

Patent claims

1. A wearable human-machine interface, comprising:

an element to be worn, the element configured to be attached to an area of
5 skin of a limb of a human or animal body,

a flexible layer, with magnetic properties, attached to the element to be worn
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 flexible layer has a
10 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
such 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
15 flexible layer caused by a corresponding deformation of the surface area of the skin,
and

an integrated or separate processing unit configured to perform an algorithm
which allocates the measured change of the magnetic properties of the flexible layer
to at least one of a configuration, a movement and a movement intensity, with the aid
20 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
25 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
30 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-machine interface according to claim 1, wherein the
35 flexible layer contains a plurality of magnets arranged in the form of an array, and
wherein the measurable change of the magnetic properties of the flexible layer
include at least one of measurable changes of a magnetic field strength of the

plurality of magnets and measurable changes of a magnetic flux density of the plurality of magnets.

3. The wearable human-machine interface according to claim 1, wherein the
5 element to be worn and the flexible layer with magnetic properties are combined in one component.

4. The wearable human-machine interface according to claim 1, wherein the
10 detection unit contains multiple magnetometers.

5. The wearable human-machine interface according to claim 1, wherein 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 organ.

6. The wearable human-machine interface according to claim 1, further
15 comprising at least one of one or more acceleration sensors and one or more rotation rate sensors, the output signals of which are fed to the processing unit.

7. The wearable human-machine interface according to claim 1, wherein the
20 human-machine interface is integrated into a smartwatch.

8. A 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
a configuration, a movement and a movement intensity, wherein the configuration is
25 a specific position of the limb of the human or animal and the movement is a temporal change of the configuration, the method comprising:

arranging an array of magnets on or close to 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
30 measuring a measurable change of magnetic properties of the array of magnets that has taken place as a result of the deformation of the skin,

performing an algorithm for allocating the determined at least one magnetic
signature to the at least one of the configuration, the movement and the movement
intensity, wherein the algorithm is a trained artificial intelligence which has
35 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
5 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,
10 the movement and the movement intensity,
transmitting the control command to a device,
performing, by the device, an action corresponding to the control command.

9. The method according to claim 8, wherein each magnetic signature includes at
15 least one of measured magnetic field strengths and measured magnetic flux densities.

10. The method according to claim 8, wherein before the measurable change of the magnetic properties of the array of magnets that occurs as a result of a
20 deformation of the skin is measured, a signal initialisation is carried out on the basis of a predetermined reference configuration.

11. The method according to claim 9, wherein the at least one of the magnetic field strengths and the magnetic flux densities are detected by multiple
25 magnetometers arranged in the form of an array.

12. The method according to claim 11, wherein the at least one of the magnetic field strengths and the magnetic flux densities are detected in at least one of the x-, y- and z-direction.
30

13. The method according to claim 10, wherein for signal initialisation, the magnetometers are zeroised in each detection direction on the basis of the predetermined reference configuration.

14. The method according to claim 8, wherein 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 organ.
35

15. The method according to claim 8, further comprising determining at least one of accelerations and rotation rates in addition to determining magnetic signatures.