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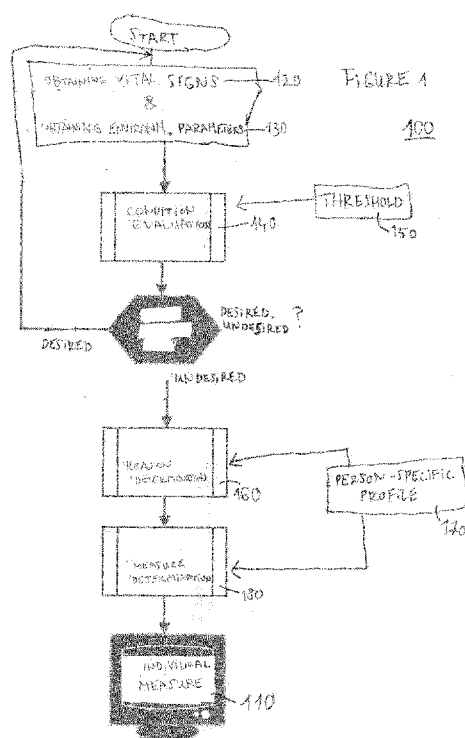
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(54) Title: METHOD, APPARATUS AND SYSTEM FOR PROVIDING A MEASURE TO RESOLVE AN UNCOMFORTABLE OR UNDESIRE PHYSIOLOGICAL CONDITION OF A PERSON



(57) Abstract: Embodiments of the present invention refer to a method for providing a measure to resolve an uncomfortable or undesired physiological condition of a person. The method comprises the step of obtaining a plurality of body/person related data for the person; followed by the step of obtaining a plurality of environmental parameters representing an environment of the person at the time of obtaining the body/person related data. The next step is evaluating the measured body/person related data with respect to one or more stored thresholds associated with respective ones of the body/person related data of the person so as to determine whether a condition of the person is an uncomfortable or undesired condition. In case the determined condition of the person is an uncomfortable or undesired condition, evaluating the body/person related data and the plurality of environmental parameters with respect to a stored person-specific profile, thereby determining a reason for the uncomfortable or undesired condition, and determining an individual measure for the person to resolve the uncomfortable or undesired condition using the person-specific profile.

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**METHOD, APPARATUS AND SYSTEM FOR PROVIDING A MEASURE TO RESOLVE
AN UNCOMFORTABLE OR UNDESIRE PHYSIOLOGICAL CONDITION OF A
PERSON**

5

Description

The present invention relates to the field of monitoring and affecting the health or a physiological condition of a person. Embodiments according to the present invention relate
10 a method for providing a measure to resolve an uncomfortable or undesired physiological condition of a person. Further embodiments according to the present invention relate to an apparatus for providing a measure to resolve an uncomfortable or undesired physiological condition of a person. Further embodiments according to the present invention relate to a system for monitoring a person, like a person suffering from dementia. Embodiments
15 according to the present invention relate to a method and an apparatus for describing a condition of a person, for analyzing the cause and for deriving measures for changing the condition of the person.

In conventional approaches nursing staff, caregivers, caring relatives, relatives, neighbors
20 or friends need to evaluate and/or recognize a condition or mental state of a patient as being incorrect, uncomfortable or undesired so as to act accordingly. Knowing the patients well over a long period of time is helpful for the nursing staff, caregivers, caring relatives, relatives, neighbors or friends. Part-time employment, shift changes and high workloads make the situation difficult. For example, in case of patients suffering from dementia, the
25 chosen behavioral and de-escalation measures to be implemented are on his/her own responsibility. Furthermore, there is already a shortage of staff today, which may have a much bigger impact in the future (nursing staff shortage). The main burden or a significant part of the responsibility rests on the shoulder of the nursing staff, caregivers, caring relatives, relatives, neighbors or friends. An adequate, sensitive patient care is both
30 mentally and physically exhausting and energy-sapping.

Patient care includes therapies to be applied which require a huge effort in terms of time, knowledge and resources. Additionally, due to lack of measurability, there are hardly any findings about their efficacy available or recorded. For example, the administration of
35 psychotropic drugs is difficult due to the prevalence of multimorbidity and polypharmacy, and is associated with side effects, which may negatively affect the degree of the condition,

for example, a course of a dementia or create new problems, such as dizziness, epilepsy, retardation. The administration of pharmaceuticals in order to reduce the occurrence of uncomfortable or undesired conditions and/or emotional states depends on a doctor, resulting in a time-delay, and may lead to side effects, or patient risks, and is, fundamentally,
5 ethically questionable.

Several computer programs, machines and robots are known in the art to support the nursing staff, caregivers, caring relatives, relatives, neighbors or friends, however, known systems have only a basic, usually very strict flowchart, and they are quite simple machines.
10 Respective functions and/or actions may be executed according to a time pattern, they are time-controlled, or under certain conditions, they are event-controlled. More complex systems with extensive control software, for example, state machines and/or operating systems and/or artificial intelligence, may make the program flow more sophisticated and behave accordingly, for example, responding to user inputs. However, the interaction is
15 limited to a classical human-machine interface, for example, keyboard, microphone, camera. Decisions in the flow of a program are based on the non-conditional and/or non-emotional contents.

Some of the systems use cameras to record a face of a person or a user and apply
20 algorithms to analyze his/her biometric features, such as gender or age, and basic facial expressions. However, these are only externally perceived verbal and non-verbal signals of the person or of the user, which are detected and evaluated in comparison with the correlating condition and/or emotional state, without identifying the upstream intrapersonal process, which created the condition and/or emotional state of the user.

25 Other solutions analyze the language, whereby rather the "how" or a tone than the "what" or a content is evaluated. The company audEERING offers, for example, software modules, which may determine the excitement, that means a two dimensional representation of an arousal and a valence, based on the voice and the speech of a person. For example, the
30 smartphone application StressSense offers a similar solution. Disadvantages of speech recognition software in general, that it does not recognize indirect speech acts, such as irony, sarcasm, cynicism, etc..

Other systems capture purely physiological characteristics, like ECG or skin conductance,
35 and derive corresponding conditions or emotional states based on the characteristic secondary parameters, like, for example, heart rate, heart rate variability. The evaluation is

usually based on conventional decision trees and/or empirical statistical databases. Within the context of stress analysis, for example, the heart rate variability is evaluated by comparing the current measurement data with typical characteristics of individuals with similar constellations, for example, sex, age, height, weight, habits. Commercial products
5 for capturing body-related data are found in the wearable- and/or consumer-electronics and/or gadget sector, like the so-called smart bands and/or smart watches. These are close-to-body sensors that record and evaluate data using optical and/or electro-physiological measurement techniques on the wrist. Medically validated products for the usage on patients are not available.

10

Several, further methods exist to measure a condition of a person. Some examples are listed below, depending on the localization or the goal of the measurement:

- subjective feeling of the person: questionnaires about self-perception
- peripheral physiology: a vegetative nervous system
- 15 • electrodermal reaction: skin conductivity (sympathetic nervous system), short term skin conductivity, galvanic skin reaction (GSR)
- cardiovascular reactions: heart rate and blood pressure (both a combination of sympathetic and parasympathetic nervous system), peripheral resistance, cardiac output, HRV (sympathetic nervous system, only possible with strong emotions)
- 20 • emotional fright: the strength of the fright reaction
- amplitude of blinking or muscle fiber contraction via electromyogram
- central physiology
- EEG, PET, MRT
- behavior
- 25 • voice: the pitch of the voice, the amplitude of the voice and the choice of words
- face detection: FACS, EMG, videotaping patients in order to detect subtle facial musculature to detect shifts in conditions or emotional states, blushing
- body posture and body tension
- endocrinology: cortisol-level, oxytocin-level, testosterone-level

30

The factors and processes underlying the respective conditions and/or emotional states are not recorded at all. Furthermore, people, their personalities and experiences, as well as their subjective evaluation of situations differ considerably. An empathetic action based on human-machine-interaction is currently not possible. Computer programs, machines and
35 robots act and/or react only to a very limited extent.

There is a need for an approach providing one or more measures, which are individually tailored to a person and suitable for a plurality of situations or environments, in order to
5 resolve an uncomfortable or undesired condition of the person.

This is solved by the subject-matter of the independent claims.

- 10 An embodiment of the present invention (see for example claim 1) provides a method for providing a measure to resolve an uncomfortable or undesired physiological condition of a person. The method comprises the following steps:
- (a) obtaining a plurality of body or person related data, for example, physiological parameters, speech, movement, place, etc., for the person,
 - 15 (b) obtaining a plurality of environmental parameters representing an environment of the person at the time of obtaining the body or person related data,
 - (c) evaluating the measured body or person related data with respect to one or more stored thresholds associated with respective ones of the body or person related data of the person so as to determine whether a condition of the person is an
20 uncomfortable or undesired condition,
 - (d) in case the determined condition of the person is an uncomfortable or undesired condition, evaluating the body or person related data and the plurality of environmental parameters with respect to a stored person-specific profile, thereby determining a reason for the uncomfortable or undesired condition, and
 - 25 (e) determining an individual measure for the person to resolve the uncomfortable or undesired condition using the person-specific profile.

The present invention provides a method or a device for providing or implementing a person-specific and a situation-appropriate measure, which may be implemented in, for
30 example, a digital assistance system.

In a first step, relevant parameters for describing the condition, such as body or person related data or environmental parameters, of a person are obtained. In a next step, the description of the condition of a person or the condition of the person is evaluated taking
35 into account the condition history of the person, recorded in a database, that means a comparison of a standard measurement data set with an individual parameter set. In a next

step, causes of the difference between the actual condition and the normal condition are analyzed on the basis of analyzing a system-history or a person-specific profile in the database. In a further step, appropriate and/or necessary system reactions and/or measures are derived and/or determined, based on a person-specific profile, in order to
5 restore the normal and/or desired condition.

At the application level, this means that embodiments of the present invention describe a device or a technical method for implementing an emotion-sensitive or an empathetic human-machine interface (EHMI) so that previous artificial intelligence (AI) or AI systems
10 may be enriched with artificial empathy (AE).

According to embodiments (see for example claim 2), the person-specific profile characterizes the person in terms of physical attributes, and in terms of environmental preferences, for example certain maximum or minimum thresholds for environmental
15 conditions.

In accordance with embodiments of the present invention the identified parameters are assigned a person-specific meaning or profile and a derivation of a situation-specific meaning or profile is determined in order to "feel" and/or measure the context. Person-specific and situation-relevant data may be measured by a multimodal sensor system, such as a close-to-body or a wearable sensor system and/or an environmental sensor system within the infrastructure. For example, in the field of physiology ECG signals, breathing, motion or activity and/or skin conductance may be measured, e.g., by wearable electronics on a textile carrier. By using a camera, for example, facial expressions and/or optical body
20 or person related data may be obtained. By using a microphone, a speech of a person may be recorded and analyzed, wherein the intonation may contain the main information. By using tracking and/or geofencing sensors, the retention of movements and/or physical activity may be measured. These sensors may be integrated in the infrastructure, for example, in a living room and/or in a television and/or in a corridor of a nursing home.

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In accordance with embodiments, a wearable, close-to-body signal processing unit may implement the following process steps. The measured signal is (1) processed, (2) digitalized and from the digitalized signal a (3) secondary value is derived. For example, an ECG signal is a base for a heart rate value, which is a base for the heart rate variability-parameter
35 (HRV).

The person-specific profile may be loaded with an initial data collection or assessment and may be continuously expanded or improved based on the secondary values and/or a feature vector created from the secondary values with the usage of a self-learning algorithm.

5 According to embodiments (see for example claim 3), the physical attributes comprise one or more of the following data:

- age,
- gender,
- one or more physiological parameters, like blood pressure, respiratory rate, heart rate,
- 10 • facial expression of the person,
- speech of the person, like intonation, and

the environmental preferences comprise one or more of the following:

- certain maximum or minimum thresholds for environmental conditions, like temperature, noise level, brightness, smell, sounds.

15

In accordance with embodiments, the person-specific profile may be loaded with an initial data collection or assessment and may be continuously expanded or improved based on physical attributes and/or environmental preferences with the usage of a self-learning algorithm, making the present invention self-learning and continuously improving.

20

According to embodiments (see for example claim 4), the person-specific profile represents the person as a digital twin that was created within a person specific assessment and further characterizes the person in terms of

- activities of the person, for example reading newspaper, solving crosswords, listening to the radio, walking around, playing cards, singing songs,
- 25 • infrastructure of the environment where the person is located, for example the person's home, a seniors living group, a retirement center, a hospital, nature, assistance for orientation, assistance for localization, walking aid, scooter,
- a movement pattern of the person, such as specific ways at home, e.g., from bed to bath, from living room to kitchen, walking stairs, going outside, shopping in stores,
- 30 • visiting the church or a cemetery,

35

The person-specific properties or parameters may be classified by activities or physical activities of the person, by the infrastructure of the environment of the person and/or by the movement patterns of the person. These parameters are measured in order to determine a condition or an emotional state of a person and may be used for continuously expanding or

improving the person-specific profile. In order to determine a condition or an emotional state of a person, many different parameters of different modalities may be obtained. These may be current parameters such as physiological signals, language or speech, facial expressions, movement, behavior or ambient conditions as well as individual long-term
5 parameters such as education, job, family, personal experiences, diseases, etc. .

According to further embodiments (see for example claim 5), the person-specific profile characterizes the person using the following attributes:

- 10 • policy, wherein the policy describes a combination of the person's specific characteristics and attitudes that determine the person's behavior, e.g. "basic structure" and its scaling from "low" to "high". For example, people with a high basic structure may have higher expectations to the environment they live in or to services they are offered, while people with a lower basic structure may have lower expectations to their environment or the offered services. People with a lower basic
15 structure tend to trust other persons and will more often subordinate, while people with a higher basic structure are encouraged, take responsibilities and take decisions.
- energy, wherein the energy describes physical, motoric and cognitive capabilities a person may apply in different stages of quality and relating to the execution of
20 "activities". When considering, for example, a person used to do longer walks, due to increasing physical restrictions, e.g. aching knee, cardiac insufficiency and the like, the person may not be able to walk that much, which will cause an "uncomfortable or undesired" situation, like disaffection, stress, anger.
- target, wherein the target describes an initial impulse for starting an "activity". Targets may be motivated explicitly or induced implicitly, also as kind of "desire". For example.
25 the desire "I am thirsty" initiates the movement towards a beverage. The target "I would like to call my daughter" starts a process including several concatenated single activities, like looking for the phone, remembering the phone number, pressing buttons, speaking, etc., and
- activity, wherein the activity describes and task or dedicated behavior of a person
30 caused by inner conditions such as "target" or "desire". In contrast to targets and desires, activities normally are perceptible and may be from the outside.

According to embodiments (see for example claim 6), responsive to identifying an actual condition of the person to be an uncomfortable or undesired situation using the current
35 body/person related data and the current environmental parameters for the person, the

cause for the uncomfortable or undesired situation is deducted by analyzing the attributes policy, energy, target and activity.

According to embodiments (see for example claim 7),

- 5 • analyzing the policy comprises determining whether the current situation complies with the policy of the person's basic attitude,
- analyzing the energy comprises determining whether it is possible to realize the current target and performed activity with the given/available energy or has the status of energy, like physical, mental, cognitive degenerative changes, recently decreased,
- 10 • analyzing the target comprises determining whether the current target contributes to the persons policy or whether the target/desire may be realized/achieved with the given/changed energy conditions, like physical, mental, cognitive capabilities,
- analyzing the activity comprises determining whether the current activity contributes to the persons targets/desires or whether the activity may be performed with the
15 given/changed energy conditions, like physical, mental, cognitive capabilities, or whether the activity is an intrinsic wish of the person or an extrinsic objective given by a third person.

Thus, according to embodiments, an actual condition of the person and especially an
20 uncomfortable situation has been identified by the current body/person related data / vital signs and the current environmental parameters for the person, and the cause for the uncomfortable situation may be deducted by analyzing the attributes policy, energy, target and activity (as the uncomfortable situation is correlated often with a mismatch of the current attribute properties in comparison to the persons standard profile for these attributes):

- 25 • policy: does the current situation comply with the policy of the person's basic attitude, for example the person is asked to present something to others while normally the person is rather more shy, this causes an uncomfortable situation,
- energy: may the current target and performed activity be realized with the given/available energy or has the status of energy (physical, mental, cognitive
30 degenerative changes) recently decreased, for example earlier the person used to do shopping on his/her own by walking to the shops. If the capability of the eyes or the legs has decreased, the shopping and walking, respectively, may not be performed independently any longer and causes an uncomfortable situation,
- target: does the current target contribute to the persons policy or may the target/desire
35 be realized/achieved with the given/changed energy conditions (physical, mental, cognitive capabilities)? Example: if a person wants to be independent and do

shopping on her own but this is not possible due to physical restrictions, a delivery service might solve the problem to get food, but it shows to the person she requires an external service and she is no longer independent and this causes an uncomfortable situation,

- 5 • activity: does the current activity contribute to the persons targets/desires or may the activity be performed with the given/changed energy conditions (physical, mental, cognitive capabilities), is the activity an intrinsic wish of the person or an extrinsic objective given by a third person? Example: if a person that normally sleeps longer is forced to get up earlier, this causes an uncomfortable situation.

10 These four attributes: policy, energy, target, and activity may be concretized by objective measurement data and may be used as an actual condition. Policy, energy, target, and activity are attributes used in the psychology and/or coaching, such as the HyperSkill-Method. The attributes policy, energy, target and activity serve to characterize a person. In the context of the above mentioned assessment, corresponding profiles are created for
15 each patient or person which are, for example, characterized by these attributes. Using these attributes may result in a simplified representation of the condition of the person.

According to further embodiments (see for example claim 8), wherein the person-specific profile is updated at certain intervals, e.g., periodically, and/or responsive to certain events,
20 e.g., if a specific "activity" up to that point was performed with a satisfying mind but now turns out to be unsatisfying, the "energy" related to that activity, e.g., physical fitness, capability and performance to walk, capability and performance to read, is analyzed and, if necessary, updated or even removed. For example, a patient likes to be informed about the current political situation and regularly watches the news. One day the patient gets very
25 upset during the news and keeps this behavior in the following days. He still enjoys television programs about animals and music. It is judged that the patient is no longer able to follow the speed of the news and the activity "watching the news" is dismantled and an alternative activity, like "reading the daily newspaper", is offered.

30 Updates of the person-specific profile may be performed at certain intervals, they may be paced periodically and/or in response to a certain event. For example, the occurrence of an uncomfortable or undesired condition of the person may result in a profile-update. Furthermore, the reason of the uncomfortable or undesired condition, determined by a root-cause-analysis, may result in an update. Moreover, the individual measures and/or their
35 efficacy may be used in an update of the person-specific profile of the given person.

The identified measures may be implemented in different ways. For example, caregivers and/or outpatients and/or nurses may be suggested to not talk about a specific topic, and/or discontinue a certain activity and/or for example, change a specific external variable, such as light, temperature, music. Another example may be, in the context of the home environment, such as smart home, ambient assisted living, that certain reactions, or measures, may also be implemented automatically, such as, for example, lighting control, ventilation, heating, music, etc. The reaction to these individual measure may also be logged and used in an update of the person-specific profile of the given person.

10 According to embodiments (see for example claim 9), step (e) comprises selecting the individual measure for the person from a plurality of available measures using the person-specific profile.

The determined measures may be implemented in different forms. For example, a simple measure is displaying the condition of the person to the nurse and/or to the relatives of the person. The condition of the person may be displayed as a traffic light, wherein the green sign is representing the OK-condition, the yellow sign represents a warning, and the red sign represents an acute condition. In accordance with embodiments nurses and/or relatives may be warned about particular procedures, like responses, or touching or about certain keywords or topics of conversation or about certain activities, which may result in an uncomfortable or undesired physiological condition of the person. In accordance with further embodiments, the nurse and/or the relatives of the person may be suggested not to speak about certain topics, discontinue a certain activity and/or change a specific external variable, like, for example, light, temperature, volume of music.

25 In accordance with yet further embodiments, in the context of the home environment, like a smart home, or an ambient assisted living (AAL) environment, certain measures may also be implemented automatically, such as, for example, lighting control, ventilation, heating, or music.

30 Furthermore, embodiments of the described system may be a submodule of a caregiver robot, which has artificial empathy (AE), which means it may recognize, for example, a specific condition, analyze the cause of it, and derive an appropriate individual measure.

35 In accordance with embodiments, the defined condition and/or measure may also be used as telemetric information, such that the relatives receive a message on, for example, their

mobile devices, such as a smartphone or a smartwatch. The message, for example, may state that everything is OK, thus calming down the relatives, or they may be informed about the fact that a certain action and/or a visit is necessary.

- 5 The selection of the person-specific measure from a plurality of available measures may be based on a person-specific profile, which may be updated at certain intervals.

According to further embodiments (see for example claim 10), the method further comprises the step, outputting the determined individual measure for the person, and wherein
10 outputting the determined individual measure for the person comprises one or more of the following:

- presenting the individual measure to the person or to a third person, like nursing staff, caregivers, caring relatives, relatives, neighbors or friends, so as to allow the person or the third person to apply the measure, and/or
- 15 • outputting a control signal causing a nursing robot to apply the measure, and/or
- outputting a control signal causing an actuator to effect a change in the environmental condition.

According to embodiments (see for example claim 11), the method further comprises the
20 following steps:

- determining a current condition of the person, and
- transmitting a current condition of the person to a third person, like a nursing staff, caregivers, caring relatives, relatives, neighbors or friends,
- wherein, in case of an uncomfortable or undesired condition, transmitting the current
25 condition includes transmitting a description of the uncomfortable or undesired condition and individual measure to be applied.

After the determination of the current condition of the person, the nursing staff, caregivers, caring relatives, relatives, neighbors, friends and/or any third person may be informed about
30 the current condition of the person. For example, the defined condition and/or measure may also be used in telemetric information, such that, for example, the relatives receive a message on, for example, their mobile devices, such as a smartphone or a smartwatch. The information, which is transmitted to a third person, like nursing staff, caregivers, caring relatives, relatives, neighbors or friends, may include, for example, the current condition
35 and/or a description of the uncomfortable or undesired condition and/or an individual, person-specific measure to be applied. The message, for example, may state that

everything is OK, thus calming down the relatives, or they may be informed about the fact, for example, that a certain action and/or a visit is necessary. Informing a third person, and/or a an AAL-actuator and/or a nursing robot about the condition of a person and/or about the measures recommended may reduce the time, the given person being in an uncomfortable or undesired condition.

According to embodiments (see for example claim 12),

- step (c) comprises updating the person-specific profile with the occurrence of the uncomfortable or undesired condition of the person, e.g., in an incident log,
- 10 • step (d) comprises updating the person-specific profile with the reason for the uncomfortable or undesired condition with the occurrence of the uncomfortable or undesired condition, e.g., in the incident log, and
- step (e) comprises updating the person-specific profile with the individual measure with the occurrence of the uncomfortable or undesired condition, e.g., in the incident log.

Updates of the person-specific profile may be executed at certain intervals, for example periodically or event-based. The person-specific profile may be updated by the occurrence of an uncomfortable or undesired condition of the person, in the step of the evaluation of the measured body or person related data. Furthermore, in accordance with embodiments, the possible reasons of an uncomfortable or undesired condition may be updated after a root-cause-analysis, in case the determined condition of the person is an uncomfortable or undesired condition. Moreover, the possible individual measures and/or their efficacy may be updated after the determination and/or application of a person-specific measure for the given person in order to resolve a next uncomfortable or undesired condition faster and/or more effectively.

According to embodiments (see for example claim 13), the one or more thresholds associated with respective ones of the body or person related data of the person and the person-specific profile are stored in one or more databases.

Physical attributes and/or environmental preferences and/or other data of the person-specific profile, such as occurrences of the uncomfortable or undesired condition and/or reasons for the uncomfortable or undesired condition and/or individual measures are stored in one or more databases and/or in one or more data tables. Such a database may be a patient event log database and/or a patient incident log database and/or a patient identity

database and/or a patient activity database. Saving data in multiple databases is a safe way of storing data, resulting in losing just a portion of the data in case of technical problems.

According to embodiments (see for example claim 14), the method further comprises the following steps after applying the individual measure:

- obtaining a plurality of body or person related data for the person,
- evaluating the measured body or person related data with respect to the one or more stored thresholds associated with respective ones of the body or person related data of the person so as to determine whether the uncomfortable or undesired condition of the person is resolved by applying the individual measure,
- in case the uncomfortable or undesired condition of the person is not resolved, updating the person-specific profile with information indicating that the individual measure does not resolve the determined uncomfortable or undesired condition, and repeating steps (d) and (e) so as to determine another individual measure to be applied, and
- in case the uncomfortable or undesired condition of the person is resolved, updating the person-specific profile with information indicating that the individual measure resolves the determined uncomfortable or undesired condition.

After applying the individual measures, the condition of the person may be evaluated in order to verify the improvement of the condition of the person. Body or person related data of the person are obtained and evaluated with respect to the one or more stored (person-specific) thresholds in order to decide whether the applied person-specific measure resolved the uncomfortable or undesired condition or not. Results of this condition evaluation may be logged in the person-specific profile. In case of a resolved condition, a positive report is recorded and in case of uncomfortable or undesired condition, a negative report is recorded in the person-specific profile. In case the uncomfortable or undesired condition of the person is not resolved, the root-cause-analysis may be repeated and a new person-specific measure may be provided, based on the result of the root-cause-analysis, thus making the process a self-learning process and improving the probability of determining the most beneficial measure at next time.

According to embodiments (see for example claim 15), the step of obtaining the plurality of body or person related data of the person and/or the step of obtaining the plurality of environmental parameters comprises measuring the body or person related data and/or the environmental parameters, and/or receiving data representing the body or person related

data and the environmental parameters, e.g., from respective measurement devices or sensors.

5 Person-specific and/or situation-relevant data may be measured by a multimodal sensor system, such as a close-to-body or a wearable sensor system and/or an environmental sensor system within the infrastructure. The multimodal sensor system may be part of the present invention. The present invention may obtain body or person related data and/or the environmental parameters, for example, by being connected to a measuring device and obtaining the measured data electronically, or for example, the data is typed into a database
10 of the present invention. The present invention is open for a plurality of data-input ways, in order obtain more input data about the given person.

According to embodiments (see for example claim 16), the person suffers from dementia, and the individual measure comprises one or more of the following:

- 15
- avoiding specific topics when talking to the person,
 - performing/avoiding a specific action,
 - changing a certain environmental condition

In the course of the disease, a person suffering from dementia loses more and more of
20 his/her motoric and cognitive abilities as well as parts of his personality. Due to his/her reduced abilities and limitations of his/her perception, the patient may no longer handle everyday situations independently, such as for example, cooking and/or repairing electrical appliances and/or finding out the intentions of a conversation partner. The patient is increasingly irritated and/or dissatisfied by the fact that his/her previous abilities are reduced
25 and/or he/she is not in control in certain everyday situations. If, additionally, the patient is not able to articulate and/or communicate his/her condition and/or emotional state, due to speech restrictions or due to no suitable opportunities, the responsible caregiver finds the patient in a negatively biased and/or pre-stress condition, that is usually unforeseen by the caregiver.

30

Speaking to the patient as usual, as under normal and/or relaxed conditions, certain topics of the conversation, keywords or even actions may escalate the already tense situation. The condition and/or emotional state of the patient degenerates even more and any effort to de-escalate the situation becomes more time consuming, nerve-racking and cost-
35 intensive.

Until now, recognizing which measure is the right one for which patient was a problem, that has been overcome on the basis of the empathy, knowledge, and experience of the caregivers. Moreover, for example, in nursing homes, it is even more complicated as a nurse and/or a caregiver usually has to look after a large number of patients, and may not know them well. A supportive technical device, such as the present invention, may inform him/her in advance about avoiding specific topics when talking the person and/or avoiding and/or performing a specific action, like stirring dough and/or replacing batteries in a flashlight, or even a very different patient-specific measure, like changing a certain environmental condition.

The present invention provides (see for example claim 17) a computer program product comprising instructions which, when the program is executed by a computer, causes the computer to carry out one or more methods in accordance with the present invention.

Further embodiments according to the present invention create respective apparatuses and/or create respective systems comprising the respective apparatuses. However, it is noted that the apparatuses and the systems are based on the same considerations as the corresponding methods. Moreover, the apparatuses and the systems may be supplemented by any of the features, functionalities and details which are described herein with respect to the methods, both individually and taken in combination.

The present invention provides (see for example claim 18) an apparatus for providing a measure to resolve an uncomfortable or undesired physiological condition of a person, the apparatus comprising:

a first interface for receiving a plurality of body or person related data for the person, a second interface for obtaining a plurality of environmental parameters representing an environment of the person at the time of obtaining the body or person related data, a processor configured to

evaluate the measured body or person related data with respect to one or more stored thresholds associated with respective ones of the body or person related data of the person so as to determine whether a condition of the person is an uncomfortable or undesired condition,

in case the determined condition of the person is an uncomfortable or undesired condition, evaluate the body or person related data and the plurality of environmental parameters with respect to a stored person-specific profile, thereby determining a reason for the uncomfortable or undesired condition, and

determine an individual measure for the person to resolve the uncomfortable or undesired condition using the person-specific profile, and a third interface for providing the individual measure for the person.

- 5 The present invention provides (see for example claim 19) a system for monitoring a person, like a person suffering from dementia, the system comprising:
- the inventive apparatus,
 - one or more first sensors coupled the first interface, the first sensors configured to measure the body or person related data for the person,
 - 10 one or more second sensors coupled the second interface, the first sensors configured to measure the environmental parameters, and
 - an output device coupled to the third interface.

According to embodiments (see for example claim 20),

- 15
- the apparatus is configured to determine a current condition of the person, and
 - the output device is configured to transmit the current condition of the person to a third person, like nursing staff, caregivers, caring relatives, relatives, neighbors or friends, wherein, in case of an uncomfortable or undesired condition, a description of the uncomfortable or undesired condition and the individual measure to be applied is
 - 20 transmitted.

According to embodiments (see for example claim 21), the output device is configured to present the individual measure to the person or to a third person, like nursing staff, caregivers, caring relatives, relatives, neighbors or friends, so as to allow the person or the

25 third person to apply the measure.

According to embodiments (see for example claim 22), the system comprises a nursing robot, wherein the output device is configured to output a control signal to the nursing robot causing the nursing robot to apply the measure.

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According to embodiments (see for example claim 23), the system comprises one or more actuators coupled to one or more devices and allowing for a control of the device for changing one or more environmental conditions, wherein the output device is configured to output a control signal causing an actuator to drive a device to effect a change in the

35 environmental condition.

Embodiments of the present invention are now described in further detail with reference to the accompanying drawings:

5 Fig. 1 shows a schematic flowchart of an embodiment of the core-process of the present invention;

Fig. 2 shows a schematic flowchart explaining an embodiment of the "condition evaluation" sub-process of Fig. 1;

10

Fig. 3 shows a schematic flowchart explaining an embodiment of the "reason determination" sub-process of Fig. 1;

15

Fig. 4 shows a schematic flowchart explaining an embodiment of the "measure determination" sub-process of Fig. 1;

Fig. 5 shows a schematic flowchart of an embodiment of the present invention extending the core-process of Fig. 1;

20 Fig. 6 shows a schematic flowchart explaining an embodiment of the "lessons learnt" sub-process of Fig. 5;

Fig. 7 shows a schematic representation of an embodiment of the present invention applied for a use-case "person suffering from dementia";

25

Fig. 8 shows an example of a computer system on which units or modules as well as the steps of the methods described in accordance with the inventive approach may execute.

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In the following, different inventive embodiments and aspects are described. Also, further embodiments are defined by the enclosed claims.

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It is noted that any embodiments as defined by the claims may be supplemented by any of the details, features and functionalities described herein. Also, the embodiments described herein may be used individually, and may also optionally be supplemented by any of the

details, features and functionalities, included in the claims. Also, it is noted that the individual aspects described herein may be used individually or in combination. Thus, details may be added to each of said individual aspects without adding details to another one of said aspects. Moreover, features and functionalities disclosed herein relating to a method may also be used in an apparatus or in a system, configured to perform such functionality. Furthermore, any features and functionalities disclosed herein with respect to an apparatus may also be used in a corresponding method. In other words, the method disclosed herein may be supplemented by any of the features and functionalities described with respect to the apparatuses.

The present invention is understood more fully from the detail description given below, and from the accompanying drawings of embodiments of the present invention, which, however, are not be taken to limit the present invention to the specific embodiments described, but are for explanation and understanding only.

Fig. 1 shows an embodiment of a flowchart of a core-process 100 according to the present invention for providing an individual measure 110 to resolve an uncomfortable or undesired physiological condition of a person, which may also be referred to as an undesired physiological condition of a person. In a first step of the core-process 100, a plurality of body or person related data of the person are obtained 120 and a plurality of environmental parameters are obtained 130, e.g., in parallel. In a next step, a condition of the person is evaluated 140. The body or person related data may include one or more of the following: physiological parameters, speech, movement, place, vital signs etc. The measured body or person related data are evaluated with respect to one or more stored thresholds 150, which are associated with the respective body or person related data of the person. The condition evaluation step 140 determines whether a condition of the person is a desired condition or an uncomfortable or undesired condition.

In case the determined condition is a desired one, the steps before, such as obtaining body or person related data 120, obtaining environmental parameters 130, and the condition evaluation 140, may be repeated, for example, at a later time, periodically or at certain intervals.

In case the determined condition of the person is an uncomfortable or undesired condition, the next step of core-process 100 is the reason determination step 160, where a reason for the uncomfortable or undesired condition is determined. In the reason determination step

160, the plurality body or person related data and the plurality of environmental parameters are evaluated with respect to a stored person-specific profile 170, in order to determine a reason for the uncomfortable or undesired condition. The person-specific profile may represent the person as a digital twin. The digital twin of the person may be created within
5 a person specific assessment and may further characterize the person in terms of activities of the person, infrastructure of the environment where the person is located, and a movement pattern of the person. Thus, the person-specific profile may also be referred to as the person's or patient's digital twin. In a next step, a measure is determined 180 for the person in order to resolve the uncomfortable or undesired condition, using the person
10 specific profile 170, and the result of the measure determination step 180 is provided as the individual measure 110, e.g., by outputting a signal, information or the like.

For example, in accordance with embodiments, the condition of the person may be described using a feature vector created after obtaining the body or person related data 120
15 and the environmental parameters 130. In the condition evaluation step 140, the condition of the person is evaluated, namely whether he/she is in a normal or desired condition or not. The normal/desired condition is described in a person-specific way, e.g., in form of a database or a threshold-database 150. The database 150 is loaded with an initial data collection or assessment and may be adapted continuously through a self-learning
20 algorithm. The differences between the normal/desired condition and the feature vector of a person are defined using an analysis method, which may abstract the feature vector. Abstracting the feature vector, also referred to as input feature vector, may simplify the evaluation and/or the determination of measures. The next step, the reason determination or a root-cause-analysis step 160, searches for the reason that the person is not in a
25 normal/desired condition. In the next step, the measure determination step 180, appropriate reactions and/or recommendations and/or measures are determined so as to provide an individual measure 110 for restoring the normal/desired condition.

Embodiments of the main function blocks or steps/sub-processes of the core-process 100
30 are now described with reference to a person or patient being agitated. For example, a feature vector for the condition evaluation step 140 may indicate the person being agitated when including one or more of the following body or person related data an environmental parameters:

- an increased heart rate,
- 35 • a low heart rate variability,
- an intensive breathing,

- an open window,
- a high noise level in room.

Comparing the body or person related data in the feature vector with a databank or a
5 threshold-databank 150 holding values for the heart rate, the heart rate variability, the
breathing or respiratory rate representing a normal condition, which may be loaded with an
initial data collection or assessment, results in a conclusion that the patient or person is
agitated, meaning, for example, the person or patient gets annoyed easily and is huffing
and puffing. In the reason determination step 160 the person-specific profile 170 or a
10 databank and assessment is examined using again the body or person related data and
now, in addition the environmental condition. According to the person-specific profile it is
judged that the patient likes it calm and the open window and the noise outside is judged to
be the reason that annoys him/her. The individual measure 110, determined by the
measured determination step 180, is to close the window. In accordance with embodiments,
15 the implementation of the individual measure 110 may be automated, e.g., by an advanced
assisted living (AAL) actuator.

Fig. 2 shows an embodiment of the sub-process or step "condition evaluation" 140 of the
core-process 100 in Fig. 1. The sub-process 200 compares 210 the body or person related
20 data 220, obtained in the obtaining body or person related data step 120 in Fig. 1, with
person-specific thresholds from the threshold database 230, which is an example of the
threshold database 150 in Fig. 1. The obtained body or person related data 220 may
comprise measured data 240, such as heart rate, blood pressure, respiratory rate, etc. The
threshold database 230 may be updated or improved by a self-learning algorithm, e.g., on
25 the basis of a patient event log database 250 storing certain events that the person may be
subjected to. The result of the comparison 210 of the body or person related data 220 and
the thresholds of the threshold database 230 may be recorded or logged 260 in the patient
incident log database 270, which may be used by the self-learning algorithm in order to
update other databases. Furthermore, the result of the comparison 210 may be displayed
30 280 to a third person, such as a nurse or a caregiver. In a next step, the sub-process 200
returns 290 the result of the comparison 210 to the core-process 100 in Fig. 1.

If the condition of the person is an uncomfortable or undesired condition, according to the
condition evaluation sub-process 140 of the core-process 100 in Fig. 1 then a process
35 including a root-cause-analysis 300 as shown in Fig. 3 may be applied. Fig. 3 shows a
detailed flowchart of an embodiment of the root-cause-analysis 300 used in the step or sub-

process "reason determination" 160 in Fig. 1. Based on the obtained body or person related data 310, obtained by the step 120 in Fig. 1, and the obtained external or environmental parameters 320, obtained by the step 130 in Fig. 1, a feature vector is calculated and compared 330 with data from a plurality of databases 340. The plurality of existing
5 databases 340 may comprise a patient event log database 343, a patient identity database 346, a patient activity database 349 and a patient incident log database 395. The body or person related data may comprise measured vital data 350 such as blood pressure, heart rate, respiratory rate, etc. The environmental parameters 320 may comprise measured environmental data 360 such as noise level, temperature, brightness, activity, etc. The
10 result of the calculation and comparison 330 of the feature vector with data from the plurality of databases 340 may be displayed 370 to a third person, such as a nurse or a caregiver. In a next step, one result of the results of the calculation and comparison 330 is selected 380. Optionally, the selected result may be revised or confirmed manually 385 by a third person, such as a nurse, caregiver, etc. The reason selected in the step 380 may be
15 recorded or logged 390 in the plurality of databases 340, especially in the patient incident log database 395. The reason selected in 380 is returned 398 to the core-process 100 as the result of the reason determination step 160 in Fig. 1.

In accordance with embodiments, the evaluation or evaluation system applied in the reason
20 determination step 160 may be considered as an algorithm for data analysis digital that uses four attributes: policy, energy, target and activity in order to characterize a person (e.g. according the Hyper-Skill-Method). These attributes may be further concretized based on measurement data used for determining the actual condition. Conventionally, an evaluation of the situation so as to determine the reason that lead to the situation may be human-
25 based or machine-based. The human-based approach is based on human empathy including the human's perception of the situation on the basis of which the feelings of the person and how to behave are determined. On the other hand, a machine-based approach may employ a digital assistance system receiving measurement data representing the body or person related data of the person, which are fed to an evaluation system so as to detect
30 an emotional condition or state. Based on the state a measure, action or reaction is suggested. Contrary to such conventional approached, embodiments of the present invention provide an evaluation system employing/relying not only on the body or person related data but also on the environmental condition, both being represented, e.g., by a feature vector. The system may have two key aspects: the "root-cause-analysis" and the
35 "determination of a proper measure". The root-cause-analysis allows searching for a reason for the person not being in a normal/ desired condition taking into consideration the body or

person related data and on the environmental condition where the patient is located, and the "determination of a proper measure" allows searching for a measure which improves the condition of the person.

5 In accordance with embodiments, the root cause analysis is strongly individualized, as shown in the following example of a heart rate monitor. Conventional heart rate monitors measure the heart rate and then divide activity into typical heart rate zones, like basic stamina, moderate exercise, intense exercise and peak exercise. Classification into these heart rate zones is based on look-up tables, which are preset by statistical information about
10 the user, for example, gender, age, body height, weight, performance level. In addition, individualized concepts may access performance curves of earlier training curves and evaluate the current condition. From this, individual, up-to-date, personalized training instruction may be derived. For example, "Today you are fine. You may exercise extensively", or "You are relatively unfit, be careful!". Other than the just described conventional
15 approached, the present invention provides for an even further individualization taking into consideration the environmental condition. For example, also the location or a current whether situation is taken into account together with a person's preferences associated with such conditions. For example, a person may not like training at certain times of the day or at temperature levels above or below certain threshold. Such information may be part of the
20 person's profile and used in addition on to judge or evaluate the situation.

Fig. 4 shows a detailed flowchart of a sub-process 400, which shows an embodiment of the "measure determination" step 180 in Fig. 1 in detail. The sub-process 400 starts with calculating measure alternatives 440 based on the one or more reasons 410 determined in
25 the reason determination step 180 in Fig. 1 and based on the data provided by the databases 450. The plurality of databases 450 comprises person-specific databases like patient event log database 452, patient activity database 454, patient identity database 456, patient incident log database 470 and a general age-based database 458 as well. Optionally, the calculation of measure alternatives 440 may be manually confirmed or
30 revised 420 by a third person, for example a nurse. The measure alternatives provided by the calculating of the measure alternatives step 440 are recorded or logged 460 in the patient incident log 470. The measure alternatives provided by the calculation of the measure alternative step 440 are returned 490 as the result of the sub-process 400 to the core-process 100 in Fig. 1. The measure alternatives provided by the calculation of the
35 measure alternative step 440 may be displayed as individual measures 110 in Fig. 1 to any third person, for example, nurses, caregivers, etc.

Fig. 5 shows a flowchart 500 illustrating a further embodiment of the present invention. The embodiment extends the process of Fig. 1, and the flowchart of Fig. 5 comprises the core-process 100 described in Fig. 1, and a feedback or update sub-process 520. The core-process 100 includes the sub-processes 150 to 170 described above, which are not described here again. The core-process 100 of Fig. 1 is complemented by the feedback or update sub-process 520, which transforms the core-process to a self-learning process. The update sub-process 520 is responsible for applying 530 the individual measure displayed at the end of the core-process 100, reviewing the effectivity of the individual measure by evaluating the condition 535 of the person, and updating or recalculating database values in a lesson learnt sub-process 550. More specifically, once the measure to resolve the uncomfortable or undesired condition has been applied, the condition is again evaluated at 535, e.g., using the sub-process 140 described above in more detail. According to the re-evaluated condition of the person, the process 500 may be restarted at the sub-process 160, in case the condition is still not desired, so as find another individual measure to be applied. Complementing the core process with the feedback sub-process 520, which updates the databases based on the effectivity of the individual measures, transforms the core-process into a self-learning system.

Fig. 6 shows a detailed flowchart of a sub-process 600 which is an embodiment of the "lesson learned" step 550 in Fig. 5. The sub-process 600 decides 610 whether the individual measure was beneficial or not. In the case of a non-beneficial measure, the results are recorded 620 in a plurality of databases 630. The plurality of databases 630 comprises the patient incident log database 633, patient activity database 636, patient event log database 639. In a next step, the process decides 640 whether the measure is a person-specific measure or not. In the case of a patient-specific measure, the results are recorded 650 in a plurality of databases 630. The process further decides 660 whether the measure is a general measure or not. In case of a general measure, the results are recorded 670 in a plurality of databases 630. After applying specific updates on the plurality of databases, the process ends and returns to the extended core-process 500 in Fig. 5.

Fig. 7 shows an exemplary use case 700 of the core-process 100 in Fig. 1 for a person suffering from dementia 790. In a first step, a plurality of body or person related data and environmental parameters are obtained, such as physiological parameters 710a, facial expressions 710b, language or speech parameters 710c, motion or activity parameters 710d and other ambient information 710e. The plurality of sensor outputs, such as

physiological parameters 710a, facial expressions 710b, language and/or speech parameters 710c, motion or activity parameters 710d and other ambient information 710e are merged into a feature vector 720, which may be used in a context analysis or in a conditional evaluation 730. In the conditional evaluation step 730, which corresponds to the
5 above described condition evaluation step 140 of Fig. 1, the values of the feature vector 720 are compared to basic information in the database 740. The basic information in the database 740 is loaded from an initial assessment 750 and is continuously expanded, e.g., using a self-learning algorithm. The feature vector 720 may be supplied by a multi-modal signal obtainer. In a next step, a root cause analysis 760, corresponding to the reason
10 determination step 160 in Fig. 1, is performed based on the feature vector 720 and the basic information in the databank 740. Based on the reason or cause determined by the root-cause-analysis 760, an individual measure 770, as in 110 in Fig. 1, is provided. An appropriate individual measure restores the normal/desired condition. In case of dementia, an appropriate person and/or situation-specific measure may lead to an improvement of the
15 condition. In a last step, the individual measure is applied or performed by actuators 780a, nursing robots 780b, nurses 780c, and/or nursing relatives 780d.

Thus, embodiments of the present invention allow implementing an automated system to be used in the care of persons suffering from a certain illness, like dementia, which
20 measures and evaluates human emotional conditions. Conventionally, computer programs, machines and robots only detect human emotions and/or emotional states to a very limited extent. They do not interpret emotions reliably and thus they do not use emotional information effectively. Only global indicators, like facial expressions, language and/or speech parameters and/or body or person related data are measured, but only as a basis
25 for a rough estimate of current stress levels. Currently, there is no standard definition of the term "emotion". The leader in current emotion research is the "assessment theory" (Ortony et al., Lazarus). Scherer's so-called "component-process" model provides a contemporary working definition of emotion: Emotion is an episode of temporal synchronization of all the major subsystems of the organism that form five components. These are: cognition
30 physiological regulation, motivation, motor expressions and subjective feelings. The response and the evaluation of an external or an internal stimulus is as significant to the central needs and goals of the organism (Scherer, 2005). Emotions have as further dimensions different valences, positive and/or pleasant or negative and/or unpleasant, different degrees of excitement, big or strong, and a tendency to approach or avoid.
35 Emotional states are based on emotions or emotional processes but are "seen in terms of their intensity and object relatedness of lesser and with respect to their duration of greater

expression as emotions" (Otto, Euler, Mandl, 2000). In contrast to emotion, emotional states may also be influenced or generated externally, both in a positive sense, like encouragement, recognition, optimism, and in negative sense, like demotivation or pulling down. In the field of emotions, direct measurements are not possible so that emotions are measured by indicators. Indicators are observable data that has a certain relation to a hypothetical construction. There is a unanimous opinion in scientific literature that emotions may not be measured by a single measurement method. According to Scherer (2005), in order to fully technically register an emotion, one needs to measure at least five (5) components simultaneously:

- the continuous changes at all levels of the central nervous system (appraisal process);
- all response patterns generated at the neuroendocrine and autonomic nervous system levels;
- the changes in behavioral motivation (including the neural impulses);
- the patterns of facial expression, voice and body movements and
- the subjective feeling that combines all these component changes.

To date, measurements are limited to externally perceptible indicators (mainly facial expressions, and more recently also speech) and/or physiological aspects. Time-lasting factors that trigger, control and/or otherwise influence conditions and/or emotions and/or emotional states are not recorded.

People who are, due to age or illness, not or not any more able to communicate and regulate their condition or emotional state depend on their interaction partners being able to handle the situation competently. Most of these people are showing the behavioral and psychological symptoms of dementia (BPSD). Approximately 90% of all dementia patients in the course of the disease have one or more of so-called provocative symptoms or behaviors, such as agitation, hallucinations, depression, aggression, anxiety, disinhibition, day-night reversal, etc. These BPSDs may be understood as ineffective coping strategies on environmental and physiological stress factors. It may be impossible for a healthy person to put themselves in the position of a person suffering from, for example, dementia. All the signals that a demented person transmits are processed by healthy people having a fully functional brain, which, in the best case, may be able to determine the origin of the respective behavior or feeling. The subjective experience of the patient is so far only surveyed, which requires understanding of speech and/or expressiveness from the patient and requires a sensitive questioning technique from the interviewer. In an advanced stage of a dementia this is hardly feasible. In addition, purely observed and/or self-disclosed data

may be influenced by other factors, such as a time-dependent condition of the patient, waiting for food or a visit, being after a pleasant activity, but also by the atmosphere of the observation or questioning situation. Also it may be likely that a patient gives the answer he/she thinks the nurse wants to hear.

5

There are a number of conventional approaches, therapies or recommendations for dealing with BPSDs. For example, non -pharmacological interventions may include one or more of the following:

- understanding the causes of the peculiar behavior is crucial
- 10 • improve the communication
- relationship work
- changing the environment, focusing on orientation and safety
- psychological stimulation
- psychoeducation of relatives and caregivers
- 15 • music therapy, reminiscence therapy, validation therapy
- recommendation of patience, time and humor

Further practiced solutions may include one or more of the following:

- fixation of agitated or aggressive patients
- 20 • pharmacological interventions: psychotropic drugs (e.g., antipsychotics, neuroleptics, sedations)

In order to measure the symptoms of dementia and/or detect the BPSDs, three different methods may be applied or combined:

- 25 • interviewing the patient,
- interviewing the caregiver and
- filling out a standardized clinical questionnaire survey, such as:
- SMMSE - Standardized Mini-Mental State Examination, and/or
- CMAI - Cohen Mansfield Agitation Inventory, and/or
- 30 • the BEHAVE-AD Assessment System.

In addition, there are a number of instruments that may be used, in order to record the quality of a life, a condition and/or an emotion or emotional state of dementia patients. Few examples are listed below:

- 35 • H.I.L.DE. (Heidelberg Instrument for Recording Quality of Life in Dementia, 2005)

- OERS (Observed Emotion Rating Scale) (Lawton et al., 1996)
- DMPT (Dementia Mood Picture Test) (Tappen & Barry, 1995)

Thus, when considering a person suffering from dementia, conventionally a condition/emotion/mood/feeling are "results" of an internal evaluation processes, which again are based on different criteria and/or factors. The better processes succeed in identifying and deciphering the criteria and/or factors and assigning them to specific statements or examples, so as to allow understanding feelings and explain how they evolve.

In accordance with embodiments of the present invention, when applying the inventive approach to persons suffering from dementia, the evaluation may be based on the combination of the three factors "energy", "policy" and "goal" in connection with "activities" to be carried out which enables a high "decoding rate" and thus a better understanding of the respective feeling and its history as well as the possibility of acting in a targeted manner, in order to reduce negative conditions and/or emotions and/or mental states. The simultaneous measurement of physiological values and the investigation of situation-specific aspects results in a higher accuracy, by allowing counterchecks. Thus, embodiments provide a device, enabling a third person, such as a caregiver, to scan the condition and/or emotional state of a person suffering from dementia at any time and/or to be warned in the event of acute emergencies offers the following advantages:

- more targeted approach and possibly an activation of the patient
- prevention, mitigation and reduction of conflict situations
- supporting or relieving the nursing staff, caregivers, caring relatives, relatives, neighbors or friends of the pressure to always act as ad hoc as possible individually "correctly".
- improving the quality of life of demented people
- improving the work-situation of caregivers and/or as well as, above all, even low-threshold staff
- easing the situation for caring relatives, for example, in case of short-term absence, such as shopping, visiting a doctor, hairdresser, etc.

The core-process 100 in Fig. 1 may be applied in a use-case 700 for people suffering from dementia. Several body or person related data and/or environmental parameter may be obtained and merged into the feature vector 720. The condition of a dement patient is evaluated 730, based on the data in the database 740. If the condition is uncomfortable or undesired, a measure is provided 770, based on the root-cause-analysis 760. The

individual measure may be applied by a third person, such as a nurse 780c and/or a relative 780d, and/or by a nursing robot 780b and/or by an AAL-actuator 780a as well.

The present invention may be used in other situations as well. Further technical use-cases of the present invention are listed exemplary below:

- quantification of moods:
- definition of an individual "feel-good state" per patient
- measurement of situational deviation and measures
- improvement of emotion regulation of dementia patients; relief of aggression and mood lability or stabilization of self-esteem ("I may still ...")
- self-learning system: suggestions for resource activation etc.
- self-learning system: recognition of "strange" but self-protective assignments of the patients. For example, in cases, where the common sense of nursing staff, caregivers, caring relatives, relatives, neighbors or friends is a drawback.
- explicit interventions via algorithm are possible in case certain evidences indicate "synaptic detours"
- assistance system in nursing, giving negative feedback: displaying irritation and concrete measures
- empathic human-machine interface, ones with artificial empathy, such as nursing robots
- support for autistic people
- support of language disabled people
- support for mentally disabled people
- supporting people from different cultures
- extended stress management and root-cause-analysis
- level 1: multi-parameter measurement and context evaluation, such as HRV and activity
- level 2: assignment and link to the situation as well as person / personality
- increasing safety during autonomous driving
- rating system for (small) children

Although some aspects of the described concept have been described in the context of an apparatus, it is clear that these aspects also represent a description of the corresponding method, where a block or a device corresponds to a method step or a feature of a method

step. Analogously, aspects described in the context of a method step also represent a description of a corresponding block or item or feature of a corresponding apparatus.

Various elements and features of the present invention may be implemented in hardware
5 using analog and/or digital circuits, in software, through the execution of instructions by one or more general purpose or special-purpose processors, or as a combination of hardware and software. For example, embodiments of the present invention may be implemented in the environment of a computer system or another processing system. Fig. 8 illustrates an example of a computer system 800. The units or modules as well as the steps of the
10 methods performed by these units may execute on one or more computer systems 800. The computer system 800 includes one or more processors 802, like a special purpose or a general purpose digital signal processor. The processor 802 is connected to a communication infrastructure 804, like a bus or a network. The computer system 800 includes a main memory 806, e.g., a random-access memory (RAM), and a secondary
15 memory 808, e.g., a hard disk drive and/or a removable storage drive. The secondary memory 808 may allow computer programs or other instructions to be loaded into the computer system 800. The computer system 800 may further include a communications interface 810 to allow software and data to be transferred between computer system 800 and external devices. The communication may be in the form of electronic, electromagnetic,
20 optical, or other signals capable of being handled by a communications interface. The communication may use a wire or a cable, fiber optics, a phone line, a cellular phone link, an RF link and other communications channels 812.

The terms "computer program medium" and "computer readable medium" are used to
25 generally refer to tangible storage media such as removable storage units or a hard disk installed in a hard disk drive. These computer program products are means for providing software to the computer system 800. The computer programs, also referred to as computer control logic, are stored in main memory 806 and/or secondary memory 808. Computer programs may also be received via the communications interface 810. The computer
30 program, when executed, enables the computer system 800 to implement the present invention. In particular, the computer program, when executed, enables processor 802 to implement the processes of the present invention, such as any of the methods described herein. Accordingly, such a computer program may represent a controller of the computer system 800. Where the disclosure is implemented using software, the software may be
35 stored in a computer program product and loaded into computer system 800 using a removable storage drive, an interface, like communications interface 810.

The implementation in hardware or in software may be performed using a digital storage medium, for example cloud storage, a floppy disk, a DVD, a Blue-Ray, a CD, a ROM, a PROM, an EPROM, an EEPROM or a FLASH memory, having electronically readable control signals stored thereon, which cooperate (or are capable of cooperating) with a programmable computer system such that the respective method is performed. Therefore, the digital storage medium may be computer readable.

Some embodiments according to the present invention comprise a data carrier having electronically readable control signals, which are capable of cooperating with a programmable computer system, such that one of the methods described herein is performed.

Generally, embodiments of the present invention may be implemented as a computer program product with a program code, the program code being operative for performing one of the methods when the computer program product runs on a computer. The program code may for example be stored on a machine readable carrier.

Other embodiments comprise the computer program for performing one of the methods described herein, stored on a machine readable carrier. In other words, an embodiment of the inventive method is, therefore, a computer program having a program code for performing one of the methods described herein, when the computer program runs on a computer.

A further embodiment of the inventive methods is, therefore, a data carrier (or a digital storage medium, or a computer-readable medium) comprising, recorded thereon, the computer program for performing one of the methods described herein. A further embodiment of the inventive method is, therefore, a data stream or a sequence of signals representing the computer program for performing one of the methods described herein. The data stream or the sequence of signals may for example be configured to be transferred via a data communication connection, for example via the Internet. A further embodiment comprises a processing means, for example a computer, or a programmable logic device, configured to or adapted to perform one of the methods described herein. A further embodiment comprises a computer having installed thereon the computer program for performing one of the methods described herein.

In some embodiments, a programmable logic device (for example a field programmable gate array) may be used to perform some or all of the functionalities of the methods described herein. In some embodiments, a field programmable gate array may cooperate with a microprocessor in order to perform one of the methods described herein. Generally,
5 the methods are preferably performed by any hardware apparatus.

The above described embodiments are merely illustrative for the principles of the present invention. It is understood that modifications and variations of the arrangements and the details described herein are apparent to others skilled in the art. It is the intent, therefore,
10 to be limited only by the scope of the impending patent claims and not by the specific details presented by way of description and explanation of the embodiments herein.

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Technology-based biography work and remembrance care

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5 Adaptation of assistance systems to the individual needs of the person by means of
a computer brain interface for emotion recognition.

- <http://www.emasin-projekt.de/>

Emotion-sensitive assistance systems for the reactive psychological interaction with
humans

10

CLAIMS

1. A method for providing a measure to resolve an uncomfortable or undesired physiological condition of a person, the method comprising:

5

- (a) obtaining a plurality of body/person related data for the person,
- (b) obtaining a plurality of environmental parameters representing an environment of the person at the time of obtaining the body/person related data,

10

- (c) evaluating the measured body/person related data with respect to one or more stored thresholds associated with respective ones of the body/person related data of the person so as to determine whether a condition of the person is an uncomfortable or undesired condition,

15

- (d) in case the determined condition of the person is an uncomfortable or undesired condition, evaluating the body/person related data and the plurality of environmental parameters with respect to a stored person-specific profile, thereby determining a reason for the uncomfortable or undesired condition, and

20

- (e) determining an individual measure for the person to resolve the uncomfortable or undesired condition using the person-specific profile.

2. The method of claim 1, wherein the person-specific profile characterizes the person in terms of physical attributes, and in terms of environmental preferences, for example certain maximum or minimum thresholds for environmental conditions.

25

3. The method of claim 2, wherein the physical attributes comprise one or more of the following:

30

- age,
- gender,
- one or more physiological parameters, like blood pressure, respiratory rate, heart rate,
- facial expression of the person,
- speech of the person, like intonation, and

35

wherein the environmental preferences comprise one or more of the following:

- certain maximum or minimum thresholds for environmental conditions, like temperature, noise level, brightness, smell, sounds.

5 4. The method of claim 2 or 3, wherein the person-specific profile represents the person as a digital twin that was created within a person specific assessment and further characterizes the person in terms of

- activities of the person,
- infrastructure of the environment where the person is located, and
- 10 • a movement pattern of the person.

5. The method of any one of the preceding claims, wherein the person-specific profile characterizes the person using the following attributes:

- 15 • policy, wherein the policy describes a combination of the person's specific characteristics and attitudes, that determine the persons behavior,
- energy, wherein the energy describes physical, motoric and cognitive capabilities a person may apply in different stages of quality and relating to the execution of "activities",
- target, wherein the target describes initial impulse for starting an "activity", and
- 20 • activity, wherein the activity describes and task or dedicated behavior of a person caused by inner conditions such as "target" or "desire".

6. The method of claim 5, wherein, responsive to identifying an actual condition of the person to be an uncomfortable or undesired situation using the current body/person related data and the current environmental parameters for the person, the cause for the uncomfortable or undesired situation is deducted by analyzing the attributes policy, energy, target and activity.

7. The method of claim 6, wherein

- 30 • analyzing the policy comprises determining whether the current situation complies with the policy of the person's basic attitude,
- analyzing the energy comprises determining whether it is possible to realize the current target and performed activity with the given/available energy or has the status of energy, like physical, mental, cognitive degenerative changes, recently
- 35 decreased,

- analyzing the target comprises determining whether the current target contributes to the persons policy or whether the target/desire may be realized/achieved with the given/changed energy conditions, like physical, mental, cognitive capabilities, and
- 5 • analyzing the activity comprises determining whether the current activity contributes to the persons targets/desires or whether the activity may be performed with the given/changed energy conditions, like physical, mental, cognitive capabilities, or whether the activity is an intrinsic wish of the person or an extrinsic objective given by a third person.

10

8. The method of any one of the preceding claims, wherein the person-specific profile is updated at certain intervals, e.g., periodically, and/or responsive to certain events, e.g., if a specific "activity" up to that point was performed with a satisfying mind but now turns out to be unsatisfying, the "energy" related to that activity is analyzed and
- 15 if necessary updated or even removed.

9. The method of any one of the preceding claims, wherein step (e) comprises selecting the individual measure for the person from a plurality of available measures using the person-specific profile or digital twin.

20

10. The method of any one of the preceding claims, further comprising outputting the determined individual measure for the person, and wherein outputting the determined individual measure for the person comprises one or more of the following:

25 presenting the individual measure to the person or to a third person, like nursing staff, caregivers, caring relatives, relatives, neighbors or friends, so as to allow the person or the third person to apply the measure, and/or

outputting a control signal causing a nursing robot to apply the measure, and/or

30

outputting a control signal causing an actuator to effect a change in the environmental condition.

11. The method of any one of the preceding claims, further comprising:

35

determining a current condition of the person, and

transmitting a current condition of the person to a third person, like a nursing staff, caregivers, caring relatives, relatives, neighbors or friends,

5 wherein, in case of an uncomfortable or undesired condition, transmitting the current condition includes transmitting a description of the uncomfortable or undesired condition and individual measure to be applied.

12. The method of any one of the preceding claims, wherein

10

step (c) comprises updating the person-specific profile with the occurrence of the uncomfortable or undesired condition of the person, e.g., in an incident log,

15

step (d) comprises updating the person-specific profile with the reason for the uncomfortable or undesired condition with the occurrence of the uncomfortable or undesired condition, e.g., in the incident log, and

20

step (e) comprises updating the person-specific profile with the individual measure with the occurrence of the uncomfortable or undesired condition, e.g., in the incident log.

13. The method of any one of the preceding claims, wherein the one or more thresholds associated with respective ones of the body/person related data of the person and the person-specific profile are stored in one or more databases.

25

14. The method of any one of the preceding claims, further comprising the following steps after applying the individual measure:

30

obtaining a plurality of body/person related data for the person,

evaluating the measured body/person related data with respect to the one or more stored thresholds associated with respective ones of the body/person related data of the person so as to determine whether the uncomfortable or undesired condition of the person is resolved by applying the individual measure,

35

5 in case the uncomfortable or undesired condition of the person is not resolved, updating the person-specific profile with information indicating that the individual measure does not resolve the determined uncomfortable or undesired condition, and repeating steps (d) and (e) so as to determine another individual measure to be applied, and

10 in case the uncomfortable or undesired condition of the person is resolved, updating the person-specific profile with information indicating that the individual measure resolves the determined uncomfortable or undesired condition.

10

15 15. The method of any one of the preceding claims, wherein obtaining the plurality of body/person related data for the person and/or obtaining the plurality of environmental parameters comprises measuring the body/person related data and the environmental parameters, and/or receiving data representing the body/person related data and the environmental parameters, e.g., from respective measurement devices or sensors.

15

20 16. The method of any one of the preceding claims, wherein the person suffers from dementia, and wherein the individual measure comprises one or more of the following:

- avoiding specific topics when talking to the person,
- performing/avoiding a specific action
- changing a certain environmental condition

20

25 17. A computer program comprising a program code for performing a method according to any one of the preceding claims, when the computer program runs on a computer or a micro-controller.

25

30 18. An apparatus for providing a measure to resolve an uncomfortable or undesired physiological condition of a person, the apparatus comprising:

30

a first interface for receiving a plurality of body/person related data for the person,

a second interface for obtaining a plurality of environmental parameters representing an environment of the person at the time of obtaining the body/person related data,

35

a processor configured to

evaluate the measured body/person related data with respect to one or more stored thresholds associated with respective ones of the body/person related data of the person so as to determine whether a condition of the person is an uncomfortable or undesired condition,

5 in case the determined condition of the person is an uncomfortable or undesired condition, evaluate the body/person related data and the plurality of environmental parameters with respect to a stored person-specific profile, thereby determining a reason for the uncomfortable or undesired condition, and determine an individual measure for the person to resolve the uncomfortable or
10 undesired condition using the person-specific profile, and

a third interface for providing the individual measure for the person.

19. A system for monitoring a person, like a person suffering from dementia, the system
15 comprising:

the apparatus of claim 28,

one or more first sensors coupled the first interface, the first sensors configured to
20 measure the body/person related data for the person,

one or more second sensors coupled the second interface, the first sensors configured to measure the environmental parameters, and

25 an output device coupled to the third interface.

20. The system of claim 19, wherein

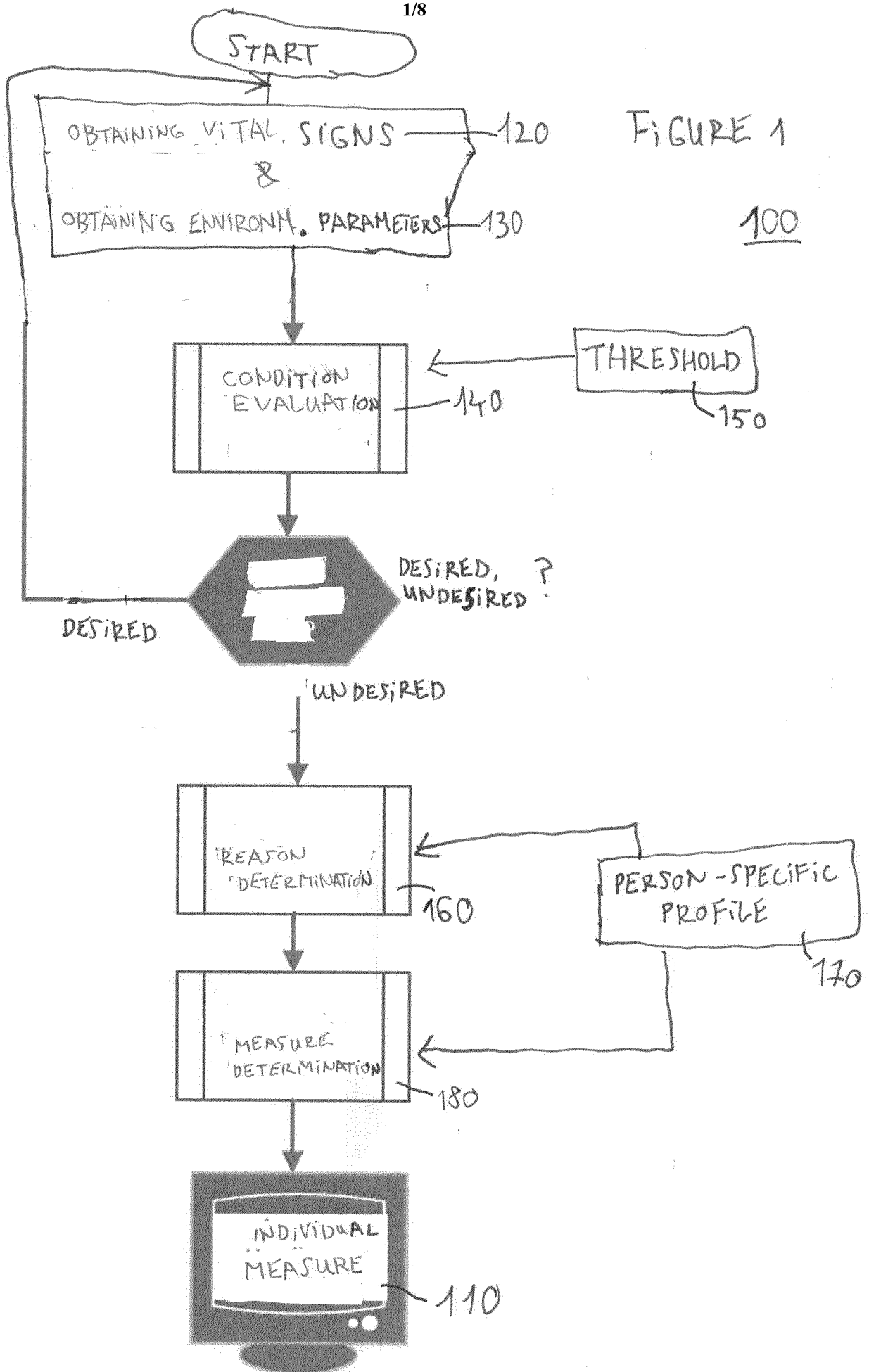
- the apparatus is configured to determine a current condition of the person, and
- the output device is configured to transmit the current condition of the person
30 to a third person, like a nursing staff, caregivers, caring relatives, relatives, neighbors or friends, wherein, in case of an uncomfortable or undesired condition, a description of the uncomfortable or undesired condition and the individual measure to be applied is transmitted.

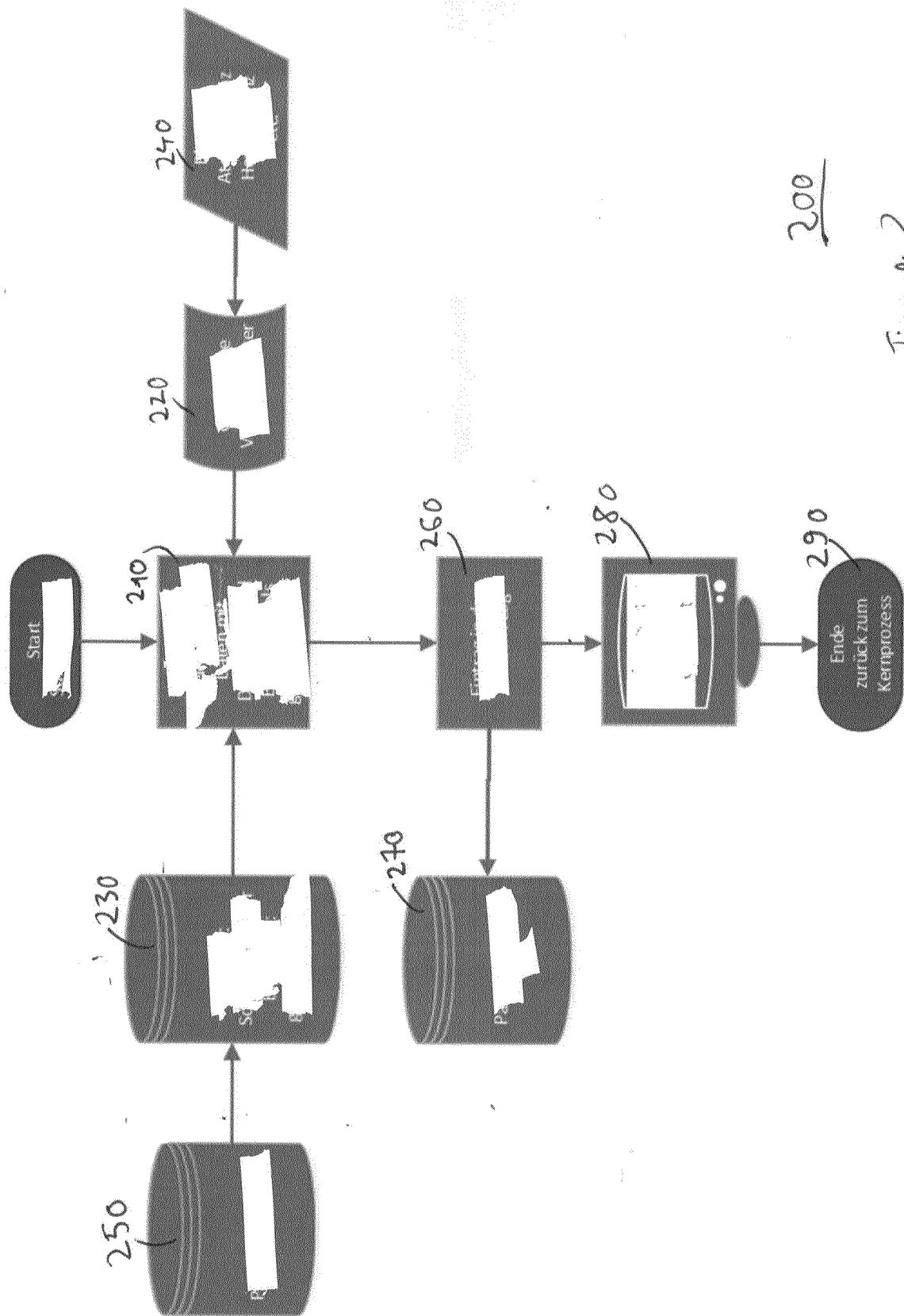
35 21. The system of claim 19 or 20, wherein the output device is configured to present the individual measure to the person or to a third person, like nursing staff, caregivers,

caring relatives, relatives, neighbors or friends, so as to allow the person or the third person to apply the measure.

5 22. The system of any one of claims 18 to 20, comprising a nursing robot, wherein the output device is configured to output a control signal to the nursing robot causing the nursing robot to apply the measure.

10 23. The system of any one of claims 19 to 22, comprising one or more actuators coupled to one or more devices and allowing for a control of the device for changing one or more environmental conditions, wherein the output device is configured to output a control signal causing an actuator to drive a device to effect a change in the environmental condition.





200

Figure 2.

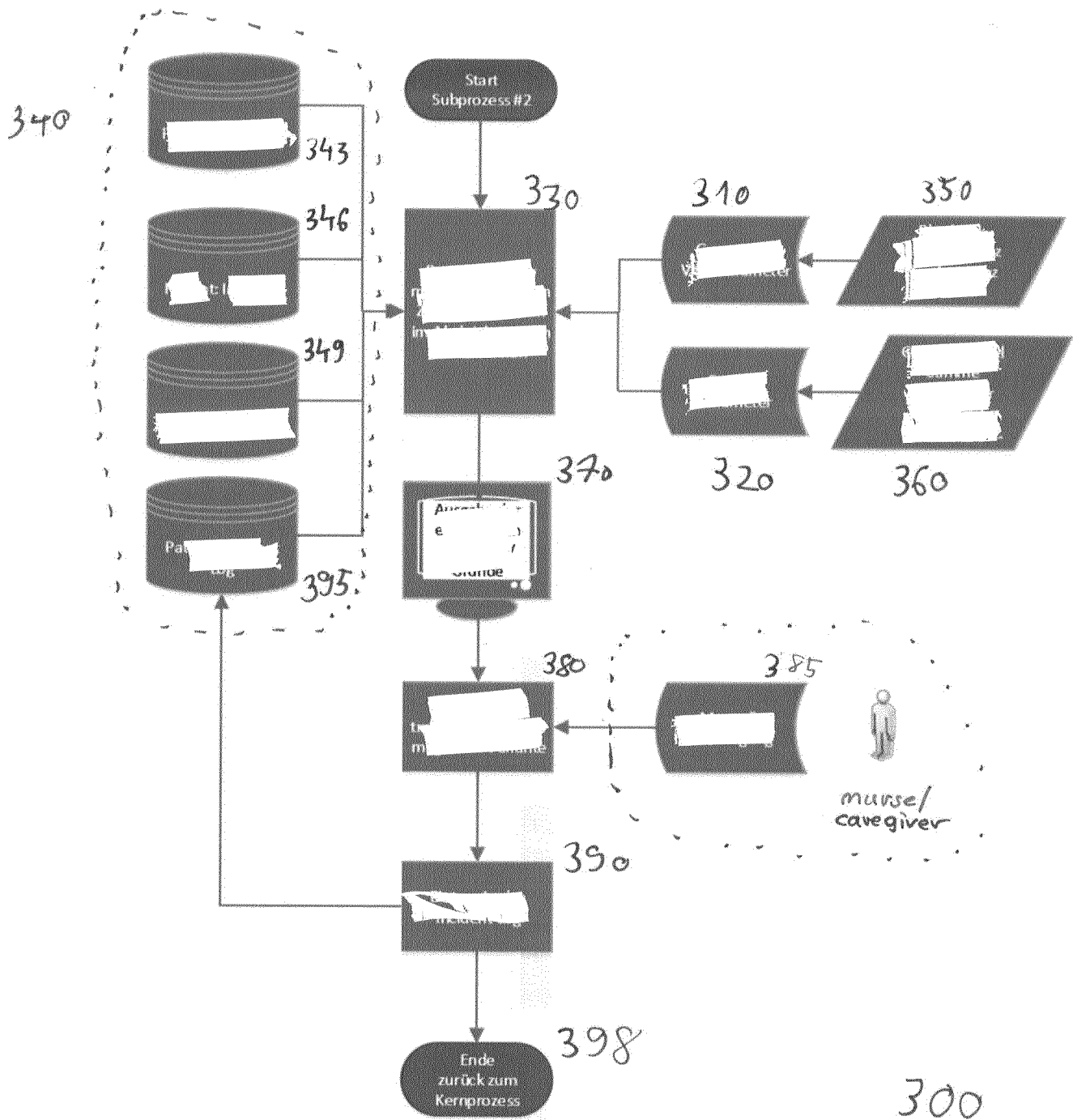


Figure 3

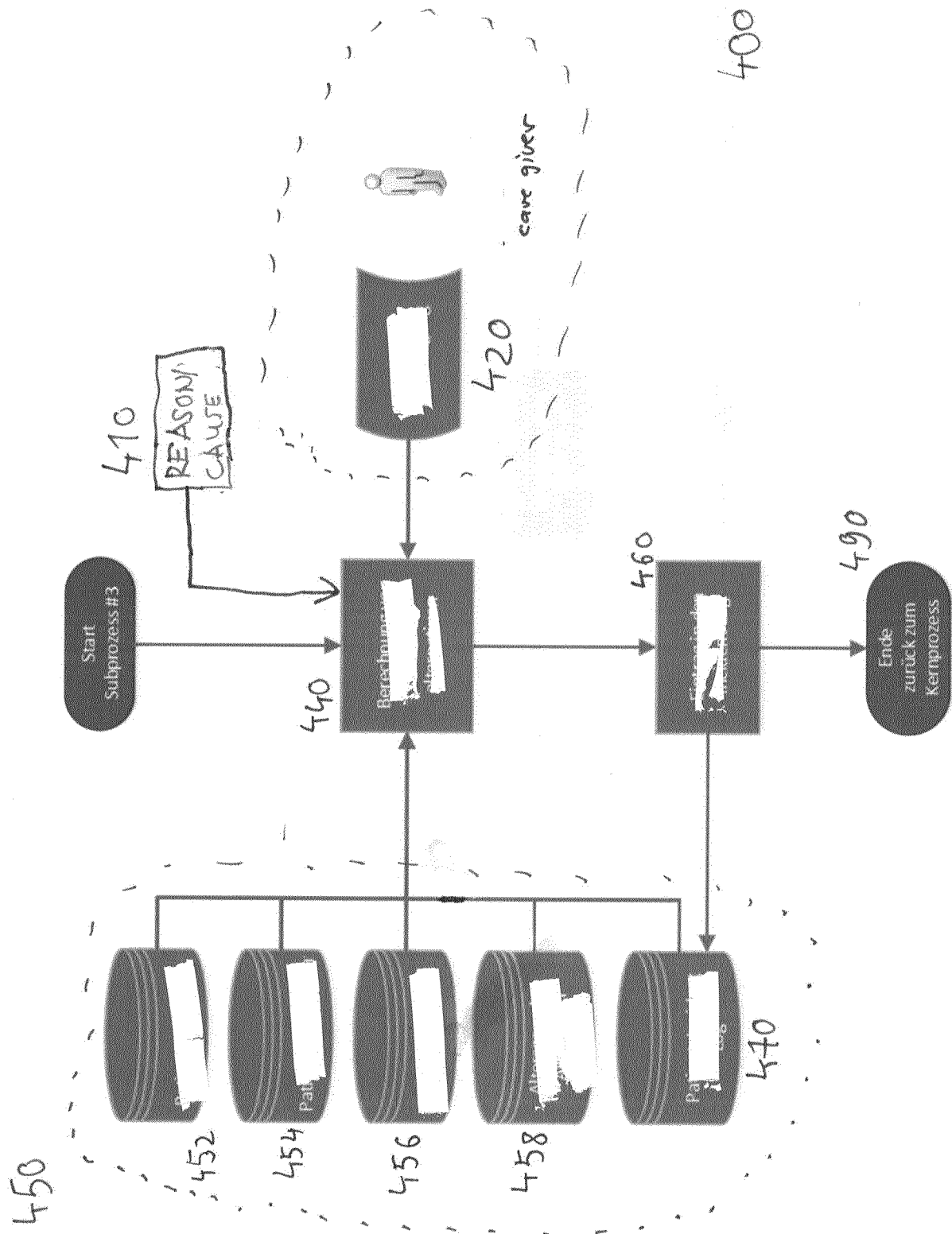


Figure 4

500

FIGURE 5

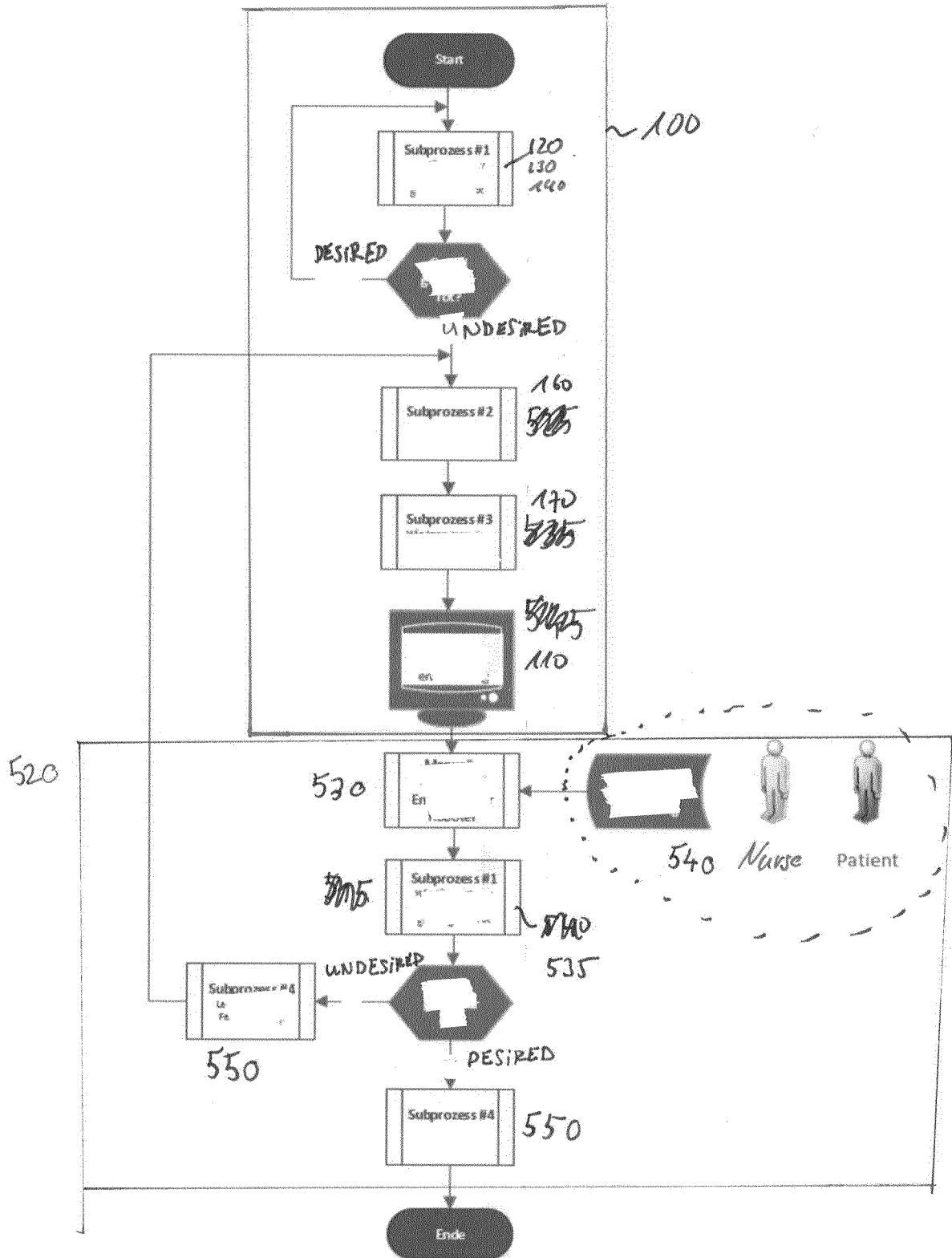
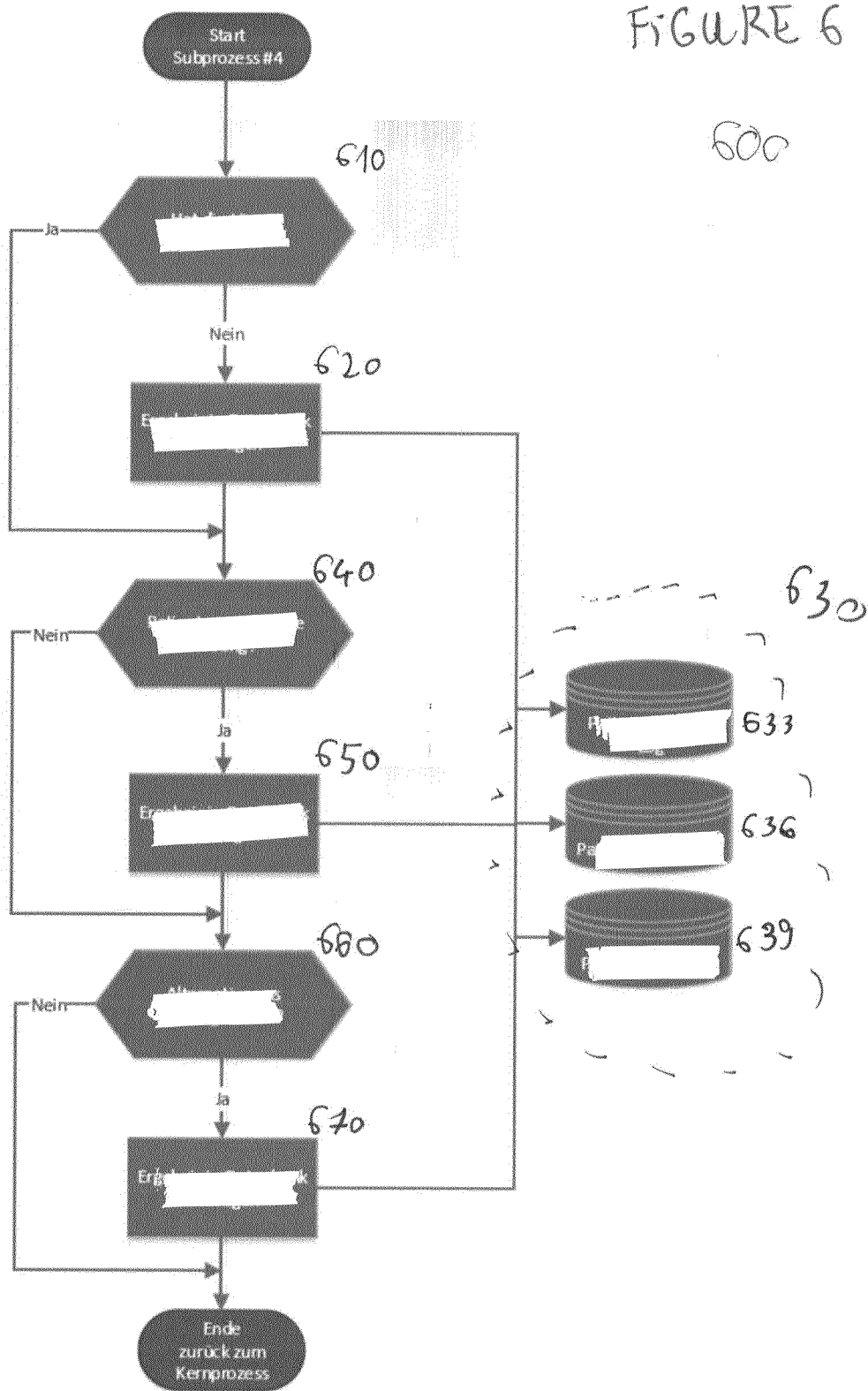


FIGURE 6



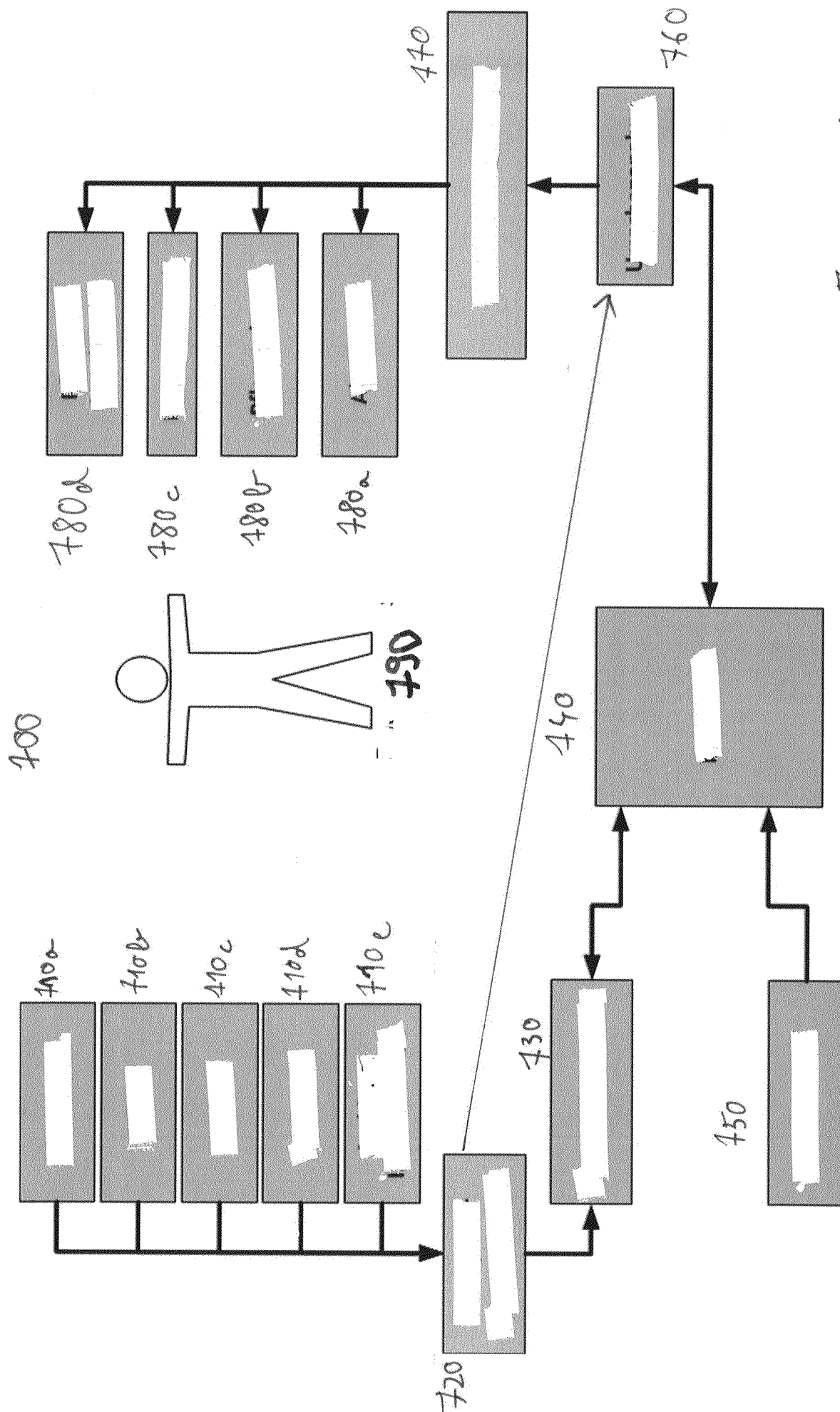


FIGURE 7

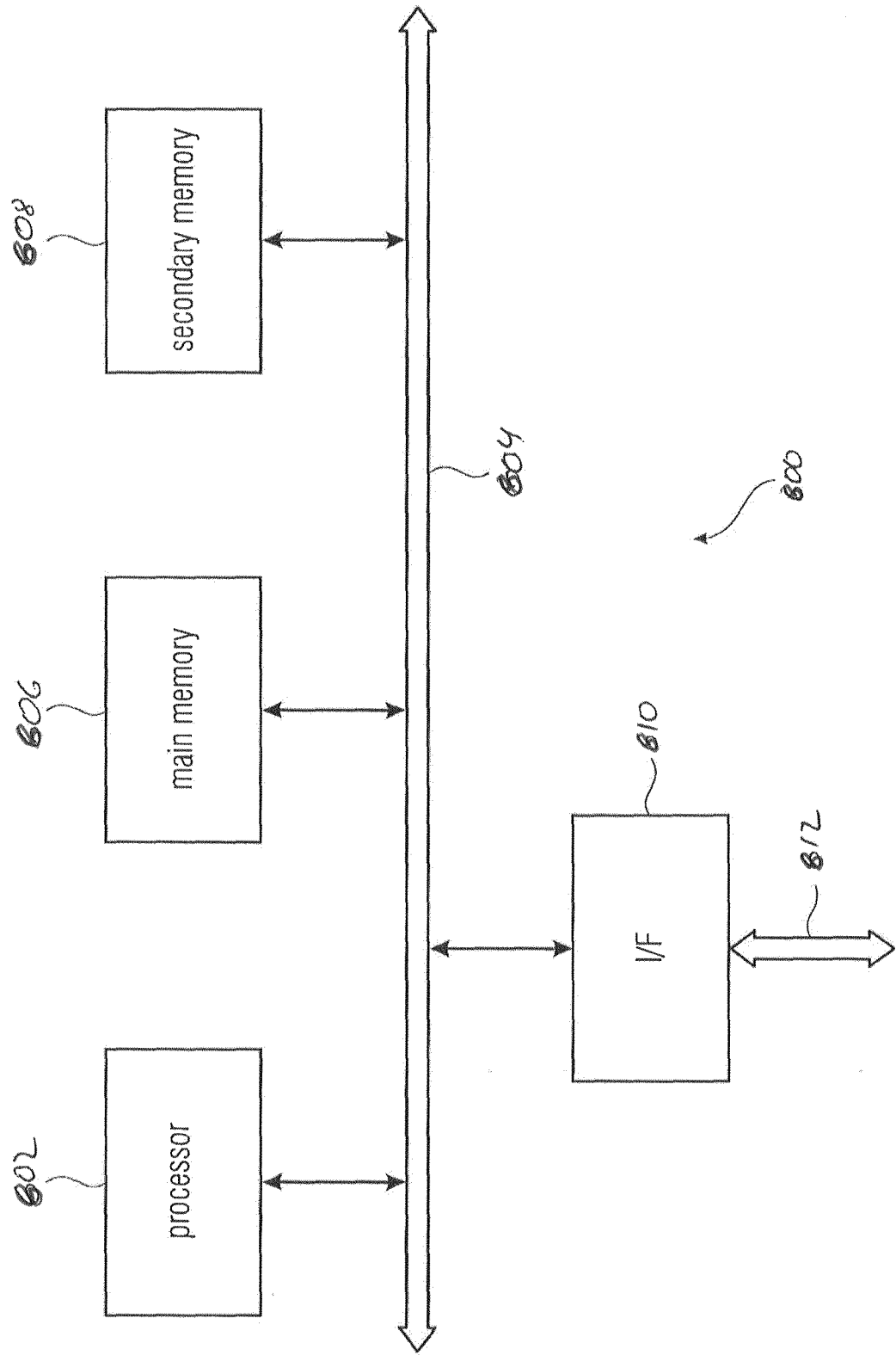


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/053181

A. CLASSIFICATION OF SUBJECT MATTER
INV. G16H20/70
ADD. G16H80/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/347906 A1 (INTRATOR NATHAN [IL]) 7 December 2017 (2017-12-07) abstract paragraphs [0002], [0005], [0006], [0008], [0013], [0015], [0018], [0108], [0157], [0173], [0185], [0199], [0215], [0300], [0683]; claim 16 paragraph [0542] ----- -/--	1-23



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 April 2019

Date of mailing of the international search report

09/05/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Schmitt, Constanze

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/053181

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Marta Belay ET AL: "A Data Framework to Understand the Lived Context for Dementia Caregiver Empowerment", MAICS, 1 January 2015 (2015-01-01), XP055582973, Retrieved from the Internet: URL:http://ceur-ws.org/Vol-1353/paper_21.pdf [retrieved on 2019-04-24] page 3, column 2, paragraph 3 page 6, column 1, paragraph 2 -----	1,18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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US 2017347906 A1	07-12-2017	AU 2017278992 A1	20-12-2018
		CA 3026607 A1	14-12-2017
		EP 3463062 A1	10-04-2019
		US 2017347906 A1	07-12-2017
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