(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 September 2017 (21.09.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/160155 A1

(51) International Patent Classification:
A61B 5/11 (2006.01) *A63K 3/00* (2006.01)
A01K 15/02 (2006.01) *G08B 23/00* (2006.01)
A63K 1/00 (2006.01) *G01P 15/00* (2006.01)

(21) International Application Number:
PCT/NO2016/050053

(22) International Filing Date:
18 March 2016 (18.03.2016)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **ZXY SPORT TRACKING AS** [NO/NO]; Ingvald Ystgaardsvei 23, 7047 Trondheim (NO).

(72) Inventor: **OLSTAD, Rolf**; Övre Granaaslia 28, 7047 Trondheim (NO).

(74) Agent: **CURO AS**; Vestre Rosten 81, 7075 Tiller (NO).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2017/160155 A1

(54) Title: SYSTEM AND METHOD FOR CAPTURING MOVING BEHAVIOURS OF A HORSE

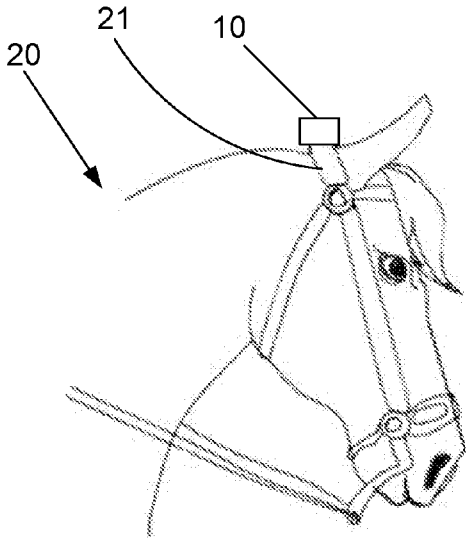

Fig. 2.

(57) Abstract: System and method for capturing moving behaviour of a horse by means of a system including at least one sensor unit (10) arranged to a horse, which sensor unit including a protective housing (11), power supply (13), microcontroller (14), internal and external memory (15), communication unit (16) and at least one sensor device (12a-d), wherein the method by means of the at least one sensor device (12a-d). By measuring one or more of: movements, accelerations, forces, changes in heading and direction, the moving behaviour of the horse can be captured and mobbing behaviour can be detected. The present invention is especially suitable as support for referees in horse races for detecting illegal or unwanted running mode and for trainers of horses.

System and method for capturing moving behaviours of a horse

The present invention relates to a system for capturing moving behaviours of a horse, according to the preamble of claim 1.

The present invention also relates to a method for capturing moving behaviours of a horse, according to the preamble of claim 6.

The present invention is especially related to detecting if a horse enters unwanted or illegal running modus or gait of the horse during a race or a training period. Also mobbing behaviour can be detected by means of the present invention.

Background

In both training and horse competitions, the running mode or gait of the horse is evaluated manually by a trainer, rider or a referee.

In e.g. a trotting race, the horse is not allowed to gallop, or more precisely gallop longer than a certain distance a given number of times to not be disqualified. If the horse enters into gallop and gains position compared to its opponents, it will be disqualified. Similar rules also apply for e.g. pace races.

Prior art discloses some solutions for observing a horse.

From GB2452538 A (THE ROYAL VETERINARY COLLEGE) it is known an apparatus for identifying sub-optimal performance in e.g. a race horse, comprising means for measuring a gait related characteristic, e.g. frequency of stride, maximum acceleration, pitch variations, and means for measuring speed or time elapsed over a measured section of the horse. The means transmits a signal to four spaced receiver feeding data processing means as to identify a predetermined physiological condition, e.g. fatigue, in the horse. The measuring can take place in real time, e.g. during a race. Speed and position can be tracked by e.g. utilising time of flight, Doppler effects, GPS. The apparatus can also be used to measure performance of a rider on the horse by sensing rider motion as well as horse motion in order to identify excessive rider motion and cost to the horse of carrying the rider.

TurfTrax Tracking System (TTS) discloses on http://www.turftrax.co.uk/tracking-technologies.html and http://svgeurope.org/blog/headlines/tracking-race-horses-in-realtime/ a radio frequency tracking system where, among others, acceleration is registered.

From US 8,166,923 B2 (Equusys Incorporatet) it is known animal instrumentation comprising one or more wireless sensors attached to the animal, for example, to measure motion-related parameters associated with one or more parts of the animal. Sensor data is received from the sensors and processed to identify a characteristic of the motion of the animal, such as a quality of gait. The sensor data can also be used to avoid injury to the animal and/or the rider, and to verify the identity of an animal.

US 5138550 describes a device for monitoring the gait of a horse comprises a device for measuring displacement parameters of the horse along at least one axis, processing device for processing the signals coming from the measuring device, microprocessor for comparing the amplitude of the output signals from the processing device means with at least one given value characterizing a gait error of the horse, and a device for indicating a gait error.

In US 2012/0225674 it is disclosed a measurement system including a wireless relay device, a moving-object-mounted terminal and a data processor. The moving-object-mounted terminal is mounted to a moving object within the wireless area. The moving-object-mounted terminal includes a Global Positioning System (GPS) unit and a wireless unit. The GPS unit acquires positional data of the moving object and time data indicating the time when the positional data has been acquired by GPS. The data processor receives the wireless signal from the moving-object-mounted terminal via the wireless relay device, and calculates time required for the moving object to move a predetermined distance within the wireless area based on the positional data and the time data.

From US 2008/0129825 it is known systems and methods facilitate autonomous image capture and/or picture production. A location unit is attached to each tracked object. An object tracking device receives location information from each location unit. A camera control device controls, based upon the location information, at least one motorized camera to capture image data of at least one tracked object.

None of the prior art solutions are arranged for detecting illegal or unwanted running mode or gait in training or competition of a horse over a measured distance in real time.

None of the prior art solutions are arranged for detecting that the state of the horse is in such a condition that the horse is to enter an illegal or unwanted running mode or gait.

None of the prior art solutions are arranged for detecting mobbing behaviour or abnormal situations due to adjacent horses in e.g. a horse race.

There is accordingly a need for providing a system and method which can be utilized by trainers or referees, arranged for detecting that the state of the horse is in such a condition that the horse is to enter an illegal or unwanted running mode gait or that the horse performs an illegal running mode or gait over a measured distance, all this in real time.

It is further a need for providing a system and method which can be utilized by trainers or referees, arranged for detecting mobbing behaviour.

Object

The main object of the present invention is to provide a system and method solving the above mentioned lacks of prior art.

It is further an object of the present invention is to provide a system and method arranged for, in real time, capturing moving behaviour of a horse and convert such moving behaviour into digital signals which can be used for registration of different running modes, such as trotting, pace or gallop of the horse.

An object of the present invention is to provide a system and method arranged for giving valuable support to referees following horse races in terms of looking for unwanted or illegal running modus or gait of the horse during the race.

Another object of the present invention is to provide a system and method arranged for giving valuable support to trainers or riders of a horse in training in terms of looking for unwanted or illegal running modus or gait of the horse during the training.

It is further an object of the present invention to provide a system and method arranged for detecting, in real time, the distance which an unwanted or illegal running modus or gait has occurred.

Another object of the present invention is to provide a system and method which by simultaneous application of the system on several horses are arranged for identifying whether an abnormal situation occurs due to impact or physical distractions caused by adjacent horse(s), by time synchronised detection of data from several sensor units.

Further objects of the present invention will appear by considering the following description, claims and drawings.

The invention

A system according to the present invention for achieving the above mentioned objects is described in claim 1. Preferable features of the apparatus are described in the claims 2-5.

A method according to the present invention for achieving the above mentioned objects is described in claim 6. Preferable features of the method are described in the claims 7-13.

The present invention is based on a sensor unit including sensor devices capable of detecting one or more of:

- movements or impact,
- accelerations,
- forces, and
- changes in heading & directions,

and by this, in real time, capture the moving behaviour of the horse.

The sensor unit is further provided with a housing which can be located or arranged to a horse for monitoring of the moving behaviour of the horse by one or more of the above mentioned measurements.

Whereupon the sensor device will capture such moving behaviours of the horse, convert such moving behaviour into digital signals which further can be logged and temporarily stored locally in the device or transmitted by an integrated radio transceiver wirelessly, and in real time, to a central unit for further processing and presentation.

By signal analysis of data collected by the sensor device it will be possible to detect if a horse enter an unwanted or illegal running modus or gait of the horse during the race or training period. If the sensor unit further either is provided with a Global Positioning receiver or connected to an automatic tracking system, one can also decide the actual position, running distance and/or time of the occurred unwanted or illegal running mode, in real time. This could be used as support for referees in horse races, such as trotting races, pace race or gallop races.

A sensor unit like this will also be able to detect if there has been an impact between horses in a race which can be used for investigating incidents in a race.

If the sensor unit is connected to an automatic tracking system provided with at least one controllable camera, the camera(s) can be controlled automatically by letting the pan, tilt and zoom parameters of the camera(s) be steered by the captured position data for the horse, thus focusing the horse entering an unwanted or illegal running mode, impact or other similar incidents, for both real time and post analysis.

A method according to the present invention will include arranging a sensor unit as described above to a horse.

The method will further include measuring movements by means of an accelerometer capable of detecting each foot step and by such, the foot step frequency as well as any impact.

The method can further include measuring rotation or speed of rotation of the horse body or part of the body the sensor unit is fixed to by means of a gyroscope. By this further information will be added to the measured data from the accelerometer.

The method can further include detecting heading of the horse by means of a magnetometer.

The method can further include using an Inertial Measurement Unit for measuring velocity, orientation, and gravitational forces for the horse.

The method will further include analysis measured data for indicating if a horse has entered an illegal or unwanted running mode by considering frequency of foot steps and peak amplitude values. If the frequency/intensity drops and the peak amplitude values deviates considerably in a time sequence this is an indication of that the running mode has changed. A gallop sequence readout of the accelerometer has a characteristic image, which consequently can be used as an event trigger for gallop.

The method can further include transmitting measured data by the sensor device(s) wirelessly by means of a Radio Frequency transmitter.

The method can further include communication with an automatic tracking system including one or more positioning sensor capable of computing the position of the horse based on analysis of transmitted radio frequency signals from the Radio Frequency transmitter of the sensor unit or by using a GPS-receiver arranged in the sensor unit for computing position, distance and speed.

The method can further include detection of mobbing behaviour by using a software application and by simultaneous application of the system on several horses for identifying whether an abnormal situation occurs due to impact or physical distractions caused by the adjacent horse, by time synchronised detection of data from several sensor units.

The method further includes combining data from the different accelerometer and automatic tracking system or GPS to detect running distance in an illegal or unwanted running mode.

The method can further include controlling a controllable camera based on positioning data from the automatic tracking system focusing on a horse in question.

The method can further include combining measured data from the accelerometer, gyroscope and magnetometer for computing displacement data for a horse.

Further preferable features and advantageous details of the present invention will become apparent from the example description below.

Example

The present invention will now be described in further details with references to the attached drawings, where:

Figure 1 is a principle drawing of a sensor unit according to the present invention,

Figure 2 is an example of a favourable arrangement of the sensor unit on a horse,

Figure 3 is an example of registration of step frequency at high intensity trotting,

Figure 4 is an example of registration of step frequency at low intensity trotting into walk,

Figures 5a-b is an example of characteristics of data when a horse changes from trotting to gallop and typical sequence of a gallop modus, respectively,

Figure 6 is a principle drawing of resulting X,Y signal vector in a pacing sequence,

Figure 7 is a principle drawing of resulting X,Y signal vector in a trotting sequence,

Figure 8 is a principle drawing of a first embodiment of system architecture, and

Figure 9 is a principle drawing of a second embodiment of system architecture.

Reference is now made to Figure 1 showing a sensor unit 10 according to the present invention. The sensor unit 10 includes a protective housing 11 (indicated by dotted lines) and the sensor unit is provided with sensor devices 12a-c for detecting one or more of: movements, acceleration, forces, changes in heading and direction. Examples of such sensor devices 12a-c are accelerometer 12a, gyroscope 12b and magnetometer 12c. Other examples of such sensor devices can be IMU (Inertial Movement Unit) 12d (shown in Figures 8 and 9). The sensor unit 10 is further provided with a power supply unit 13, advantageously in the form of batteries, but can in addition include means for harvesting energy from the environment for charging the batteries in the form of solar cells or other known means being known for a skilled person. The sensor unit 10 further includes a microcontroller 14 and internal or external memory 15 interfacing the sensor. The sensor unit 10 is further provided with a communication unit 16 in the form of a Radio Frequency (RF) transceiver and antenna for wireless transmission of the sensor device 12a-d signals.

The microcontroller 14 will be provided with software for controlling the communication, timing (clock) and logging of data from the sensor device 12a-d in the memory 15.

The protective housing 11 is preferably provided with means for arrangement of the sensor unit 10 to a horse 20. However, tests show that by locating the sensor unit 10 on the horse head, as shown in Figure 2, e.g. to a strap 21 firmly arranged to the head of the horse, it will be possible to register and log any abnormal movement of the horse head during a race or training, which might be valuable for analysis by coaches or referees. In connection with competitions/race where several horses are running in a group it will advantageous to position the communication unit 16 of the sensor unit 10 at the highest point of the horse for best communication signal.

By using a 3-axis accelerometer 12a, the sensor unit 10 will be capable of detecting each foot step or impact of the horse.

By using a 3-axis gyroscope 12b, the sensor unit 10 will be capable of detecting rotations (speed of rotation) of the body or part of the body the sensor unit 10 is fixed to.

By using a 3-axis magnetometer 12c, the sensor unit 10 will be capable of detecting the heading.

By combining measured data from the accelerometer 12a, gyroscope 12b and magnetometer 12c, this can be used to compute displacement data for the horse in situations where the external positioning system should by occlusions be prevented from computing reliable data.

The sensor unit 10 is accordingly arranged for capturing movements and moving behaviours of the horse, convert such moving behaviour into digital signals which further can be logged and temporarily stored locally in the sensor unit 10 or transmitted by the integrated radio frequency transceiver 16 wirelessly, and in real time, to a central unit 40 for further processing and presentation.

How the present invention can be used will now be described.

By means of the sensor unit 10 automatic registration of the different running modus of horse, for instance, a horse doing trotting race, pace race or gallop racing, is achieved, which might give valuable support to the referees following the races in terms of looking for unwanted or illegal running modus of the horse during the race or a trainer which would like to evaluate the horse performance.

It is known that a horse in a trotting race is not allowed to gallop, or more precisely gallop longer than a certain distance a given number of times to not be disqualified. If the horse enters into gallop and gains position compared to its opponents, it will be disqualified. Similar rules also apply for other kinds of horse races.

An example of use is for observing a horse in a trotting race. A horse in a trotting race is not allowed to gallop, or more precisely gallop longer than a certain distance a given number of times to not be disqualified. If the horse enters into gallop and gains position compared to its opponents, it will be disqualified. The present invention will be able to detect this state of gallop, and accordingly provide a support for the referee making decisions.

The measured frequency of the horse foot ranging typically from 1 to 4 steps per second (1-4 Hz) and by capturing and transmitting data at 20-30 Hz will make it possible to reproduce such moving behaviours at the central site through the involved Analogue to Digital to Analogue signal processing chain.

By performing a signal analysis of the data from the accelerometer 12a during trotting and gallop, this is characterized as shown Figures 3 and 4. The amplitudes of the peaks correspond to the power of each foot step. The time period between the peaks gives the foot step frequency. The

diagrams shown in Figures 3 and 4 clearly show changes in both foot frequency and peak amplitude values.

Figure 3 shows Footstep: 3.2 Hz → 2.6 Hz (high intensity), while Figure 4 shows low intensity trotting to walk; Frequency = 2.2 Hz.

In Figure 5a it is presented a diagram showing the characteristic of the data when the horse changes from trotting to gallop; frequency at trotting: 3.3 Hz, frequency at gallop: 1.2 Hz. In Figure 5b it is shown a sequence of a gallop modus.

From the Figures 5a-b a typical signal sequence of a gallop modus is indicated by letters A, B, C and D, where:

Letter A – indicates right foot hitting the ground

Letter B – indicates left front foot hitting the ground

Letter C – indicates right rear foot hitting the ground

Letter D – indicates left rear foot hitting the ground

From this analysis it is seen that the data sequence from the sensor unit 10 located on the horse 20 can be used to indicate whether the horse 20 is in trotting or gallop modus.

There are other types of horse running modus, such as where the horse for instance is a pacer.

Pacers move both legs on the same side forward in unison. Most wear hopples - straps connecting front and rear legs on the same side. Hopples - straps help the horse keep stride without limiting speed. Trotters move left front and right rear legs forward almost simultaneously, then follow suit with right front and left rear.

Where it might be interesting to get measures that indicate whether the horse is trotting or galloping, it might as well be interesting to get a measure whether the horse is pacing, trotting or galloping. When the characteristics of a gallop are clearly addressable, data from a more complete Inertial Motion Unit (IMU) might be needed to judge whether the horse is trotting or pacing. One addressable difference between these two modus can be derivated from more detailed analysis of the data from all three coordinate axes (X,Y,Z). Where the data analysis above is generated and shown as the absolute value of the Pythagoras sum of the data from all three axes, and a direction vector computed from the X,Y,Z - axes will be changing when the pacer shifts from left to right

foots, as shown in Figures 6 and 7, where Figure 6 shows resulting X,Y-signal vector in a pacing sequence and Figure 7 shows resulting X,Y-signal vector in trotting sequence. The change in the computed vector angle from step to step in a pacing modus is noticed to be higher than in a trotting modus due to the characteristically distribution of stabilizing power from diagonal to unison moving of the legs (as shown in Figures 6 and 7). It is verified that combining the other sensors devices of the sensor unit 10 (gyroscope, magnetometer) will be preferable to get a global representation and stabilized X- and Y-axes during a pacing /trotting sequence, resulting in a more reliable signal analysis.

System architecture of the present invention will now be described with references to Figures 8 and 9.

One or more sensor devices, here represented by an IMU section 12d, can be applied simultaneously for wireless transmission of signals to a centrally located RF receiver 41.

While this system is capable of detecting the mobbing behaviours and present the results in real time by a corresponding software application 42, it will as well be interesting to read the actual position, running distance and speed of the horse during a race. The software application 42 will further be arranged for analysing the data from the sensor devices 12a-d, especially for detecting if the frequency/intensity drops and the peak amplitude values deviate considerably in a time sequence, and this will indicate that the running mode has changed. By extending the system with a automatic tracking system 43 including one or several positioning sensors capable of computing the position of the horse based on analysis of the received radio frequency signal from each sensor unit 10, this system will provide additional information, i.e. position, distance and speed to be used by the referees in connection with horse disqualifying issues.

Alternatively, the sensor unit 10 itself can be provided with a GPS receiver 44 (indicated by dotted line in Figure 1) for computing of position, distance and speed.

Accordingly, the software application will further be arranged to combine position, running distance and speed of the horse, with running mode, in real time, and thus give an indication of the distance run by the horse in an illegal or unwanted running mode.

As mentioned above mobbing behaviour is also of interest. The software application 42 can be arranged to detect mobbing behaviour by considering time synchronised detection of data from several sensor units 10 arranged on several horses for identifying whether an abnormal situation occurs due to impact or physical distractions caused by the adjacent horse. This can also, as above,

be combined with position distance and speed of the horses, thus providing a valuable decision basis.

If the system includes an automatic tracking system 43, video cameras 45 (Figure 9) might be added with motorized pan, tilt and zoom capabilities where these parameters can be controlled by the positioning data computed by the automatic tracking system 43. In e.g. the event that a gallop will occur during a trotting race, the camera(s) 45 can then automatically be focused on the horse in question providing added information for both real time and post analysis.

The software application 42 can further be arranged for combining measured data from the accelerometer, gyroscope and magnetometer for computing displacement data for a horse in situations where external positioning system are prevented from computing reliable data.

It should further be mentioned that all the information from the sensor devices 12a-d can be of interest for a trainer of a horse. E.g. the trainer can learn more about the horse by considering information from the sensor devices 12a-d in the time before the unwanted or illegal running mode occurred. E.g. it might be that the horse moves the head more or that the horse is tripping or similar prior to the change of running mode. The trainer or rider can then use this information later for preventing the horse from doing this in the future. It can also be valuable to evaluate how a horse responds and acts in a race with other horses.

Further, the information from the sensor devices 12a-d can also be used for detecting injuries by considering the frequency and amplitude of the foot steps. If the amplitude of e.g. one foot step is lower than the others, this can indicate that there is something with this foot that needs to be investigated.

At e.g. galloping, an indication of gallop is not without further consideration a basis for disqualification. For a possible disqualification to occur the horse must have run for at least 100 meters, have repeated this a number of times, and that one in connection with gallop shall not disturb adjacent horses, and that one should get advantages or advance position in the race, etc.

In prior art there is no indication of solutions capable of detecting the above mentioned, as prior art solution only will only detect gallop and a referee must then make a subjective evaluation.

In the present invention it is provided a system where one combine transmission of (physiological) data in the same radio packet which is basis for calculating position and thus in this way ensuring automatic synchronization (time tagging) of position with the point in time when possible

irregularities occur (gallop indicator). This is vital in relation to the criteria mentioned above. A horse can run 15-16 meter per second, something which requires that the instrumentation must be precise in the time domain. In other words, with a solution according to prior art a horse will move several tens of meters before a referee is aware of an irregular gait having occurred.

By that one in the present invention ensures real-time collection of data from all the horses in a race (e.g. 100 Hz data acquisition from all the horses) also mobbing effect on adjacent horses can be measured.

By that one in addition have time synchronized position for all horses one can also measure distances between the horses and in this way establish that a galloping horse does not gain position in the field during a gallop, and at the same time the moving pattern will show that the horse is pulled out of the field.

Further, real-time in the present invention is ensured by that the signal processing is performed centrally and not in the sensor unit itself, which is natural due to size and power. The task of the sensor unit is to be time-synchronized with all the other sensor units in the system and that all data is transferred in given time slots to avoid re-transmission due to packet loss. Time-synchronization is achieved by a separate controller unit ensuring continuous (over separate wireless channel) calibration of all the clocks of the sensor units.

Accordingly, in the present invention "raw data" which is time-controlled is transferred from all the sensor units in the system to a central computer. If a horse should affect another horse, one can with the present invention with high reliability establish this by considering the characteristics in the signals from the respective sensor units at the accurate same point in time. Real-time in the present invention means ready processed data from all the horses up to 100 times per second.

Further, in the present invention tracking by camera is activated by an irregular incident and the focus is then set on the horse having an irregular incident to document that the horse with irregular incident do not disturb adjacent horses, does not gain advantages or advance position in the race, etc.

Modifications

The captured data can be visualized and distributed live on big monitors for the audience or broadcasted in TV during horse races. Visualized data might be combinations of horse positions, speed, acceleration, moving behaviour indicator (e.g. as Red, Green, Yellow flag.)

5

Claims

1. System for detecting unwanted or illegal running modus or gait horses (20) during a race, which system includes:

- at least one sensor unit (10) for arrangement to each horse (20), the sensor unit (10) including a protective housing (11), power supply (13), at least one sensor device in the form of a 3-axis accelerometer (12a) for measuring movements by detecting each foot step of the horse and by such, the foot step frequency as well as any impact, internal and external memory (15), communication unit (16), and a microcontroller (14) provided with software for controlling the communication unit (16), timing and logging of data from the sensor device (12a-d) in the memory (15),

- an automatic tracking system (43) including one or several positioning sensors capable of computing position, distance and speed of each horse (20) based on analysis of received radio frequency signal from each sensor unit (10), or the sensor unit (10) is provided with a GPS receiver (44) for calculating position, distance and speed for each horse (20),

- a central unit (40) provided with a communication unit (41) and a software application (42) being arranged for, in real time, based on signal analysis of data collected by the 3-axis accelerometer (12a), detect if a horse (20) during the race enter an unwanted or illegal running modus or gait,

characterized in that

- a central unit (40) provided with a communication unit (41) is arranged for real time simultaneous detection of time synchronized data from sensor units (10) arranged to the horses (20), and

- the software application (42) is further arranged for, in the event unwanted or illegal running modus or gait, combining position, running distance and speed of the horse (20) to find distance run by the horse (20) in the unwanted or illegal running mode, and detect mobbing behaviour by considering time synchronised detection of data from sensor units (10) arranged on all horses (20) for identifying whether an abnormal situation occurs due to impact or physical distractions caused by the horse (20) in unwanted or illegal running modus or gait, combined with position distance and speed of the horses (20).

2. System according to claim 1, wherein the sensor unit (10) further includes one ore more of:

    - 3-axis gyroscope (12b),
    - 3-axis magnetometer (12c),
    - Inertial Measurement unit (12d).

3. System according to claim 1, wherein the communication unit (16) is a radio frequency transmitter and antenna.

4. System according to claim 1, wherein the system further includes at least one video camera (45) with motorized pan, tilt and zoom capabilities where these parameters can be controlled by the positioning data computed by the automatic tracking system (43) in the event of a horse (20) entering an unwanted or illegal running mode, impact or other similar incidents, for both real time and post analysis.

5. System according to claim 2, wherein the software application (42) is further arranged for combining measured data from the 3-axis accelerometer (12a), 3-axis gyroscope (12b), and 3-axis magnetometer (12c) for computing displacement data for a horse (20) in situations where automatic tracking system (43) or GPS receivers (44) are prevented from computing reliable data.

6. Method for detecting unwanted or illegal running modus or gait a horse (20) during a race by means of a system including:

    - at least one sensor unit (10) arranged to each horse (20), the sensor unit (10) including a protective housing (11), power supply (13), at least one sensor device in the form of a 3-axis accelerometer (12a) for measuring movements by detecting each foot step of the horse and by such, the foot step frequency as well as any impact, internal and external memory (15), communication unit (16), a microcontroller (14) provided with software for controlling the communication unit (16), timing and logging of data from the sensor device (12a-d) in the memory (15), an automatic tracking system (43) including one or several positioning sensors capable of computing position, distance and speed of each horse (20) based on analysis of received radio frequency signal from each sensor unit (10), or the sensor unit (10) is provided with a GPS receiver (44) for calculating position, distance and speed for each horse (20),

- a central unit (40) provided with a communication unit (41) for real time simultaneous detection of time synchronized data from sensor units (10) arranged to the horses (20), and a software application (42), wherein the method includes::

    - by means of the 3-axis accelerometer (12a) measure movements by detecting each foot step of the horse (20) and by such, the foot step frequency as well as any impact, and by means of the software application (42), based on signal analysis of data collected by the 3-axis accelerometer (12a), detect if a horse (20) during the race enter an unwanted or illegal running modus or gait,

characterized in that the method further includes,

- real time simultaneous detection of time synchronized data from sensor units (10) arranged to the horses (20), and

- and in the event unwanted or illegal running modus or gait combine position, running distance and speed of the horse (20) to find distance run by the horse (20) in the unwanted or illegal running mode, and detect mobbing behaviour by considering time synchronised detection of data from sensor units (10) arranged on all horses (20) for identifying whether an abnormal situation occurs due to impact or physical distractions caused by the horse (20) in unwanted or illegal running modus or gait, combined with position distance and speed of the horses (20).

7. Method according to claims 6, further comprising using a gyroscope (12b) for measuring rotation or speed of rotation of the horse body or part of the body the sensor unit (10) is arranged to.

8. Method according to claim 6, further comprising using a magnetometer (12c) for detecting heading of the horse.

9. Method according to any one of the claims 6-8, further comprising using an Inertial Measurement Unit (12d) for measuring velocity, orientation, and gravitational forces for the horse.

10. Method according to claim 6, further comprising analysing measured data from the accelerometer (12a) for indicating if a horse has entered an illegal or unwanted running mode by considering frequency of foot steps and peak amplitude values.

11. Method according to any one of the claims 6-10, further comprising transmitting measured data by the sensor units (10) wirelessly by means of a Radio Frequency transmitter.

12. Method according to claim 6, further comprising, in the event of a horse (20) entering an unwanted or illegal running mode, impact or other similar incidents, for both real time and post analysis, controlling a controllable camera based on positioning data from the automatic tracking system focusing on the horse (20) in question.

13. Method according to any one of the claims 6-12, further comprising combining measured data from the accelerometer, gyroscope and magnetometer for computing displacement data for a horse.

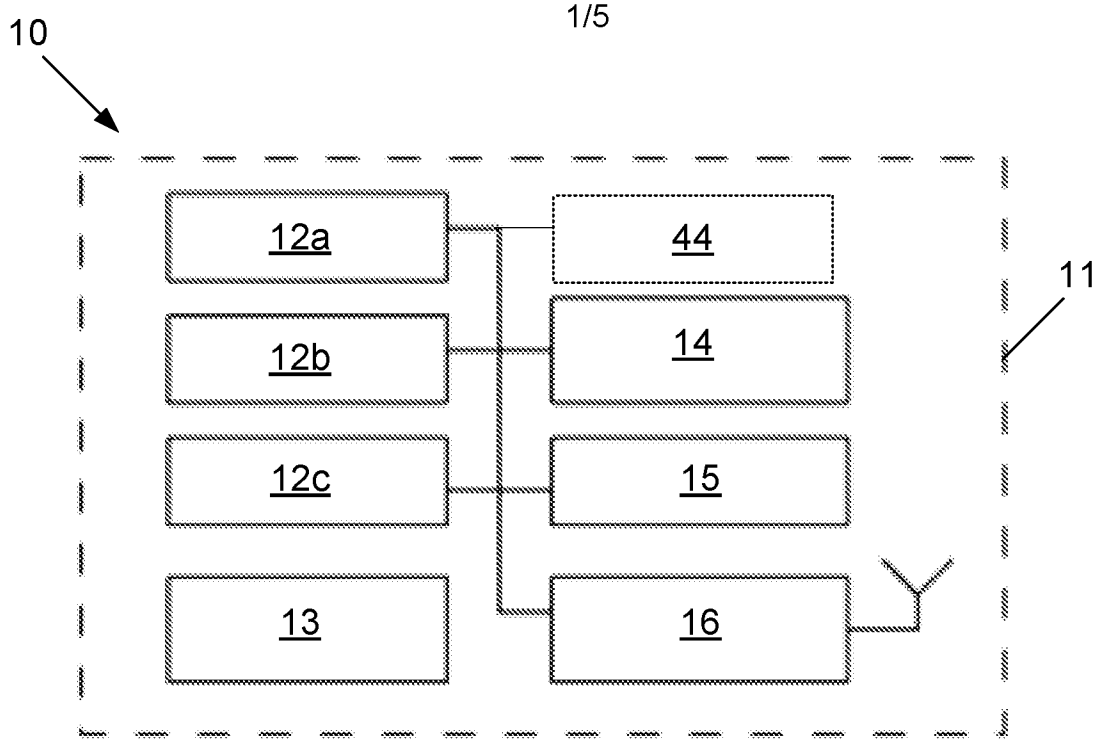

Fig. 1.

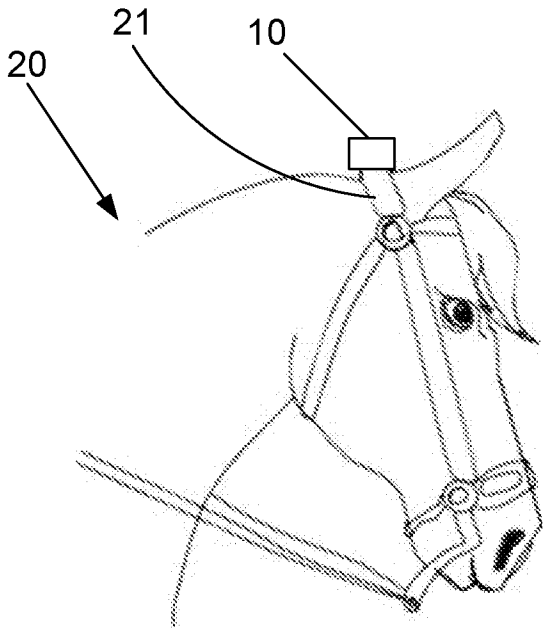

Fig. 2.

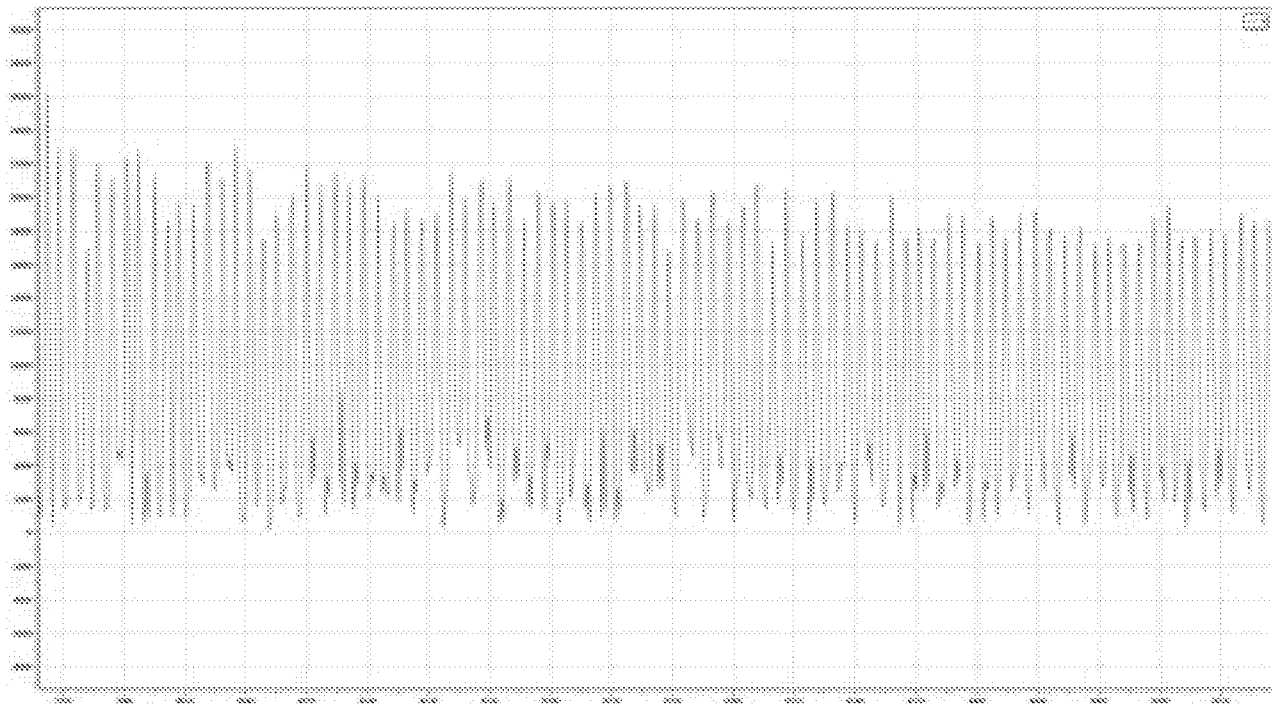

Fig. 3.

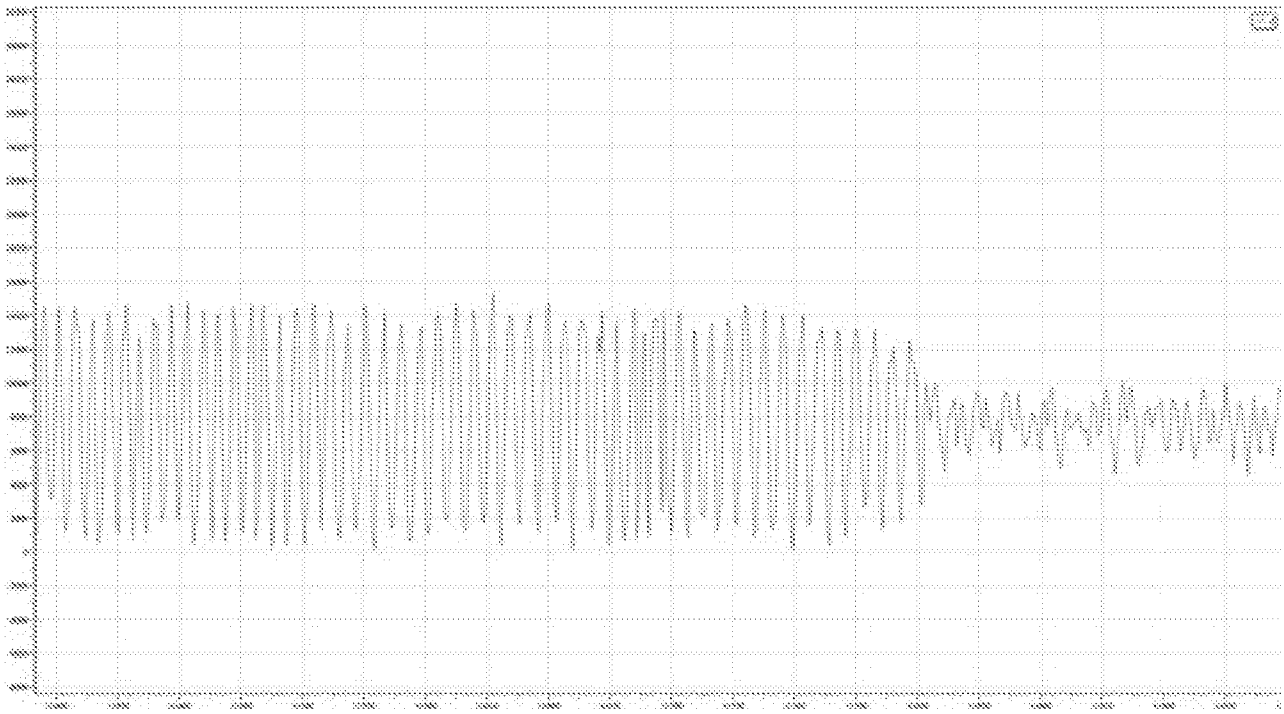

Fig. 4.

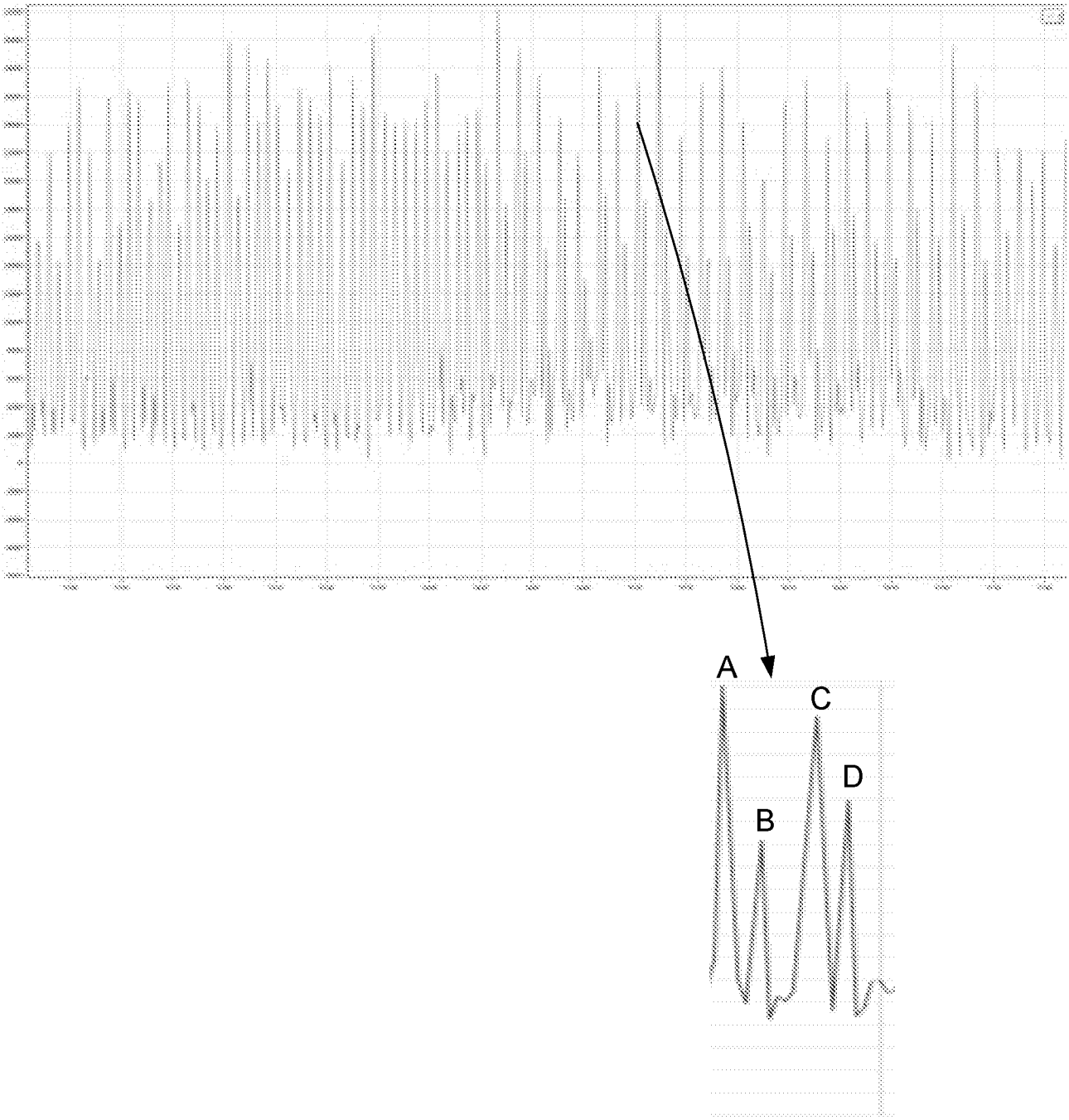

Fig. 5a.

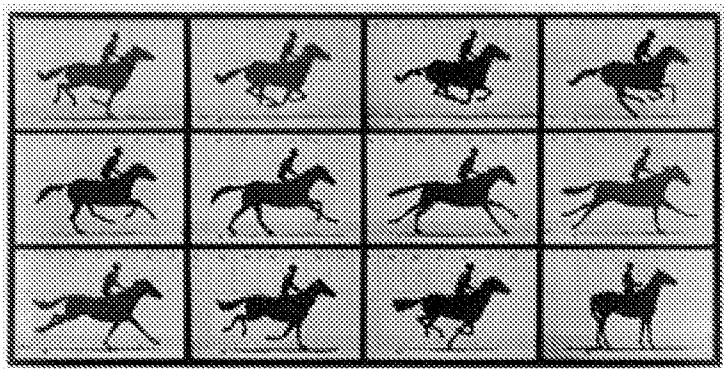

Fig. 5b.

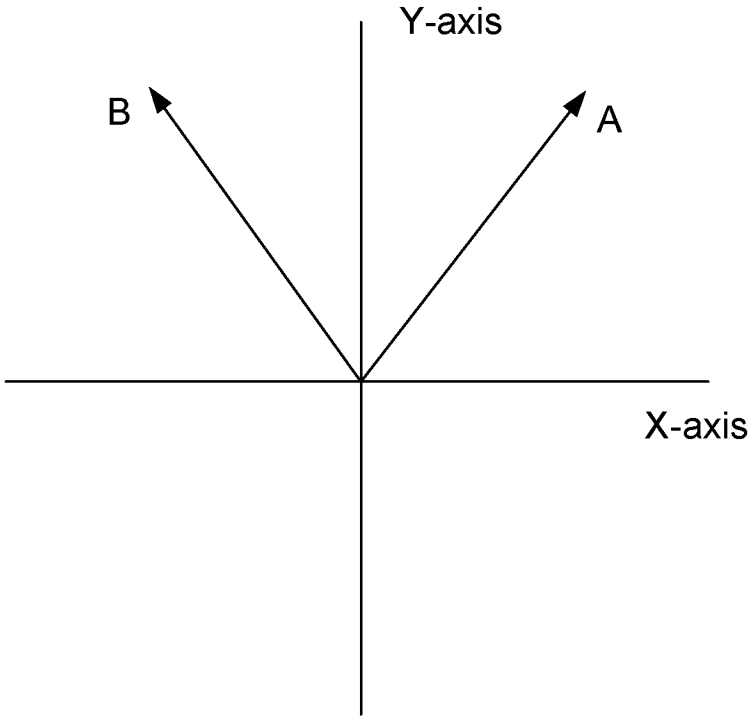

Fig. 6.

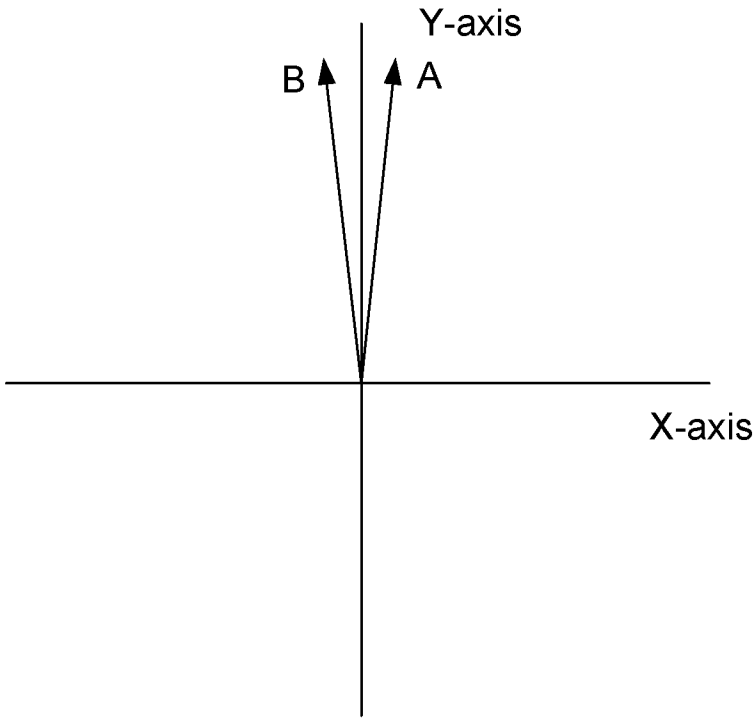

Fig. 7.

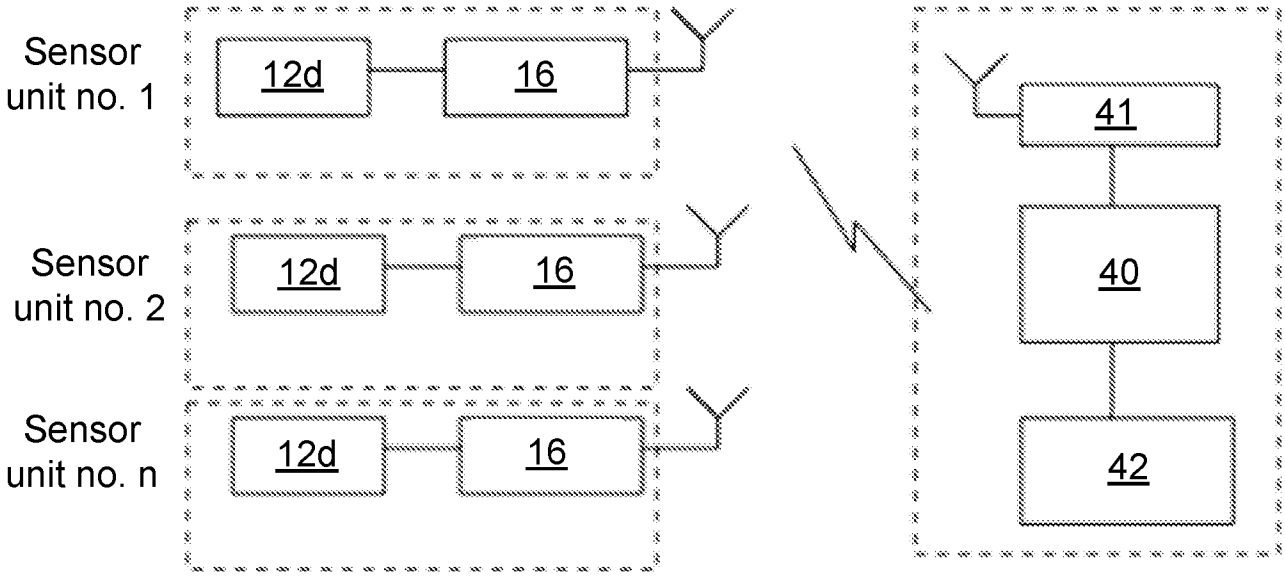
Sensor unit no. 1
12d
16
Sensor unit no. 2
12d
16
Sensor unit no. n
12d
16
41
40
42

Fig. 8.

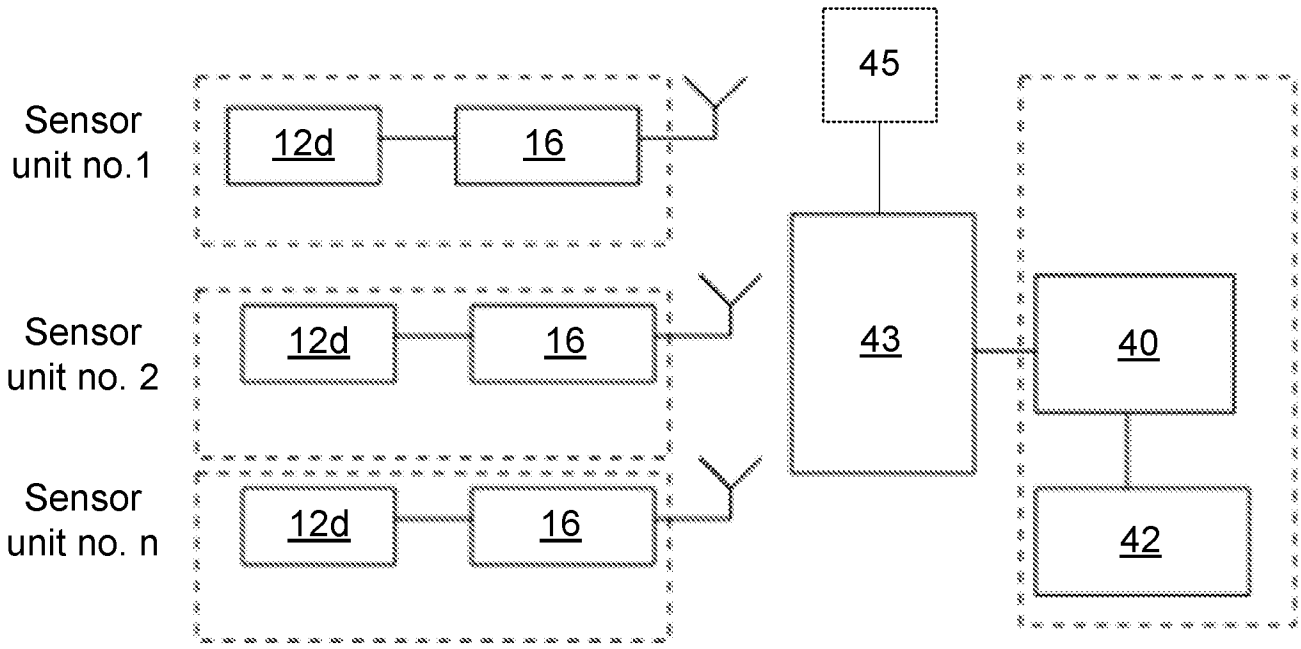
Sensor unit no.1
12d
16
Sensor unit no. 2
12d
16
Sensor unit no. n
12d
16
45
43
40
42

Fig. 9.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2016/050053

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: A01K, A61B, A63K, G01P, G08B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5138550 A1 (ABRAHAM RAYMOND ET AL), 11 August 1992 (1992-08-11); column 1, line 66 - column 2, line 16; column 2, line 34 - line 42; column 3, line 10 - line 22; column 4, line 23 - line 56; figure 2 ---	1-13
A	GB 2452538 A (ROYAL VETERINARY COLLEGE), 11 March 2009 (2009-03-11); page 2, line 4 - page 3, line 24; page 6, line 16 - line 32; page 8, line 32 - page 9, line 22; page 10, line 14 - line 29; page 12, line 8 - line 12; page 14, line 4 - line 7; page 14, line 16 - page 15, line 3; figures 1-9 ---	1-13

☒ 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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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	Date of mailing of the international search report
21-12-2016	22-12-2016

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Jenny Wallner Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2016/050053

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 8901760 A1 (NYBERG KARL ERIK), 9 March 1989 (1989-03-09); page 1, line 1 - line 4; page 2, line 10 - line 29; page 3, line 1 - line 33; figure 1	1-13
	--	
A	US 20110218463 A1 (HODGINS DIANA ET AL), 8 September 2011 (2011-09-08); paragraphs [0001], [0006]-[0009], [0025]; figures 1a-b	1-13
	--	
A	US 20110105862 A1 (GIES VALENTIN ET AL), 5 May 2011 (2011-05-05); paragraphs [0017]-[0021], [0050]-[0053], [0056], [0075], [0082]-[0088], [0106]; figure 1	1-13
	--	
A	US 20100250179 A1 (MARIANO THOMAS ET AL), 30 September 2010 (2010-09-30); paragraphs [0001], [0005], [0018]-[0020], [0049]-[0050], [0052], [0057], [0062]-[0063]; figures 3-4	1-13
	--	
A	US 20120059235 A1 (DAVIES MICHAEL ALLAN MARTIN), 8 March 2012 (2012-03-08); paragraphs [0027]-[0030], [0034], [0050], [0071], [0090], [0105]; figures	1-13
	--	
A	EP 1992389 A1 (MNT INNOVATIONS PTY LTD), 19 November 2008 (2008-11-19); paragraphs [0001], [0011], [0013], [0021], [0060]; column 12, line 27 - line 35; figure 7	1-13
	--	
A	US 20160021492 A1 (CARLSSON GREGORY PETER ET AL), 21 January 2016 (2016-01-21); paragraphs [0006], [0008], [0010]-[0012], [0039]-[0041], [0043]-[0044]; figures 1-5,7	1-13
	--	
A	K. Conroy, G. May, M. Roantree, G. Warrington, S. J. Cullen, A. McGoldrick, A. Cuzzocrea, U. Dayal, 2011, Knowledge Acquisition from Sensor Data in an Equine Environment, DaWaK 2011, Vol 6862, Springer-Verlag Berlin Heidelberg, p. 432-444, ISBN 978-3-642-23543-6; abstract; page 434, line 1 - line 6	1-13
	--	

International application No.
PCT/NO2016/050053

Continuation of: second sheet

International Patent Classification (IPC)

A61B 5/11 (2006.01)
A01K 15/02 (2006.01)
A63K 1/00 (2006.01)
A63K 3/00 (2006.01)
G08B 23/00 (2006.01)
G01P 15/00 (2006.01)

US	5138550	A1	11/08/1992	AU	4875090	A	16/08/1990
				AU	619074	B2	16/01/1992
				CA	2008855	A1	31/07/1990
				DE	69001140	D1	29/04/1993
				EP	0381553	B1	24/03/1993
				FR	2642325	B1	17/05/1991
				NZ	232299	A	23/12/1991
GB	2452538	A	11/03/2009	WO	2009030939	A3	03/12/2009
WO	8901760	A1	09/03/1989	AU	2329688	A	31/03/1989
US	20110218463	A1	08/09/2011	AU	2009315429	A1	30/06/2011
				CA	2743732	A1	20/05/2010
				EP	2378969	A1	26/10/2011
				US	8715208	B2	06/05/2014
				WO	2010055352	A1	20/05/2010
US	20110105862	A1	05/05/2011	AU	2009247945	B2	20/11/2014
				CN	102083358	A	01/06/2011
				EP	2309920	B1	06/07/2016
				FR	2930421	A1	30/10/2009
				JP	2011522569	A	04/08/2011
				WO	2009138587	A3	21/01/2010
US	20100250179	A1	30/09/2010	NONE			
US	20120059235	A1	08/03/2012	AU	2006318459	A1	31/05/2007
				EP	1956981	A1	20/08/2008
				JP	2009517047	A	30/04/2009
				US	20070130893	A1	14/06/2007
				WO	2007062102	A1	31/05/2007
EP	1992389	A1	19/11/2008	AU	2008202170	A1	04/12/2008
				US	20080284650	A1	20/11/2008
				US	8036826	B2	11/10/2011
US	20160021492	A1	21/01/2016	CN	105282219	A	27/01/2016
				TW	201616907	A	01/05/2016
				US	9516461	B2	06/12/2016