

Patent claims

1. ~~A wearable~~ human-machine interface ~~(10)~~, comprising:
an element to be worn, ~~(12) the element which is~~ configured to be attached to
an area of skin of a limb of a human or animal body,
a flexible layer, ~~(26) with magnetic properties, which is~~ attached to the element
to be worn, ~~(12) on a side of the element to be worn~~ that faces the area of skin of the
human or animal body so as to come into contact with the surface of the area of skin
upon attachment of the element to the area of skin, wherein the flexibility of the
layer has a flexibility configured to at least substantially follow deformations of the surface of the
area of skin, and wherein the magnetic properties of the flexible layer are
configured in such a manner that a deformation of the surface of the area of skin
leads to a measurable change of the magnetic properties of the flexible layer,
a detection unit which measures changes of the magnetic properties of the
flexible layer caused by a corresponding deformation of the surface area of the skin-
(26), and
an integrated or separate processing unit configured which is adapted to
perform an algorithm which allocates the measured change of the magnetic
properties of the flexible layer to at least one of a configuration, and/or movement
and/or movement intensity, with the aid of at least one of Bayes classifiers, an
artificial neural network, a support vector machine, a finite state machine, a hidden
Markov model, a relevance vector machine, a dynamic time warping method, a
conditional random field method, a decision tree, a random forest method, a k-
nearest neighbours algorithm, a discriminant analysis, a linear regression, a logistic
regression, a Gaussian process, a perceptron and ensemble methods, wherein the
ensemble methods include at least one of a Bayes optimal classifier, bagging and
boosting, wherein the configuration is a specific position of the limb of the human or
animal and the movement is a temporal change of the configuration, the integrated or
separate processing unit further configured to assign a control command to the
allocated at least one of the configuration, the movement and the movement
intensity, and to transmit the control command to a device to cause the device to
perform an action corresponding to the control command.
2. The wearable human Human-machine interface according to claim 1, wherein
characterised in that the flexible layer, ~~(26)~~ contains a plurality of magnets ~~(28) which~~
~~are preferably~~ arranged in the form of an array, and wherein in that the measurable
change of the magnetic properties of the flexible layer include at least one of (26) are

measurable changes of ~~the~~ magnetic field strength of the plurality of magnets
~~and/or~~ measurable changes of ~~the~~ magnetic flux density of the plurality of
magnets.

3. The wearable human~~Human~~-machine interface according to claim 1 ~~or 2~~,
wherein
~~characterised in that~~ the element to be worn ~~(12)~~ and the flexible layer ~~(26)~~ with
magnetic properties are combined in one component.

4. The wearable H~~human~~human-machine interface according to ~~any one of~~ claims
1 ~~to 3~~, wherein the
~~characterised in that the~~ detection unit contains multiple magnetometers ~~(20)~~.

5. The wearable human~~Human~~-machine interface according to claim 1~~any one~~
~~of the preceding claims~~, wherein a -
~~characterised in that a~~ deformation of the surface of the area of skin is based on an
involuntary or voluntary movement of at least one of a muscle, tendon, ligament,
bone and ~~/or organ movement~~.

6. The wearable human~~Human~~-machine interface according to claim 1~~any one~~
~~of the preceding claims~~, further comprising at least one of
~~characterised in that~~ one or more acceleration sensors and one or more~~/or~~ rotation
rate sensors, ~~are further provided on the human-machine interface (10)~~, the output
signals of which ~~sensors~~ are fed to the processing unit.

7. The wearable human~~Human~~-machine interface according to claim 1~~any one~~
~~of the preceding claims~~, wherein the human-machine interface is integrated into a
smartwatch
~~characterised in that the processing unit is adapted to allocate the measured change~~
~~of the magnetic properties of the flexible layer (26) to a configuration and/or~~
~~movement and/or movement intensity with the aid of Bayes classifiers, an artificial~~
~~neural network, a support vector machine, a finite state machine, a hidden Markov~~
~~model, a relevance vector machine, a dynamic time warping method, a conditional~~
~~random field method, a decision tree, a random forest method, a k-nearest~~
~~neighbours algorithm, a discriminant analysis, a linear regression, a logistic~~
~~regression, a Gaussian process, a perceptron and/or ensemble methods (Bayes~~
~~optimal classifier, bagging, boosting).~~

8. ~~Human-machine interface according to any one of the preceding claims, further comprising a communication unit for exchanging data with at least one external device which, on the basis of the data exchanged with the human-machine interface (10), is able to perform an action which corresponds to the at least one allocated configuration and/or movement and/or movement intensity.~~

9. ~~Human-machine interface according to any one of the preceding claims, characterised in that it is integrated into a smartwatch.~~

840. ~~A method~~Method for detecting a deformation of the surface of an area of skin of a limb of a human or animal body and allocating the detected deformation to at least one of ~~to~~ a configuration, ~~a and/or~~ movement and ~~or a~~ movement intensity, wherein the configuration is a specific position of the limb of the human or animal and the movement is a temporal change of the configuration, the ~~which~~ method comprising ~~comprises the steps:~~

~~—~~ arranging an array of magnets on or close to ~~an the~~ area of skin in such a manner that the array follows a deformation of the skin,

~~—~~ determining at least one magnetic signature of the array of magnets by measuring ~~a the~~ measurable change of ~~the~~ magnetic properties of the array of magnets that has taken place as a result of ~~a the~~ deformation of the skin, ~~and~~

~~—~~ performing an algorithm for allocating the determined at least one magnetic signature to ~~the at least one of the~~ configuration, ~~the and/or~~ movement and ~~the/or~~ movement intensity, wherein the algorithm is a trained artificial intelligence which has determined or learned a relationship between magnetic signatures and associated at least one of configurations, movements and movement intensities on the basis of a data set consisting of at least one magnetic signature and associated at least one of configuration, movement and movement intensity, and wherein magnetic signatures are allocated to associated at least one of configurations, movements and movement intensities with the aid of at least one of Bayes classifiers, an artificial neural network, a support vector machine, a finite state machine, a hidden Markov model, a relevance vector machine, a dynamic time warping method, a conditional random field method, a decision tree, a random forest method, a k-nearest neighbours algorithm, a discriminant analysis, a linear regression, a logistic regression, a Gaussian process, a perceptron and ensemble methods, wherein the ensemble methods include at least one of a Bayes optimal classifier, bagging, and boosting,

assigning a control command to an allocated at least one of the configuration, the movement and the movement intensity,

transmitting the control command to a device,

performing, by the device, an action corresponding to the control command.

~~11. Method according to claim 10,~~

~~characterised in that the algorithm is a trained artificial intelligence which has determined or learned the relationship between magnetic signatures and associated configurations and/or movements and/or movement intensity on the basis of a data set consisting of at least one magnetic signature and the associated configuration and/or movement and/or movement intensity.~~

~~12. Method according to claim 11,~~

~~characterised in that magnetic signatures are allocated to a configuration and/or movement and/or movement intensity with the aid of Bayes classifiers, an artificial neural network, a support vector machine, a finite state machine, a hidden Markov model, a relevance vector machine, a dynamic time warping method, a conditional random field method, a decision tree, a random forest method, a k-nearest neighbours algorithm, a discriminant analysis, a linear regression, a logistic regression, a Gaussian process, a perceptron and/or ensemble methods (Bayes optimal classifier, bagging, boosting).~~

913. The method~~Method~~ according to ~~any one of claims 810 to 12,~~ wherein characterised in that each magnetic signature includes at least one of ~~is composed of~~ measured magnetic field strengths and/or measured magnetic flux densities.

104. The method~~Method~~ according to ~~any one of claims 810 to 13,~~ wherein characterised in that, before the measurable change of the magnetic properties of the array of magnets that occurs as a result of a deformation of the skin is measured, a signal initialisation is carried out on the basis of a predetermined reference configuration.

115. The method~~Method~~ according to claim ~~913 or 14,~~ wherein the at least one of characterised in that the magnetic field strengths ~~to be measured~~ and/or the magnetic flux densities ~~to be measured~~ are detected by ~~means of~~ multiple magnetometers ~~which are preferably~~ arranged in the form of an array.

126. The method~~Method~~ according to claim 115, wherein the at least one of

~~characterised in that~~ the magnetic field strengths ~~to be measured and/or the~~ magnetic flux densities ~~to be measured~~ are detected in at least one of the x-, and/or y- and/or z-direction.

5 137. ~~The method~~Method according to claim ~~1014 in conjunction with claim 16,~~
wherein
~~characterised in that,~~ for signal initialisation, the magnetometers are zeroised in each detection direction on the basis of the predetermined reference configuration.

10 148. ~~The method~~Method according to ~~any one of claims 810 to 17,~~ wherein the
~~characterised in that the~~ deformation of the surface of the area of skin is based on an involuntary or voluntary movement of at least one of a muscle, tendon, ligament, bone and/or organ ~~movement~~.

15 159. ~~The method~~Method according to ~~any one of claims 810 to 18,~~
further comprising ~~characterised by the step of~~ determining at least one of accelerations and ~~/or~~ rotation rates in addition to determining magnetic signatures.

20 20. ~~Method according to any one of claims 10 to 19,~~
~~further characterised by the steps of~~
~~— assigning a control command to an allocated configuration and/or movement~~
~~and/or movement intensity, and~~
~~— transmitting the control command to a device.~~