area [m^2], *BM* is a basal metabolism [W/m^2], *W* is a weight [kg], *H* is a height [m], *a* is 0.425, *b* is 0.725 and *c* is 0.007184 and wherein the basal metabolism *BM* is preferably computed according to one of the following formulae (11) or (12):

$$BM = d \times (1 - BFR) \times W + i + (f \times A + g \times S + h) \times W \quad (11)$$

$$BM = d \times (1 - BFR) \times W + i \quad (12)$$

wherein *BFR* is a body fat ratio, *S* is 0.0 for men and 1.0 for women, *A* is an age of a user, *d* is 1.047, *i* is 17.93, *f* is -0.0682, *g* is -1.1 and *h* is 2.046.

[0023] The above mentioned set of formulae provides the most accurate computation of the thermal comfort temperature. It takes into account all environmental parameters that exert an influence on thermal sensation. Additionally, the computation can be personalized in two modes. In a standard mode the computation only requires a body fat ratio, a weight and a height of a user. In an advanced mode the computation requires a body fat ratio, an age, a gender, a weight and a height of a user.

[0024] Further information with respect to some of the parameters can be found in ISO 7730.

[0025] The activity level *AL* may be an average activity level and take values between 0.8 and 1.2. For residential buildings the average activity level may rather tend to lower values such as 0.8 whereas for office buildings the average activity level may be higher and have values up to 1.2.

[0026] If the quantity indicative of the thermal sensation of a user is a PMV according to formulae (1)-(12) the preferred target thermal sensation is a rather neutral *PMV* between -0.2 and 0.2, more preferably between -0.1 and 0.1, in particular a neutral *PMV* of 0.0.

[0027] It is advantageous if the control unit further comprises a memory unit, preferably a memory unit which is configured to store the at least one user-specific parameter, at least one preset value, a history of the control variables, a history of the data from the at least one sensor and/or average values of the data from the at least one sensor, wherein the at least one preset value is particularly selected from the group consisting of coefficients, e.g. coefficients for the calculation of a basal metabolic rate from the at least one user-specific parameter, a standard winter outdoor temperature, a standard winter clothing rate, a standard summer outdoor temperature, a standard summer clothing rate, an average activity level and combinations thereof.

[0028] It is further preferred if the generation unit comprises a control loop feedback unit, preferably a PID controller unit, more preferably a PID-controller unit with K_d corresponding to 0 (PI-controller), particularly a PI-controller with the constants K_p and K_i both being adapted to the characteristics of a room or building where the heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus is mounted.

[0029] The control variable (*out*(*t*)) which is output to the HVAC-apparatus is preferably calculated according to formula (13):

$$out(t) = K_p \cdot e(t) + K_i \int e(\tau)\, d\tau \quad (13)$$

with *e*(*t*) being the deviation of the calculated *PMV* at a discrete point of time from the setpoint of 0 and *d*τ being a small increment of time.

[0030] The control unit can be mounted in the same housing with the HVAC-apparatus. The user interface may be mounted at a place where users can easily input the user-specific data users.

[0031] In the method for controlling a heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus according to the invention a control loop is performed as long as the operation state of the apparatus is "ON" and the control loop comprises the following steps:

- calculation of a quantity indicative of a thermal sensation of a user based on at least one user-specific parameter and data from at least one sensor,
- determination of a deviation of this quantity from a value indicative of a target thermal sensation and
- output of a control variable correlating with this deviation to the heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus,

wherein the at least one user-specific parameter includes the body fat ratio of a user and wherein the data from at least one sensor include a room air temperature.

[0032] The quantity indicative of the thermal sensation of a user is preferably further based on preset values, more preferably preset values which are stored in a memory unit.

[0033] In a preferred embodiment of the invention the calculation of a quantity indicative of the thermal sensation of a user includes a calculation of a basal metabolism (*BM*), a body surface area (*BSA*) and a basal metabolic rate (*BMR*), these calculations being preferably dependent on the at least one user-specific parameter, wherein the at least one user-specific parameter more preferably further includes a weight, height, gender and/or age of a user.

[0034] In particular the quantity indicative of the thermal sensation of a user is a *PMV* computed according to formulae (1)-(12).

[0035] The control loop can further comprises a calculation of the clothing rate clo, preferably based on a linear regression between a standard winter clothing rate at a specified low temperature and a standard summer clothing rate at a specified high temperature, wherein the linear regression is in particular carried out based on a current outdoor temperature.

[0036] The user may determine the operation state of the apparatus. He may activate or inactivate the control method via the user interface. The user may in particular be able to switch the operation state between "ON" and "OFF".

[0037] Switching the operation state of the apparatus to "OFF" is worth considering when users leave the room for a longer period of time. In this case users need to define a target room air temperature so that the control unit controls the HVAC-system in order to keep this target room air temperature.

[0038] Additionally, the user interface may allow the user to enter the at least one user-specific parameter. In another variant of the invention the user can delete and/or reset the at least one user-specific parameter and/or values stored in a memory to factory settings via a user interface.

[0039] The control unit according to the invention is intended to be used for a heating- or cooling- and/or ventilation- and/or air-conditioning-apparatus in a room of a public place or an office building in order to adjust the room air temperature to a comfort temperature of a user which is present in the respective rooms.

[0040] The subject according to the invention should to be explained in more detail with reference to the subsequent figures without wishing to restrict said subject to the specific embodiments illustrated here.

Fig. 1 shows a linear regression for the clothing rate.

Fig. 2 is a flow chart illustrating the sequence of operations carried out in the control loop of the method according to the current invention.

[0041] The selection of a clothing rate value by linear regression can be illustrated by the graph shown in fig. 1. The clothing rate is calculated based on the measured outdoor temperature. If the outdoor temperature is lower than the standard winter outdoor temperature, the clothing rate is same as the standard winter clothing rate. If the outdoor temperature is higher than the standard summer outdoor temperature, the clothing rate is same as the standard summer clothing rate. However, if the outdoor temperature is higher than the standard winter outdoor temperature and is lower than the standard summer outdoor temperature, the clothing rate is calculated based on a linear regression between the standard summer clothing rate and the standard winter clothing rate. The standard winter outdoor temperature T_{winter} may be 0° C and the standard summer outdoor temperature T_{summer} may be 30° C. The standard winter clothing rate clo_{winter} may be 1.0 and the standard summer clothing rate clo_{summer} may be 0.6. However, these values may be changed depending on the climate in the region where the HVAC-apparatus is installed.

[0042] In the control loop which is depicted in fig. 2 the operation status of the HVAC apparatus is read at each time interval. If the operation status of the HVAC is "ON" the control loop continues with calculating the deviation of the current temperature from the thermally neutral temperature in a first step. Therefore it uses measured data and pre-set data. Based on the computed deviation a control variable is output to the HVAC apparatus in the next step order to adjust the room air temperature. Both steps are performed over and over again until the operation status of the HVAC-apparatus has changed to "OFF".

Claims

1. Control unit for a heating- or cooling and/or ventilation- and/or air-conditioning-apparatus, comprising an user interface via which at least one user-specific parameter can be entered and a generation unit which is configured to

   - receive the at least one user-specific parameter and also data from at least one sensor,
   - calculate a quantity indicative of a thermal sensation of a user based on the at least one user-specific parameter and the data from the at least one sensor,
   - determine a deviation of this quantity from a value indicative of a target thermal sensation and
   - output a control variable correlating with this deviation to the heating- or cooling and/or ventilation- and/or air-conditioning-apparatus,

   wherein the at least one user-specific parameter includes the body fat ratio of a user and wherein the at least one sensor includes a temperature sensor for room air.

2. Control unit according to the preceding claim wherein the target thermal sensation is a neutral thermal sensation.

3. Control unit according to one of the preceding claims wherein the at least one user-specific parameter further includes a height, a weight, an activity level, an age, a clothing rate and/or a gender of a user.

4. Control unit according to one of the preceding claims wherein the at least one sensor further includes a sensor selected from the group consisting of a temperature sensor for ambient air, a sensor for measuring a temperature gradient, a temperature sensor for outdoor air, a sensor for relative humidity, a sensor for air velocity, a temperature sensor for radiant room temperature, a sensor for the status of a door or a window, a sensor for the number of users present in the room and combinations thereof, preferably a thermocouple, a thermistor, a capacitive hygrometer, a resistive hygrometer, an infrared thermometer, a black-globe thermometer and/or a hot-wire anemometer.

5. Control unit according to the preceding claims wherein the quantity indicative of the thermal sensation of a user is a Predicted Mean Vote (PMV) which is preferably computed according to the following set of formulae (1)-(10):

$$\mathrm{PMV} = (0.303e^{-0.036M} + 0.028) \times L \ (1)$$

$$L = M - 3.05 \times 10^{-3}(5733 - 6.99M - p_a) - 0.42(M - 58.15) - 1.7 \times 10^{-5}M(5867 - p_a) - 0.0014M(34 - t_a) - 3.96 \times 10^{-8}f_{cl} \times \{(t_{cl} + 273)^4 - (t_r + 273)^4\} - f_{cl}h_c(t_{cl} - t_a)\ (2)$$

$$t_{cl} = 35.7 - 0.028M - I_{cl}\{3.96 \times 10^{-8}f_{cl} \times \{(t_{cl} + 273)^4 - (t_r + 273)^4\} + f_{cl}h_c(t_{cl} - t_a)\}\ (3)$$

$$f_{cl} = \begin{cases} 1.00 + 1.290I_{cl}\ for\ I_{cl} \leq 0.078m^2K/W \\ 1.05 + 0.645I_{cl}\ for\ I_{cl} > 0.078m^2K/W \end{cases}\ (4)$$

$$h_c = \begin{cases} 2.38|t_{cl} - t_a|^{0.25}\ for\ 2.38|t_{cl} - t_a|^{0.25} > 12.1\sqrt{v_{ar}} \\ 12.1\sqrt{v_{ar}}\ for\ 2.38|t_{cl} - t_a|^{0.25} \leq 12.1\sqrt{v_{ar}} \end{cases}\ (5)$$

$$p_a = 133.3e^{18.6686 - \frac{4030.183}{235 + t_a}} \times \frac{RH}{100}\ (6)$$

$$I_{cl} = clo \cdot 0.155\ (7)$$

$$M = AL \cdot \frac{BMR}{58.2}\ (8)$$

$$BMR = \frac{BM}{BSA}\ (9)$$

$$BSA = W^a \cdot H^b \cdot c\ (10)$$

wherein I_{cl} is a clothing insulation [m^{2}K/W], f_{cl} is a clothing surface area factor, *clo* is a clothing rate, t_a is an air temperature [°C], t_r is a mean radiant temperature [°C], v_{ar} is a relative air velocity [m/s], p_a is a water vapour partial pressure [Pa], h_c is a convective heat transfer coefficient [W/(m^{2}K)], t_{cl} is a clothing surface temperature [°C], *RH* is a relative humidity [%], *AL* is an activity level, *BSA* is a body surface area [m^2], *BM* is a basal metabolism [W/m^2], *W* is a weight [kg], *H* is a height [m], *a* is 0.425, *b* is 0.725 and *c* is 0.007184 and wherein the basal metabolism *BM* is preferably computed according to one of the following formulae (11) or (12):

$$BM = d \times (1 - BFR) \times W + i + (f \times A + g \times S + h) \times W\ (11)$$

$$BM = d \times (1 - BFR) \times W + i\ (12)$$

wherein *BFR* is a body fat ratio, *S* is 0.0 for men and 1.0 for women, *A* is an age of a user, *d* is 1.047, *i* is 17.93, *f* is -0.0682, *g* is -1.1 and *h* is 2.046.

6. Control unit according to one of the preceding claims further comprising a memory unit, preferably a memory unit which is configured to store the at least one user-specific parameter, at least one preset value, a history of the control variables, a history of the data from the at least one sensor and/or average values of the data from the at least one sensor, wherein the at least one preset value is particularly selected from the group consisting of coefficients, e.g. coefficients for the calculation of a basal metabolic rate from the at least one user-specific parameter, a standard winter outdoor temperature, a standard winter clothing rate, a standard summer outdoor temperature, a standard summer clothing rate, an average activity level and combinations thereof.

7. Control unit according to one of the preceding claims wherein the generation unit comprises a control loop feedback unit, preferably a PID controller unit, more preferably a PID-controller unit with a constant K_d corresponding to 0 (PI-controller), particularly a PI-controller with constants K_p and K_i both being adapted to the characteristics of a room or building where the heating- or cooling and/or ventilation-and/or air-conditioning-apparatus is mounted.

8. Method for controlling a heating- or cooling and/or ventilation- and/or air-conditioning-apparatus wherein a control loop is performed as long as the operation state of the apparatus is "ON" and the control loop comprises the following steps:

- calculation of a quantity indicative of a thermal sensation of a user based on at least one user-specific parameter and data from at least one sensor,
- determination of a deviation of this quantity from a value indicative of a target thermal sensation and
- output of a control variable correlating with this deviation to the heating- or cooling and/or ventilation- and/or air-conditioning-apparatus,

wherein the at least one user-specific parameter includes the body fat ratio of a user and wherein the data from at least one sensor include a room air temperature.

9. Method according to claim 8 wherein the calculation of a quantity indicative of the thermal sensation of a user is further based on preset values, preferably preset values which are stored in a memory unit.

10. Method according to one of the claims 8 to 9 wherein the calculation of a quantity indicative of the thermal sensation of a user includes a calculation of a basal metabolism (*BM*), a body surface area (*BSA*) and a basal metabolic rate (*BMR*), these calculations being preferably dependent on the at least one user-specific parameter, wherein the at least one user-specific parameter more preferably further includes a weight, height, gender and/or age of a user.

11. Method according to claims 8 to 10 wherein the quantity indicative of the thermal sensation of a user is a *PMV* computed according to formulae (1)-(12).

12. Method according to one of the claims 8 to 11 wherein the control loop further comprises a calculation of the clothing rate *clo*, preferably based on a linear regression between a standard winter clothing rate at a specified low temperature and a standard summer clothing rate at a specified high temperature, wherein the linear regression is in particular carried out based on a current outdoor temperature.

13. Method according to one of the claims 8 to 12 wherein a user can determine the operation state of the apparatus, preferably switch the operation state between "ON" and "OFF" via a user interface.

14. Method according to one of the claims 8 to 13 wherein a user can delete and/or reset the at least one user-specific parameter and/or values stored in a memory to factory settings via a user interface.

15. Use of a control unit according to one of the claims 1 to 7 for a heating- or cooling and/or ventilation- and/or air-conditioning-apparatus in a room of a public place or an office building in order to adjust the room air temperature to a comfort temperature of a user which is present in the respective rooms.

Figure 1

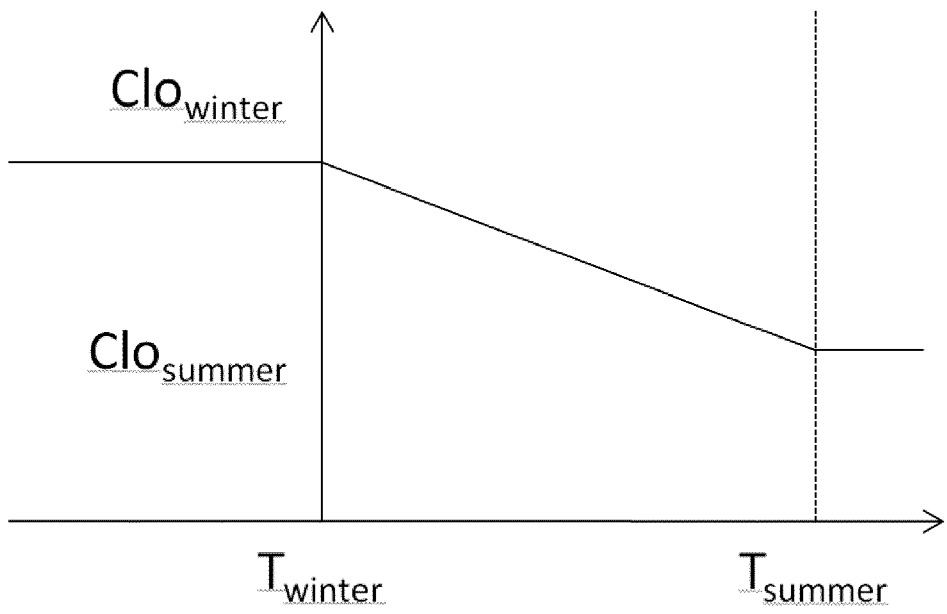
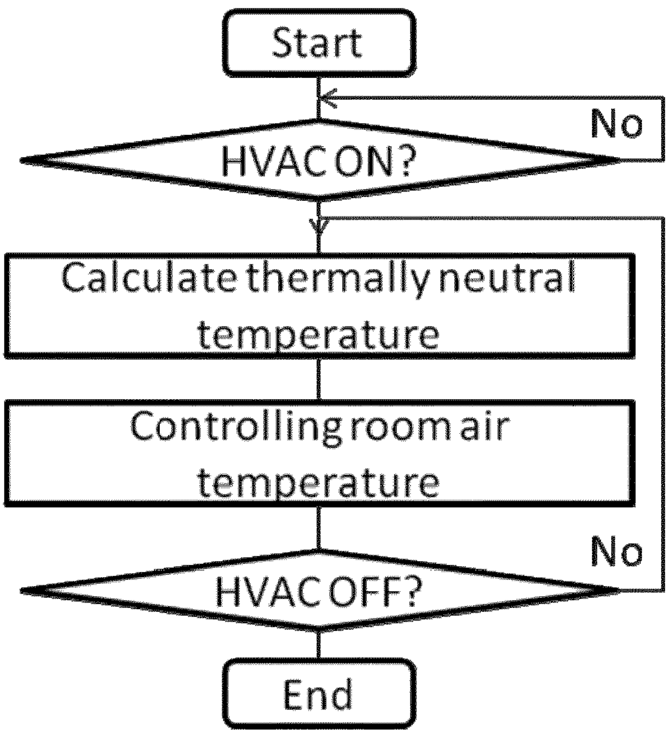


Figure 2


Start
No
HVAC ON?
Calculate thermally neutral temperature
Controlling room air temperature
No
HVAC OFF?
End

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 17 21 0238

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	JP 2011 226720 A (SHARP KK) 10 November 2011 (2011-11-10) * the whole document * -----	1-4, 6-10, 13-15 5,11 12	INV. F24F11/62 F24F120/00 F24F110/10
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