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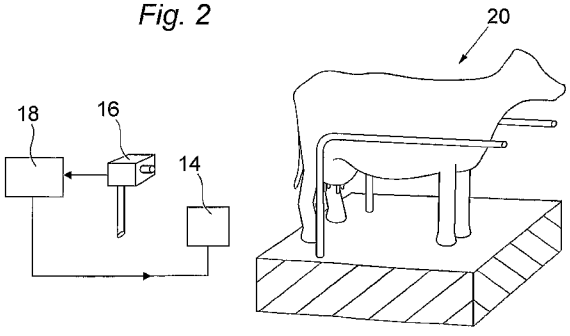
(54) Title: MILKING APPARATUS AND PROCESS

Fig. 2



(57) Abstract: The present invention relates to milking apparatus. The milking apparatus comprises sensor apparatus (16) that is operative, in use of the milking apparatus, to determine a location in a lateral direction with respect to an animal of at least one anatomical feature of the animal, the at least one anatomical feature being other than an udder of the animal. The sensor apparatus comprises image capture apparatus (16) that is operative to acquire at least one image of at least part of the animal. The milking apparatus also comprises a robot arm (14) located, in use of the milking apparatus, either behind or in front of the animal, the robot arm (14) being operative to move towards the udder in dependence upon the determined location of the anatomical feature.

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Milking apparatus and process

Field of the invention

The present invention relates to a milking apparatus and a milking process.

Background to the invention

Robotic milking apparatus is known. Such known apparatus is operative to attach teat cups to the teats of a cow that is to be milked by means of a robot arm or the like. WO 2005/015985 describes a teat locating sensor that is operative to determine locations of the teats of a cow that is to be milked. A robot arm of the robotic milking apparatus is operative to move to the teats and to attach the teat cups to the teats in dependence on the thus determined locations of the teats.

Cows vary in size and shape and are liable to move when in a milking parlour. Hence, it can be problematic to move an arm of robotic milking apparatus to a cow's udder so that the teat locating sensor of WO 2005/015985 can be brought into operation. Approaches to moving a robotic arm to a cow's udder are known. For example, WO 00/41559 describes a method of determining the general position of a cow's udder by measuring the cow in advance of the milking process and assigning the cow to one of a predetermined number of classes. The robotic milking apparatus of WO 00/41559 is operative in dependence on the assigned classification to move to the udder and to attach teat cups to the teats of the udder.

The present inventor has appreciated shortcomings of known approaches to providing for movement of a robotic milking arm to an udder of an animal.

Therefore it is an object for the present invention to provide improved milking apparatus having a robot arm that is operative to move towards an udder of an animal.

It is a further object for the present invention to provide an improved milking process in which a robot arm of milking apparatus moves towards an udder of an animal.

Statement of invention

The present invention has been devised in the light of the inventor's appreciation of the shortcomings of the above mentioned known approaches. Thus, according to a first aspect of the present invention there is provided milking apparatus comprising:

sensor apparatus operative, in use of the milking apparatus, to determine a location in a lateral direction with respect to an animal of at least one anatomical feature of the animal, the at least one anatomical feature being other than an udder of the animal, the sensor apparatus comprising image capture apparatus that is operative to acquire at least one image of at least part of the animal; and

a robot arm located, in use of the milking apparatus, either behind or in front of the animal, the robot arm being operative to move towards the udder in dependence upon the determined location of the anatomical feature.

The apparatus of WO 00/41 559 comprises a robot arm that is located to one side of an animal in the milking apparatus. Thus, the reach of the robot arm of WO 00/41559 towards the udder is unimpeded by the anatomy of the animal. The present inventor has appreciated that if the robot arm of WO 00/41 559 were to be located either behind the animal, e.g. as may be desirable in a rotary milking parlour, or in front of the animal, the classification approach of WO 00/41559 may be incapable of taking movement of the animal with respect the milking apparatus or movement of one anatomical feature of the animal in relation to another into account in providing for unimpeded movement of the robot arm to the udder. The present invention addresses these problems by determining a location in a lateral direction of an anatomical feature of the animal other than the udder and moving the robot arm in dependence on the determined location. The at least one anatomical feature may, for example, be at least one leg of the animal. The image capture apparatus is operative to acquire at least one image of at least part of the animal, e.g. an image of the rear and the hind legs of the animal.

Thus, the sensor apparatus may be operative to determine the location of at least one leg, such as at least one hind leg, of the animal in a lateral direction. More specifically, the location of at least one leg in relation to one of the sensor apparatus and the robot arm may be determined. Thus, movement of the robot arm may take account of movement of the animal in relation to the milking apparatus. Where the location in relation to the sensor apparatus is determined, a location of the robot arm in relation to the sensor apparatus may be determined, whereby the location of the robot arm in relation to the at least one leg may be determined. In use, determining the location of at least one leg may allow for the robot arm to pass the at least one leg unimpeded and towards the udder.

Alternatively or in addition, the sensor apparatus may be operative to determine a separation between two legs, such as the hind legs, of the animal. In use, determination of the separation between the legs may allow, for example, for a determination as to whether or not the reach of the robot arm is impeded by the legs or for a determination as to how much room there is for passage of the robot arm between the legs.

Alternatively or in addition, the sensor apparatus may be further operative to determine a height of the udder of an animal in relation to one of the sensor apparatus and the robot arm.

Alternatively or in addition, the sensor apparatus may be further operative to determine a distance between the udder of an animal and one of the sensor apparatus and the robot arm.

Alternatively or in addition, the sensor apparatus may be operative to determine the location of the at least one anatomical feature in relation to the sensor apparatus.

Alternatively or in addition, the robot arm may be operative to move in dependence on a location of the robot arm in relation to the sensor apparatus.

The robot arm may be configured such that it can be located behind or in front of the animal. The robot arm may be configured, for example, by having dimensions such that it can pass between legs of the animal towards the udder or by having a reach sufficient that a distal portion of the robot arm can reach the udder.

Alternatively or in addition, the sensor apparatus may be operative to provide an electronic signal corresponding to the determined location of the anatomical feature and the robot arm may be operative to move in dependence on the electrical signal provided by the sensor apparatus.

Alternatively or in addition, the sensor apparatus may be operative to determine the location of the anatomical feature without touching the animal.

More specifically, the image capture apparatus may be operative to acquire an image in at least two dimensions. Thus, for example, the image capture apparatus may comprise a two-dimension visual or thermal camera.

Alternatively or in addition, the image capture apparatus may be operative to acquire an image in three dimensions. Thus, for example, the image capture apparatus may comprise a laser triangulation sensor, a laser scanner or a time of flight camera.

Alternatively or in addition, the milking apparatus may comprise processing apparatus that is operative to process electronic signals from the sensor apparatus. The processing apparatus may comprise a microprocessor that forms part, for example, of an embedded microprocessor arrangement.

More specifically, where the sensor apparatus comprises image capture apparatus, the processing apparatus may be operative to process at least one image acquired by the image capture apparatus.

More specifically, the processing apparatus may be operative to define at least one region in an acquired image.

More specifically, the processing apparatus may be operative to define initial and searching regions in the acquired image.

More specifically, the initial region may be smaller than the searching region.

Alternatively or in addition, the processing apparatus may be operative to define an initial region in an acquired image, the initial region lacking electronic data, e.g. pixels, corresponding to a part of the animal. The initial region may be at or towards a centre of the image. If an initial region lacking electronic data corresponding to a part of the animal cannot be defined, the processing apparatus may be operative to cease operation of the milking apparatus. For example, if an animal is lying down no initial region lacking electronic data corresponding to a part of the animal may be defined and thus the milking procedure is discontinued.

Alternatively or in addition, the processing apparatus may be operative to determine whether or not the initial region is substantially clear. If the initial region is not substantially clear processing apparatus may be operative to cease operation of the milking apparatus. The lack of an initial region that is substantially clear may, for example, indicate the presence of a milking cluster that is either properly or improperly attached to the teats, whereby the teats are not yet ready for disinfection.

Alternatively or in addition, the processing apparatus may be operative to define a searching region in the acquired image and to carry out a search within the searching region for electronic data corresponding to a part of

an animal. If a search of the searching region determines no electronic data corresponding to a part of an animal, the processing apparatus may be operative to cease operation of the milking apparatus. For example, if there is no animal present no electronic data corresponding to a part of an animal may be determined and thus the milking procedure is discontinued.

More specifically, the processing apparatus may be operative to carry out a search from a first part of the searching region towards a second part of the searching region, the first part corresponding to a lower part of a view of the image capture apparatus and the second part corresponding to an upper part of the view of the image capture apparatus. Following this approach may reduce the risk, for example, that the teats of an animal are confused for legs of the animal.

More specifically, the processing apparatus may be operative to determine a representation of at least part of at least one leg in the searching region as the search progresses from the first to the second part.

More specifically, the processing apparatus may be operative to determine a representation of at least part of an udder in the searching region after determination of the representation of at least part of at least one leg as the search progresses further from the first to the second part.

Determination of a feature, such as a part of a leg or an udder, may be achieved by the processing apparatus by means of a thresholding process. More specifically, the thresholding process may comprise comparing a change in amplitude of electronic data, e.g. pixels, from one part of the searching region to another with a threshold value and if the change in amplitude is greater than the threshold value determining that a

feature is represented by one of the first and second parts of the searching region.

Alternatively or in addition, the processing apparatus may be operative to carry out a search from substantially a centre of the searching region towards a periphery of the searching region.

Alternatively or in addition, the processing apparatus may be operative to filter an acquired image. Filtering may, for example, be used to remove noise present in an acquired image.

More specifically, electronic data, e.g. pixels, in at least a part of the acquired image may be averaged.

Alternatively or in addition, electronic data in at least a part of each of a plurality of acquired images may be averaged from acquired image to acquired image.

Alternatively or in addition, electronic data in at least a part of the acquired image may be filtered using a median filter. A median filter may be used to remove or at least attenuate salt and pepper noise.

Alternatively or in addition, the processing apparatus may be operative to pre-process an acquired image.

More specifically, at least one portion of the acquired image smaller than a predetermined size may be removed from the acquired image.

More specifically and where image capture apparatus is operative to acquire the image in three dimensions, the processing apparatus may be

operative to determine objects between spaced apart distances from the image capture apparatus. The processing apparatus may be further operative to remove determined objects smaller than a predetermined size, e.g. 40 pels.

The milking apparatus may further comprise at least one stall configured to accommodate an animal and to maintain the animal in a predetermined orientation in relation to the stall, at least one of the robot arm and the sensor apparatus being disposed in relation to the stall such that the at least one of the robot arm and the sensor apparatus is either behind or in front of the animal.

The robot arm may be further operative to perform at least one of: pre-milking teat disinfection; pre-milking teat cleaning; teat cup attachment; and post-milking teat disinfection.

The milking apparatus may further comprise a teat locating sensor. The teat locating sensor may comprise an image capture apparatus that is operative to determine the location of at least one teat on the basis of an acquired image. The teat locating sensor may be of a kind as described in WO 2005/015985. Thus, the robot arm of the milking apparatus may be operative to perform an action, such as teat cup attachment, in dependence upon operation of the image capture apparatus and after movement of the robot arm towards the udder.

The milking apparatus may comprise a rotary milking parlour. More specifically, the robot arm may be located behind an animal in a stall of the rotary milking parlour. Alternatively or in addition, the sensor apparatus may be located generally behind an animal in a stall of the rotary milking parlour.

According to a second aspect of the present invention, there is provided a milking process comprising:

determining a location in a lateral direction with respect to an animal in a milking apparatus of an anatomical feature of the animal by means of sensor apparatus, the anatomical feature being other than an udder of the animal, the sensor apparatus comprising image capture apparatus that is operative to acquire at least one image of at least part of the animal; and

operating a robot arm located either behind or in front of the animal such that the robot arm moves towards the udder in dependence upon the determined location of the anatomical feature.

Features of the second aspect of the present invention may comprise one or more features of the first aspect of the present invention.

According to a third aspect of the present invention, there is provided milking apparatus comprising: a robot arm; and sensor apparatus operative, in use of the milking apparatus, to determine a height of an udder of an animal in relation to the robot arm, the robot arm being operative, in use of the milking apparatus, to move towards the udder in dependence upon the determined height of the udder.

Features of the third aspect of the present invention may comprise one or more features of the first aspect of the present invention.

According to a fourth aspect of the present invention, there is provided milking apparatus comprising: a robot arm located, in use of the milking apparatus, either behind or in front of an animal; and sensor apparatus operative, in use of the milking apparatus, to determine a location in a

longitudinal direction with respect to the animal of an udder of the animal in relation to the robot arm, the robot arm being operative to move towards the udder in dependence upon the determined location of the udder.

Embodiments of the fourth aspect of the present invention may comprise one or more features of the first aspect of the present invention.

The term lateral direction with respect to an animal as used herein means in a direction substantially orthogonal to a longitudinal direction with respect to the animal, the longitudinal direction extending between the head and the rear of the animal.

Alternatively or in addition, the term lateral direction with respect to an animal may mean in a direction substantially orthogonal to a longitudinal direction and orthogonal to a vertical direction with respect to the animal.

According to a further aspect of the present invention there is provided milking apparatus comprising:

sensor apparatus operative, in use of the milking apparatus, to determine a location in a lateral direction with respect to an animal of at least one anatomical feature of the animal, the at least one anatomical feature being other than an udder of the animal; and

a robot arm located, in use of the milking apparatus, either behind or in front of the animal, the robot arm being operative to move towards the udder in dependence upon the determined location of the anatomical feature.

Embodiments of the further aspect of the present invention may comprise one or more features of the first aspect of the present invention.

Brief description of drawings

Further features and advantages of the present invention will become apparent from the following specific description, which is given by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is representation of a milking apparatus according to the present invention;

Figure 2 is a detailed view of a stall of the milking apparatus shown in Figure 1;

Figure 3 is a view as seen by the camera of the milking apparatus of Figures 1 and 2; and

Figure 4 is a flow chart representation of the operation of the apparatus shown in Figures 1 and 2.

Figure 1 is a representation of a milking apparatus 10 according to the present invention. The milking apparatus comprises a rotary milking parlour 12 of conventional form and function, which rotates so as to position one or more cows held within stalls of the milking parlour at a robotic milking station (not shown). The milking apparatus of Figure 1 also comprises a robot teat disinfection apparatus 14 of conventional form and function except as described herein. The robot teat disinfection apparatus is operative after milking is complete to disinfect a cow's teats. The robot teat disinfection apparatus 14 is shown and described for the purposes of describing the present invention. The invention is operable with apparatus other than robot teat disinfection apparatus, such as pre-milking teat disinfection and cleaning apparatus and teat cup attachment apparatus. Such apparatus comprises a robot arm of conventional form and function that bears operative apparatus, such as teat disinfection apparatus.

The milking apparatus of Figure 1 also comprises a time of flight camera 16 (which constitutes image capture apparatus) that is oriented such that it has a view of a rear of a cow in a stall of the rotary milking parlour 12. The time of flight camera is a PhotonICs® PMD 1k-S 3D Time-of-Flight camera from PMDTechnologies GmbH, Am Eichenhang 50, D-57076 Siegen, Germany. In addition, the milking apparatus also comprises processing apparatus 18 that receives images acquired by the time of flight camera 16 and processes the received images before providing control signals to the robot teat disinfection apparatus 14. The processing apparatus comprises embedded microprocessor apparatus of conventional form and function.

Figure 2 provides a more detailed view of apparatus of the present invention. Figure 2 shows a single stall 20 of the rotary milking parlour 12 of Figure 1, which holds a cow with the time of flight camera disposed behind the cow and oriented such that the camera has a view of the rear of the cow 30 and the surrounding structure of the stall 32, as shown in Figure 3. The processing apparatus is also shown in Figure 2. The robot teat disinfection apparatus 14 is disposed behind the cow such that a robot arm of the robot teat disinfection apparatus can extend between the cow's legs 34, 36 towards the cow's udder 38.

The operation of the apparatus of Figures 1 and 4 will now be described with reference to Figure 3 and the flow chart 50 of Figure 4. An image as shown in Figure 3 is acquired 52 by means of the time of flight camera 16. An initial region 40 is defined 54 within the acquired image. The initial region has dimensions that reflect the space required for movement of the robot arm towards the udder. If no initial region lacking pixels corresponding to a part of the cow can be defined 56, the process stops 58. This is because the lack of an initial region containing no pixels

corresponding to a part of the cow is indicative of a condition that would prevent extension of the robot arm towards the cow's udder, e.g. a cow lying down in the stall. Also, if no initial region that is substantially clear can be defined, the process stops. This is because the lack of an initial region that is substantially clear indicates the presence of a milking duster that is either properly or improperly attached to the teats, whereby the teats are not yet ready for disinfection.

The processing apparatus is operative to filter pixel values of each acquired image. Averaging is over 7 x 7 pixel regions and over three successive frames. A 3 x 3 median filter is used to remove salt and pepper noise. Each image is pre-processed to detect and remove regions smaller than 40 pels. Objects within a predetermined range of distances from the image capture apparatus are determined. Then, the processing apparatus is operative to remove such determined objects where they are smaller than 40 pels.

Next a searching region 42 is defined 60. The searching region 42 is appreciably larger than the initial region 40. The searching region is of dimensions that the searching region is likely to contain at least part of each of the hind legs of the cow. A search 62 is performed on the pixels of the searching region from the centre of the rows of the searching region outwards and from the bottom row of pixels upwards row by row until pixels corresponding to spaced apart parts of the cow are determined. The search of the searching region and the determination as to whether or not the initial region contains pixels corresponding to an animal part is accomplished by means of a thresholding approach. The thresholding approach involves comparing a change in amplitude from one pixel to another or one group of pixels to another. If the change is greater than a predetermined amount this indicates the presence of pixels corresponding

to an edge of a part of the cow. Thresholding is performed on the depth information in acquired images. More specifically, information contained in an image that is closer to the image capture apparatus than a predetermined value (or threshold) is removed and information contained in an image that is further away from the image capture apparatus than a predetermined value is removed. For example, the predetermined values may be set such that the front legs of the cow are removed. Where a thermal camera is used, the predetermined values are set to allow for removal of pixels that are either too hot or too cold to be an anatomical feature of a cow. Where a visual spectrum or NIR (near infrared) camera is used, groups of pixels are characterised by the distribution of their pixel values as corresponding to cow anatomy or not.

When pixels corresponding to spaced apart parts of the cow are found this indicates that the hind legs 34, 36 of the cow have been found. The distance between the spaced apart parts and the location of each of the spaced apart parts is determined 68. If the search uncovers no spaced apart parts 64 the process stops 66. This is because uncovering no spaced apart parts is indicative of a fault condition, such as the stall being empty.

The search of the searching region 42 is continued further upwards 70 until pixels corresponding to a further animal part are found. Such pixels are sought by means of the thresholding approach described above. The finding of such pixels indicates that the udder 38 has been found. The height of the further animal part (i.e. the udder) is determined along with the distance between the time of flight camera 16 and the udder 38 by means of the three-dimension imaging capability of the camera.

Having determined the location of the legs, the distance between the legs, the height of the udder and the distance to the udder, electrical signals are provided by the processing apparatus 18 to the robot teat disinfection apparatus 14 so that the robot arm moves in an appropriate direction so as to pass between the legs and at an appropriate height and for an appropriate distance such that the robot arm is positioned nearby the cow's udder.

Although not shown in the drawings appended hereto, the robot teat disinfection apparatus comprises a teat locating sensor of the kind described in WO 2005/015985. Thus and as described in detail in WO 2005/015985, having been positioned nearby the udder by means of the present invention, the robot arm of the teat disinfection apparatus is operative to perform teat disinfection in dependence upon operation of the teat locating sensor.

CLAIMS:

1. Milking apparatus comprising:

sensor apparatus operative, in use of the milking apparatus, to determine a location in a lateral direction with respect to an animal of at least one anatomical feature of the animal, the at least one anatomical feature being other than an udder of the animal, the sensor apparatus comprising image capture apparatus that is operative to acquire at least one image of at least part of the animal; and

a robot arm located, in use of the milking apparatus, either behind or in front of the animal, the robot arm being operative to move towards the udder in dependence upon the determined location of the anatomical feature.

2. Apparatus according to claim 1, in which the image capture apparatus is operative to acquire an image in at least two dimensions.

3. Apparatus according to claim 1 or 2, in which the image capture apparatus is operative to acquire an image in three dimensions.

4. Apparatus according to claim 3, in which the image capture apparatus comprises a time of flight camera.

5. Apparatus according to any preceding claim, in which the sensor apparatus is configured such that it is operative to determine the location of the anatomical feature without touching the animal.

6. Apparatus according to any preceding claim, in which the sensor apparatus is operative to determine the location of at least one leg of the animal in a lateral direction.

7. Apparatus according to claim 6, in which the sensor apparatus is operative to determine the location of at least one leg in relation to one of the sensor apparatus and the robot arm.

8. Apparatus according to any preceding claim, in which the sensor apparatus is operative to determine a separation between two legs of the animal.

9. Apparatus according to any preceding claim, in which the sensor apparatus is further operative to determine a height of the udder of the animal in relation to one of the sensor apparatus and the robot arm.

10. Apparatus according to any preceding claim, in which the sensor apparatus is further operative to determine a distance between the udder of the animal and one of the sensor apparatus and the robot arm.

11. Apparatus according to any preceding claim, in which the sensor apparatus is operative to determine the location of the at least one anatomical feature in relation to the sensor apparatus.

12. Apparatus according to any preceding claim, in which the robot arm is operative to move in dependence on a location of the robot arm in relation to the sensor apparatus.

13. Apparatus according to any preceding claim, in which the milking apparatus comprises processing apparatus that is operative to process at least one image acquired by the image capture apparatus.

14. Apparatus according to claim 13, in which the processing apparatus is operative to define initial and searching regions in the acquired image.

15. Apparatus according to claim 14, in which the initial region is smaller than the searching region and the initial region is wholly contained within the searching region.

16. Apparatus according to any one of claims 13 to 15, in which the processing apparatus is operative to define an initial region in an acquired image, the initial region lacking electronic data corresponding to a part of the animal.

17. Apparatus according to claim 16, in which the processing apparatus is operative to determine whether or not the initial region is substantially clear.

18. Apparatus according to any one of claims 13 to 17, in which the processing apparatus is operative to define a searching region in the acquired image and to carry out a search within the searching region for electronic data corresponding to a part of an animal.

19. Apparatus according to claim 18, in which the processing apparatus is operative to carry out a search from a first part of the searching region towards a second part of the searching region, the first part corresponding to a lower part of a view of the image capture apparatus and the second

part corresponding to an upper part of the view of the image capture apparatus.

20. Apparatus according to claim 19, in which the processing apparatus is operative to determine a representation of at least part of at least one leg in the searching region as the search progresses from the first to the second part.

21. Apparatus according to claim 20, in which the processing apparatus is operative to determine a representation of at least part of an udder in the searching region after determination of the representation of at least part of at least one leg as the search progresses further from the first to the second part.

22. Apparatus according to any one of claims 18 to 21, in which the processing apparatus is operative to carry out a search from substantially a centre of the searching region towards a periphery of the searching region.

23. Apparatus according to any preceding claim, further comprising at least one stall configured to accommodate an animal and to maintain the animal in a predetermined orientation in relation to the stall, at least one of the robot arm and the sensor apparatus being disposed in relation to the stall such that the at least one of the robot arm and the sensor apparatus is either behind or in front of the animal.

24. Apparatus according to any preceding claim, in which the robot arm is configured and is further operative to perform at least one of: pre-milking teat disinfection; pre-milking teat cleaning; teat cup attachment; and post-milking teat disinfection.

25. Apparatus according to any preceding claim, further comprising a teat locating sensor, the robot arm being operative to perform at least one of pre-milking teat disinfection, pre-milking teat cleaning, teat cup attachment and post-milking teat disinfection, in dependence upon operation of the image capture apparatus and after movement of the robot arm towards the udder.

26. Apparatus according to any preceding claim, further comprising a rotary milking parlour.

27. A milking process comprising:

determining a location in a lateral direction with respect to an animal in a milking apparatus of an anatomical feature of the animal by means of sensor apparatus, the anatomical feature being other than an udder of the animal, the sensor apparatus comprising image capture apparatus that is operative to acquire at least one image of at least part of the animal; and

operating a robot arm located either behind or in front of the animal such that the robot arm moves towards the udder in dependence upon the determined location of the anatomical feature.

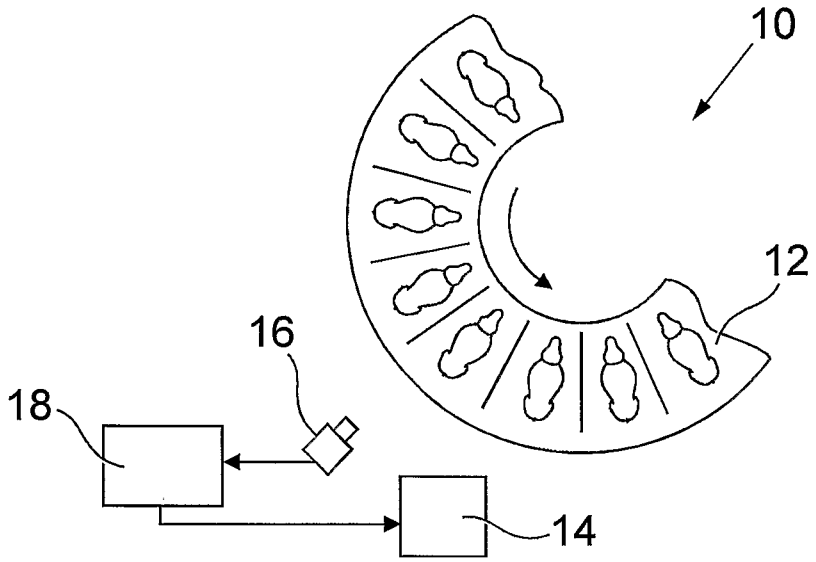

Fig. 1

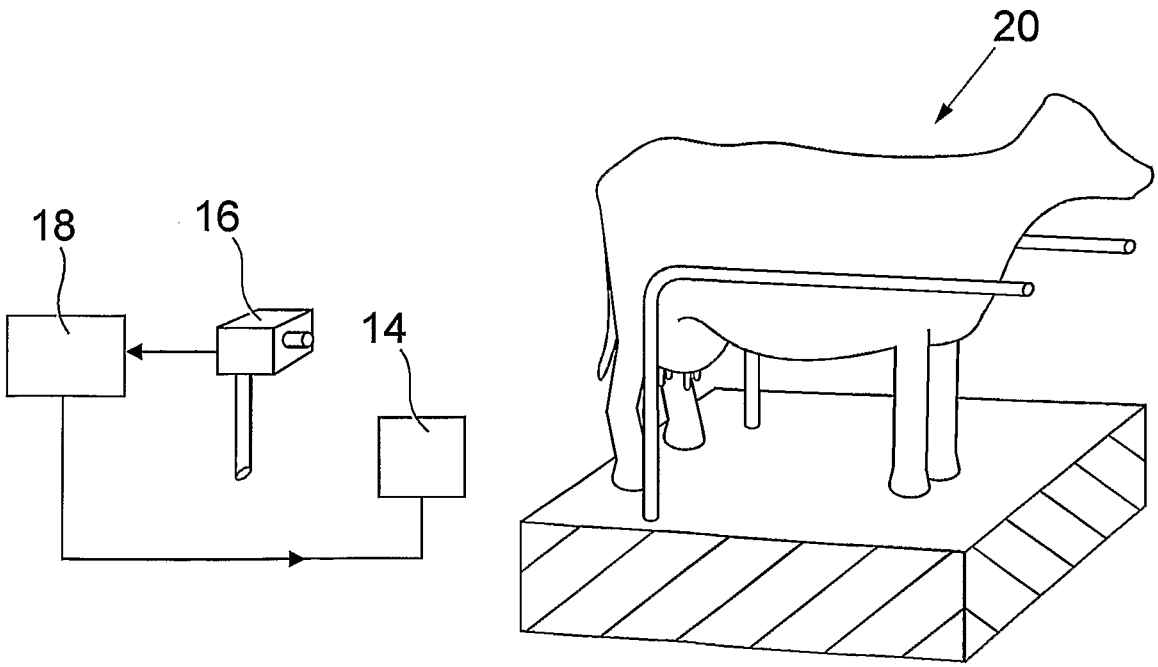

Fig. 2

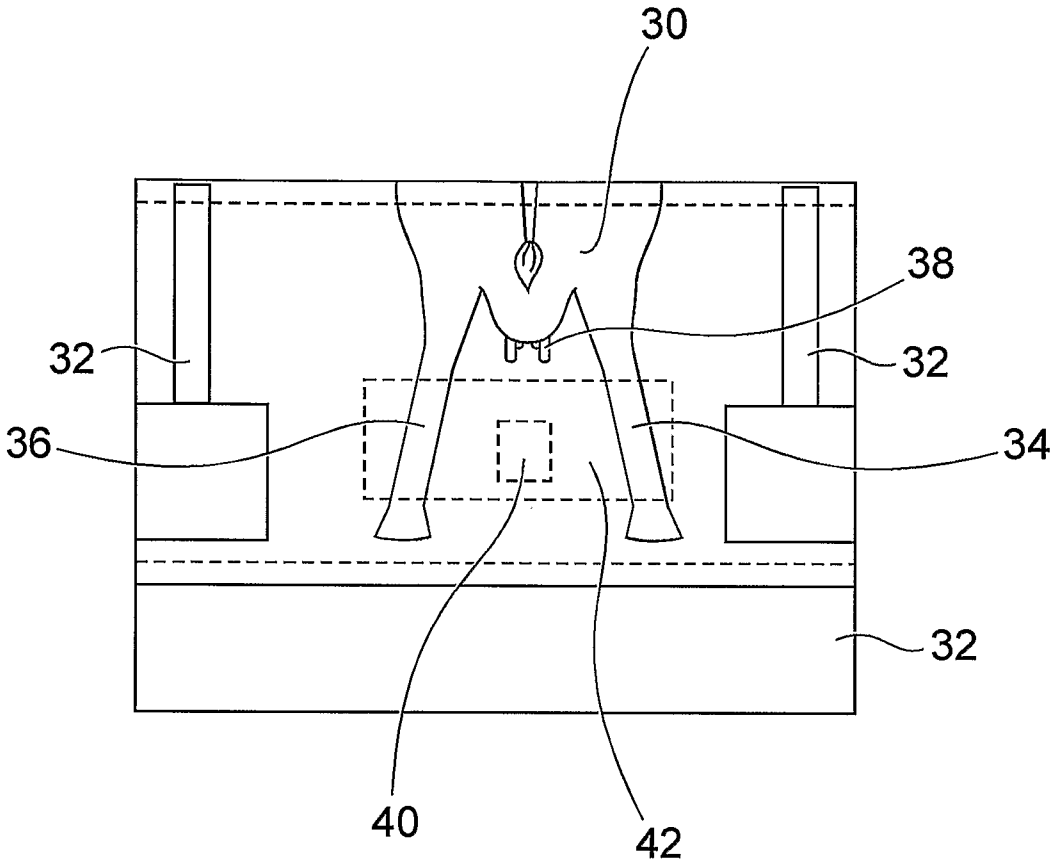

Fig. 3

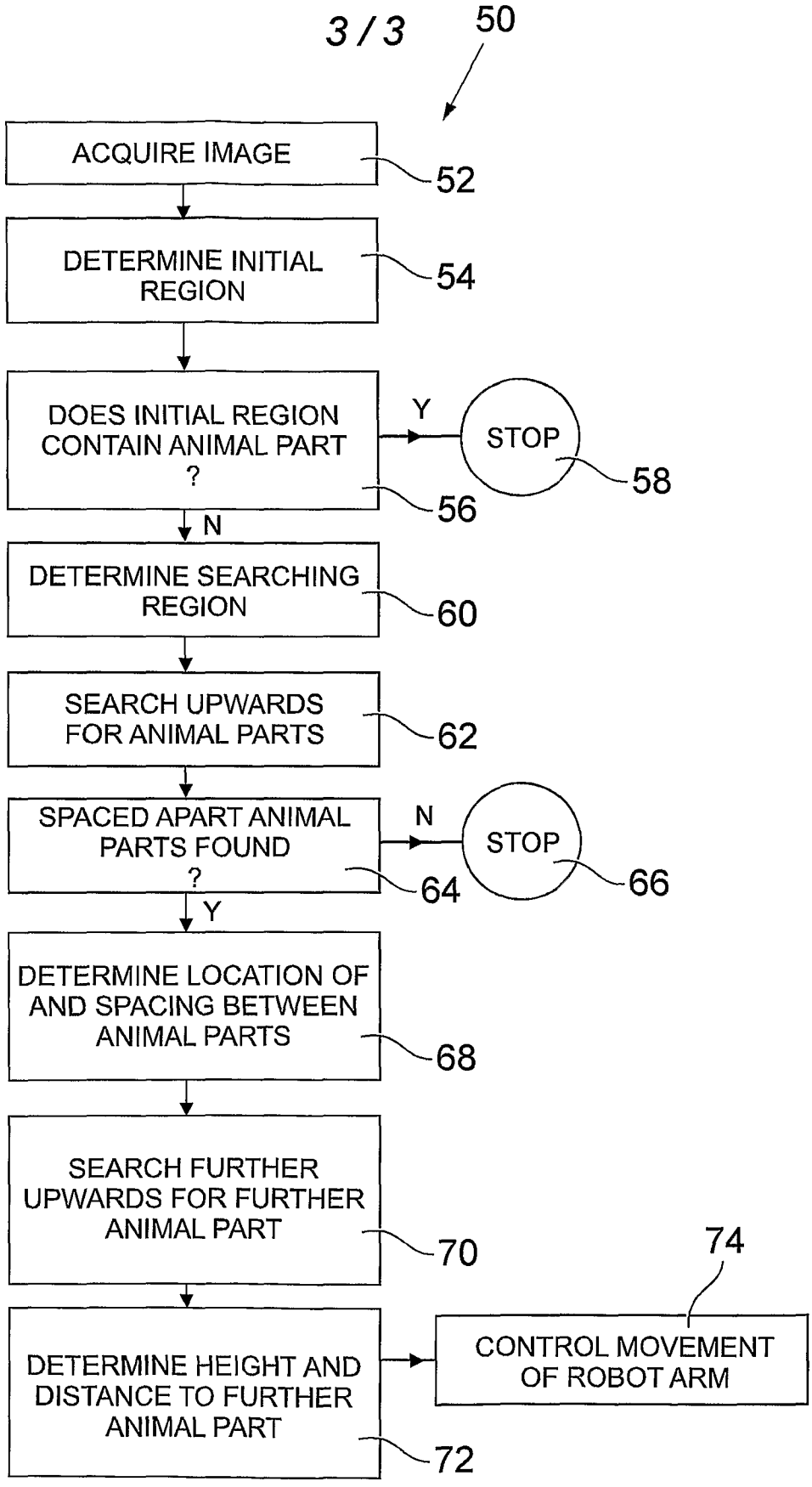
50
ACQUIRE IMAGE
52
DETERMINE INITIAL REGION
54
DOES INITIAL REGION CONTAIN ANIMAL PART ?
Y
STOP
58
56
N
DETERMINE SEARCHING REGION
60
SEARCH UPWARDS FOR ANIMAL PARTS
62
SPACED APART ANIMAL PARTS FOUND ?
N
STOP
66
64
Y
DETERMINE LOCATION OF AND SPACING BETWEEN ANIMAL PARTS
68
SEARCH FURTHER UPWARDS FOR FURTHER ANIMAL PART
70
74
DETERMINE HEIGHT AND DISTANCE TO FURTHER ANIMAL PART
CONTROL MOVEMENT OF ROBOT ARM
72

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/002548

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01J5/017

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)
AOlJ

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
Y	WO 98/07311 Al (ALFA LAVAL AGRI AB [SE]; ISAKSSON ANDERS [SE]; STARKHAMMAR JOHANNA [SE]) 26 February 1998 (1998-02-26) abstract; claims 1,2,6,7,13-15; figures 1,2 page 4, lines 10-26 page 7, lines 20-35 page 9, lines 13-20	1-13, 23-27
Y	WO 98/35547 Al (MAASLAND NV [NL]; BERG KAREL VAN DEN [NL]) 20 August 1998 (1998-08-20) abstract; claims 1,3; figures 1,2	1,23-27
Y	US 2007/215052 Al (METCALFE LEONARD [CA] ET AL) 20 September 2007 (2007-09-20) abstract; claims 1-3; figures 1-3 paragraphs [0022] - [0025]	2-13

-/--

[X] Further documents are listed in the continuation of Box C

[X] 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

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"O[1] document referring to an oral disclosure use, exhibition or other means

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

"T" later document published after the international filing date or pnonty date and not in conflict with the application but cited to understand the pnnciple 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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 February 2010	22/02/2010

Name and mailing address of the ISA/	Authonzed officer
European Patent Office, P B 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel (+31-70) 340-2040 Fax (+31-70) 340-3016	Guillem Gisbert, I

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/002548

(^Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

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