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(73) Octrooihouder(s):
**Lely Patent N.V. te Maassluis**

(72) Uitvinder(s):
**Paulus Jacobus Maria van Adrichem te Maassluis**
**Ananthu Aniraj te Maassluis**
**Yan Li te Maassluis**
**Sjoerd Timo van Vliet te Maassluis**
**Çagla Sözen te Maassluis**
**Joram Robin van der Sluis te Maassluis**

(74) Gemachtigde:
**ir. M.J.F.M. Corten te Maassluis**

(54) **Animal husbandry system**

(57) The present invention relates to an animal husbandry system with monitoring and analyzing means configured for repeatedly generating images and gathering animal data therefrom. A plurality of cameras is suitable for monitoring the area from above. Image processing means are suitable for matching animals in the field of view of multiple cameras by detecting animal silhouettes in images of different cameras; defining an animal bounding box around each animal silhouette, applying to each animal bounding box either a first projection onto an image stitching plane if the animal is standing, or a second projection if the animal is lying down, stitching the projected bounding boxes in the stitching plane and identifying identical animals in the stitched image. The reliability of the matching process is increased by taking into account whether the animal in question is standing or lying down. The quality of the data gathered in the system is improved.

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Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

**Animal husbandry system**

The present invention relates to an animal husbandry system, wherein a group of animals can move about freely in an area.

Such systems are widely known in the art. Monitoring and tracking the animals in the area and gathering relevant and reliable data plays an important role in such systems.

EP3335551 discloses a method of monitoring livestock inside of a building using cameras and light assemblies arranged above the livestock for gathering tracking data relating to the motion of tracked individual animals. WO2014/118788 relates to an optical monitoring system for livestock in which various activities and parameters are monitored and measured to determine the health state of the population of animals. WO2011/039112 shows an animal behaviour monitoring system in which several animal movement patterns are derived from recorded image data. WO2018/174812 divulges a system and method for identifying an individual animal in a group of animals with identification tags in an area with an identification station. WO2021/083381 discloses a low-cost system for animal identity recognition using animal tracking with images.

The prior art systems and methods have several drawbacks. When multiple cameras are used, an animal moving from the field of view of one camera to the field of view of a next camera has to be matched in the camera images in order to be able to track the animal in question reliably. If this is not done accurately, animals are confounded and the quality of the data gathered is severely affected.

There is a need for an improved system which guarantees a proper matching of animals registered in the fields of view of different cameras.

It is an object of the present invention to provide such an improved system.

The invention achieves the object at least in part by means of a system according to claim 1, in particular an animal husbandry system, wherein a group of animals can move about freely in an area, the system comprising monitoring and analyzing means configured for repeatedly generating images and gathering data therefrom regarding the animals in the area, the monitoring and analyzing means comprising a plurality of cameras provided in such a way that, collectively, they are suitable for monitoring substantially the complete area from above, the monitoring and analyzing means further comprising image processing means, suitable for matching animals which are in the field of view of multiple cameras, the image processing means, to this end, being configured for:

- detecting at least one silhouette of an animal in a first image of a first camera and in a

second image of a second camera;

- defining an animal bounding box around each animal silhouette in each image;
- detecting whether each animal in question is standing or lying down;
- applying to each animal bounding box either a first projection onto an image stitching plane in case the animal is standing, or a second projection onto the image stitching plane in case the animal is lying down;
- stitching the projected animal bounding boxes of the first image of the first camera and of the second image of the second camera in the image stitching plane;
- identifying identical animals in the stitched image by comparing the projected animal bounding boxes in the image stitching plane.

In this way, a highly useful and accurate system is realized. The invention is based on the insight that the reliability of the matching or pairing process can be highly increased by taking into account whether the animal in question is standing or lying down. No additional sensors are needed. The quality of the data gathered in the system is improved.

Suitable and advantageous embodiments are described in the dependent claims, as well as in the description below.

According to a first embodiment of the invention, the image processing means are configured for using a floor level of the area as the image stitching plane. This embodiment has proven to give good results.

In a further embodiment, the image processing means are configured for detecting whether each animal in question is standing or lying down by using an object detection model with neural networks, trained to classify standing and lying animals from images. This constitutes a simple, yet efficient solution.

In yet another embodiment, the image processing means are configured for detecting whether each animal in question is standing or lying down by comparing the position of the respective animal bounding box with possible animal positions in an animal lying subarea of the area. This is an alternative solution that works well.

Advantageously, the image processing means are further configured for detecting whether each animal in question is standing or lying down by comparing the orientation of the respective animal bounding box with possible animal orientations in an animal lying subarea of the area. This further improves the reliability of the alternative detection solution.

In accordance with a further embodiment, the image processing means are configured for identifying identical animals in the stitched image by comparing the

projected animal bounding boxes in the image stitching plane using a bipartite matching algorithm. In this way, a reliable identification of identical animals is ensured.

The invention will now be further elucidated with reference to the following Figures.

Figure 1 shows an area with an animal husbandry system according to the invention;

Figure 2 illustrates a projection of different objects onto a plane;

Figures 3A and 3B schematically show how two images are combined in order to match animals which are in the field of view of multiple cameras.

Figure 1 shows an animal husbandry system with an area 1, here shown as a stable or shed or barn 1, wherein a group of animals 2 can move about freely. In the example shown the animals are cows. Of course, the invention can also be applied to an animal husbandry system involving other animals, such as goats, pigs, horses, chickens, turkeys, etcetera. The area 1 can also be a structure with, for example, a partly open roof. The system according to the invention can in principle also be applied in an open area like a meadow or pasture with cattle fences.

The stable 1 has a feed alley 3, a feeding and/or drinking area 4 for the cows 2, a milking robot 5 for the cows 2 and a resting area 6 for the cows 2 with cubicles 7. One or more water troughs (not shown) may be placed in the area 4.

Furthermore, monitoring and analyzing means are provided, here in the form of a number of video cameras 8. Illumination means provided with a number of illumination elements (not shown) are also provided, each illumination element being arranged for illuminating at least a subarea of the area or shed 1. The illumination elements are suitable for illuminating respective different (possibly partly overlapping) regions. Collectively, the illumination elements are suitable for illuminating substantially the whole area or shed 1. The illumination elements may be combined with or integrated in the cameras 8, but they can also be provided separately.

Control means connected to the monitoring and analyzing means are also provided (not shown). The control means may comprise a computer or any other suitable processing means. They can also be located outside or at a distance from the area or shed 1. Image processing means, known as such, can be incorporated in the cameras 8, or in the control means.

Each camera 8 is arranged for monitoring a region or a subarea or a number of subareas of the stable 1. Of course, in principle other optical sensors can also be used, for example infrared cameras and/or time-of-flight cameras. The plurality of cameras 8 is

provided in such a way that, collectively, they are suitable for monitoring substantially the complete area 1 from above, particularly the animals 2 and the shed floor. The cameras 8 can be provided in the shed 1 above the animals 2, or as shown in Figure 1, fixedly mounted on the walls of the shed 1. They are positioned and oriented in such a way that all relevant subareas of the area 1 are monitored. The subareas may overlap. In case the invention is used in a pasture, the cameras 8 may be provided on fences, at a sufficient height above the ground. In the example shown, there are eight cameras 8. The chosen configuration obviously depends on the shape of the area or shed 1.

The monitoring and analyzing means 8 are configured for repeatedly generating images and gathering data therefrom regarding the animals 2 in the area 1. The data gathering can be performed with the image processing means in a manner known as such, using image processing techniques. Use can also be made of artificial intelligence techniques (known as such), such as machine learning or deep learning, for example using neural networks.

According to the invention, the monitoring and analyzing means comprising image processing means are suitable for matching or pairing animals 2 which are in the field of view of multiple cameras 8. To this end, the image processing means, are configured for:

- detecting at least one silhouette of an animal 2 in a first image of a first camera 8 and in a second image of a second camera 8;
- defining an animal bounding box around each animal silhouette in each image;
- detecting whether each animal 2 in question is standing or lying down;
- applying to each animal bounding box either a first projection onto an image stitching plane in case the animal 2 is standing, or a second projection onto the image stitching plane in case the animal 2 is lying down;
- stitching the projected animal bounding boxes of the first image of the first camera 8 and of the second image of the second camera 8 in the image stitching plane;
- identifying identical animals 2 in the stitched image by comparing the projected animal bounding boxes in the image stitching plane.

Image stitching is a well-known technique used for combining (video) images taken from neighbouring cameras with overlapping fields of view to produce a wider panorama image. Image stitching works best when the images are stitched on the same 2D plane. The floor of the area 1 can be used as the 2D plane for stitching or combining the images. This embodiment has proven to give good results. Other stitching planes, preferably horizontal, are also possible.

The process of object detection, wherein the location of each animal 2 in the images is found, is done at the height of the cow torso. At that level, a silhouette of each animal 2 in each image is detected and an animal bounding box is defined around each animal silhouette in each image by means of the image processing means. This will be explained in further detail below.

Thus, there is a discrepancy between the height used for image stitching (namely the floor level) and the height used for animal detection (namely the cow torso height). When the same cow 2 is seen from two cameras 8, it is detected at the cow torso height in both images. But the matching or pairing of the detections of the same cow 2 in the image stitching step is done on the floor level. Therefore, an intermediate step is performed to project the animal detections from the cow torso level onto the floor level.

To get accurate projections of detected objects on the floor, different projections are needed for different heights, as a larger pixel displacement correction is needed for detected objects that are higher, see Figure 2.

In Figure 2, camera 8 monitors a high object 9 and 2 low objects 10, illustrated schematically. The projection of the top of high object 9 on the floor results in an undesirably large displacement 11 in the target plane (i.e. the floor). This displacement constitutes a pixel displacement 11 in the projection image. The projection of the top of low objects 10 on the floor results each time in a much smaller pixel displacement 12, even if the object 10 is situated in the peripheral region of the field of view of camera 8. Such pixel displacements can be corrected by the image processing means in a known manner. High objects need a larger pixel displacement correction than low objects, as is clear from Figure 2.

In accordance with the invention, the image processing means are further configured for detecting whether each animal 2 in question is standing or lying down and then either applying to each animal bounding box a first projection (with a large correction) onto the image stitching plane in case the animal 2 is standing, or applying to each animal bounding box a second projection (with a small correction) onto the image stitching plane in case the animal 2 is lying down. In this way, both the higher standing cows 2 and the lower lying cows 2 are accurately projected onto the stitching plane (i.e. the floor), which leads to better matching results.

The image processing means can be configured for detecting whether each animal 2 in question is standing or lying down by using an object detection model with neural networks, trained to classify standing and lying animals 2 from images. This constitutes a simple, yet efficient solution.

The image processing means may also be configured for detecting whether each animal 2 in question is standing or lying down by comparing the position of the respective animal bounding box with possible animal positions in an animal lying subarea of the area, such as the resting area 6. This is an alternative solution that works well. In that case, the image processing means can be further configured for detecting whether each animal 2 in question is standing or lying down by additionally comparing the orientation of the respective animal bounding box with possible animal orientations in an animal lying subarea of the area. If a cow 2 is positioned substantially longitudinally in a cubicle 7 of the resting area 6, then it is highly likely that she is lying down. This further improves the reliability of the alternative detection solution.

To complete the matching or pairing process, the image processing means are further configured for stitching the projected animal bounding boxes of the first image of the first camera 8 and of the second image of the second camera 8 in the image stitching plane, in a manner known as such.

Finally, the image processing means are configured for identifying identical animals 2 in the stitched image by comparing the projected animal bounding boxes in the image stitching plane. This can be done, again, in a manner known as such, for example using a bipartite matching algorithm. In this way, a reliable identification of identical animals is ensured.

Bipartite matching is a standard open-source algorithm that is commonly used for finding an optimal one-to-one matching between two different object lists (or sets) of the same length.

In the present application, the goal is to find cows that are commonly seen by multiple cameras. In such a scenario it is possible that some objects (cows) are uniquely seen (seen by only one camera). The standard bi-partite matching algorithm might not be sufficient in this case of uniquely seen cows, as it always tries to find a one-to-one match between the given two lists. Sparse bipartite matching is essentially a more robust version of the standard bipartite matching algorithm where such cases of objects with no matches are also handled accurately. Therefore, a sparse bipartite matching algorithm is highly suitable here.

Figures 3A and 3B schematically show how two images are combined in order to match animals which are in the field of view of multiple cameras.

In Figure 3A two images are depicted taken from neighbouring cameras with overlapping fields of view. In this case, the images are video images recorded in the stable 1 showing detected animals along the stitching border (in the middle) where the

video images from the two cameras are stitched together to be one video image, using the known image stitching technique.

In the left and right image two cows 2 are shown standing up near a feed fence 13, whilst one cow 2 is lying down at some distance from the feed fence 13. The image processing means have detected the silhouettes of the animals 2 in the first image of a first camera (left) and in the second image of a second camera (right) and have defined an animal bounding box 14 around each animal silhouette in each image.

In accordance with the invention, it is now detected whether each animal 2 in question is standing or lying down, after which to each animal bounding box 14 either the first projection (for the cows 2 standing up) or the second projection (for the cow 2 lying down) onto the image stitching plane is applied.

Figure 3B shows the stitched image containing the combined images of Figure 3A. Due to the projections and to the stitching algorithm some distortions occur in the resulting stitched image. The projected bounding boxes 14 of corresponding cows 2 are overlapping to a large extent, indicating that the animals 2 in the left and right image of Figure 3A are identical. This is determined by the image processing means by comparing the projected animal bounding boxes 14 in the stitched image.

The multi-depth (height-dependent) projection causes the bounding boxes 14 to overlap accurately, which allows for a correct identification of identical cows 2. Tracking of cows 2 across multiple cameras 8 is thus reliably enabled. When an animal 2 moves from the field of view of a first camera 8 into the field of view of a next camera 8, it can be reliably identified as the same animal 2 and thus it can be tracked accurately. In an animal husbandry system it is very useful to be able to track animals 2 in the area 1 accurately. In accordance with the invention, individual animal data can be reliably gathered, although the animals 2 are allowed to move about freely in the area 1.

In comparison, if the height-dependent projections were not used and instead one projection irrespective of the height of the cows 2 would be used, the overlap of the bounding boxes 14 corresponding to the same cows 2 would become significantly less, leading to errors, for example when animals 2 standing close to one another are confounded. This is obviated by the invention, in particular by the differentiation between standing and lying animals.

CONCLUSIES

1. Een veehouderijsysteem, waarbij een groep dieren (2) vrij in een gebied (1) kan bewegen, het systeem omvattende bewakings- en analysemiddelen ingericht voor het herhaaldelijk genereren van beelden en het verzamelen van data daarvan met betrekking tot de dieren (2) in het gebied (1), de bewakings- en analysemiddelen omvattende een veelvoud aan camera's (8) zodanig aangebracht dat ze gezamenlijk geschikt zijn voor het bewaken van hoofdzakelijk het hele gebied (1) vanaf boven, de bewakings- en analysemiddelen omvattende voorts beeldverwerkingsmiddelen, geschikt voor het overeenstemmen van dieren (2) welke zich in het zichtveld van meerdere camera's (8) bevinden, waarbij de beeldverwerkingsmiddelen hiervoor ingericht zijn voor:
- het detecteren van ten minste één silhouet van een dier (2) in een eerste beeld van een eerste camera (8) en in een tweede beeld van een tweede camera (8);
- het definiëren van een dieromschrijvingsrechthoek (14) om elk diersilhouet in elk beeld;
- het detecteren of elk betreffende dier staat of ligt;
- het toepassen op elk dieromschrijvingsrechthoek (14) van een eerste projectie op een beeldcombinatievlak in het geval het dier (2) staat en van een tweede projectie op het beeldcombinatievlak in het geval het dier (2) ligt;
- combineren van de geprojecteerde dieromschrijvingsrechthoeken (14) van het eerste beeld van het eerste camera (8) en van het tweede beeld van het tweede camera (8) in het beeldcombinatievlak;
- identificeren van identieke dieren (2) in het gecombineerde beeld door het vergelijken van de geprojecteerde dieromschrijvingsrechthoeken (14) in het beeldcombinatievlak.

2. Systeem volgens conclusie 1, waarbij de beeldverwerkingsmiddelen ingericht zijn voor gebruik van een vloerniveau van het gebied als het beeldcombinatievlak.

3. Systeem volgens één der conclusies 1 - 2, waarbij de beeldverwerkingsmiddelen ingericht zijn voor het detecteren of elk betreffende dier (2) staat of ligt door gebruik van een objectdetectiemodel met neurale netwerken, getraind voor het classificeren van staande en liggende dieren in beelden.

4. Systeem volgens één der conclusies 1 - 2, waarbij de beeldverwerkingsmiddelen ingericht zijn voor het detecteren of elk betreffende dier (2) staat of ligt door het vergelijken van de positie van de overeenkomstige dieromschrijvingsrechthoek (14) met mogelijke dierposities in een deelgebied (6) van het gebied (1) voor liggende dieren.

5. Systeem volgens conclusie 4, waarbij de beeldverwerkingsmiddelen voorts ingericht zijn voor het detecteren of elk betreffende dier (2) staat of ligt door het vergelijken van de oriëntatie van de respectievelijke dieromschrijvingsrechthoek (14) met mogelijke dieroriëntaties in een deelgebied (6) van het gebied (1) voor liggende dieren.

6. Systeem volgens één der conclusies 1 - 5, waarbij de beeldverwerkingsmiddelen ingericht zijn voor het identificeren van identieke dieren (2) in het gecombineerde beeld door middel van het vergelijken van de geprojecteerde dieromschrijvingsrechthoeken (14) in het beeldcombinatievlak door gebruik van een bipartite matching algorithme.

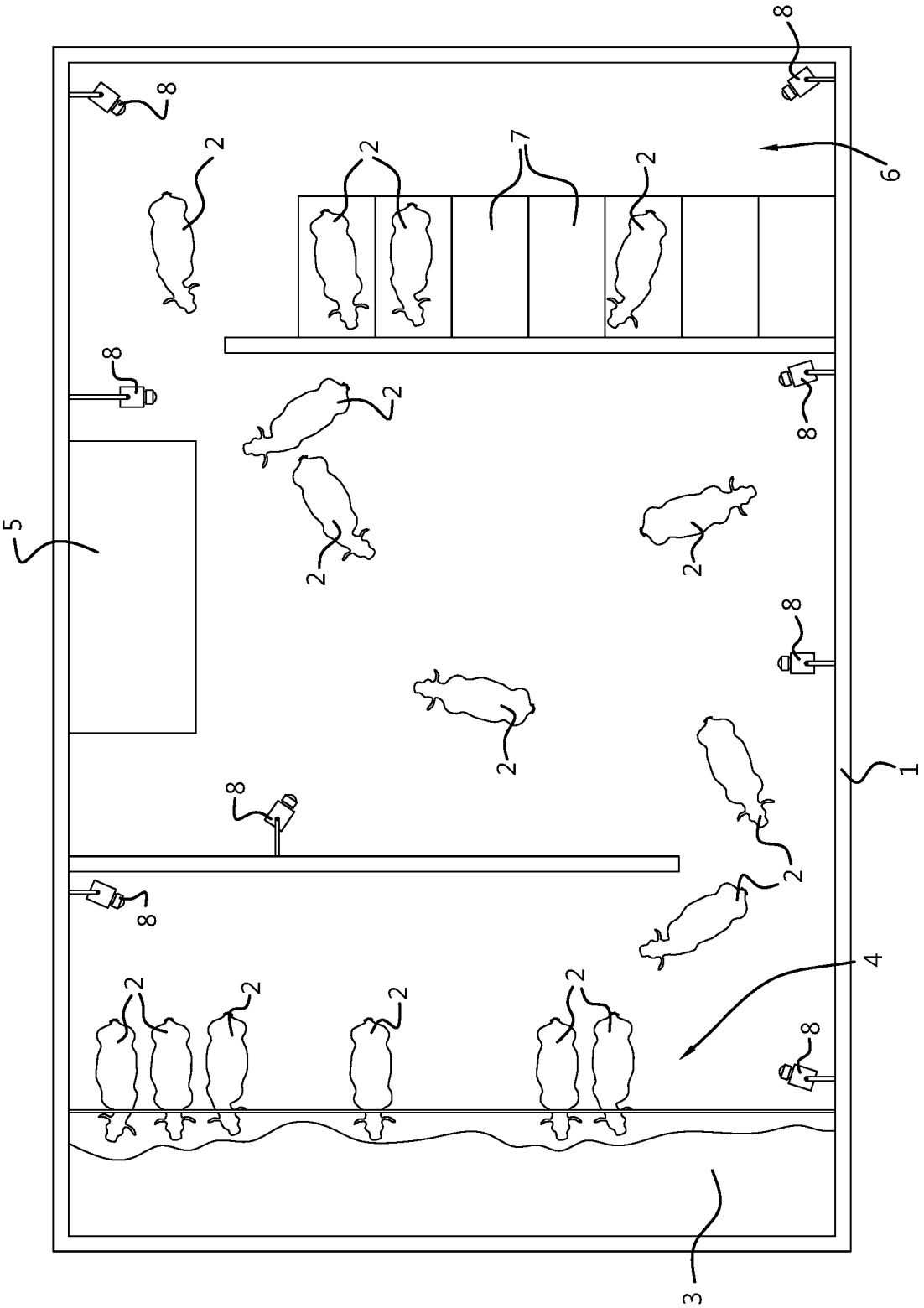



Fig. 1

Fig. 2

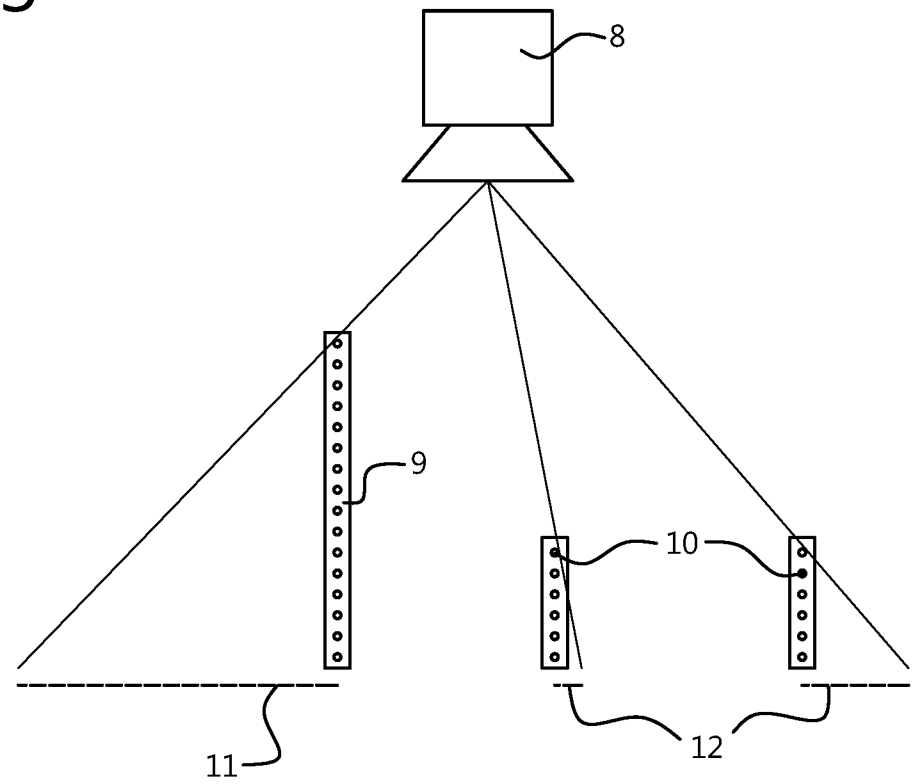


Fig. 3A

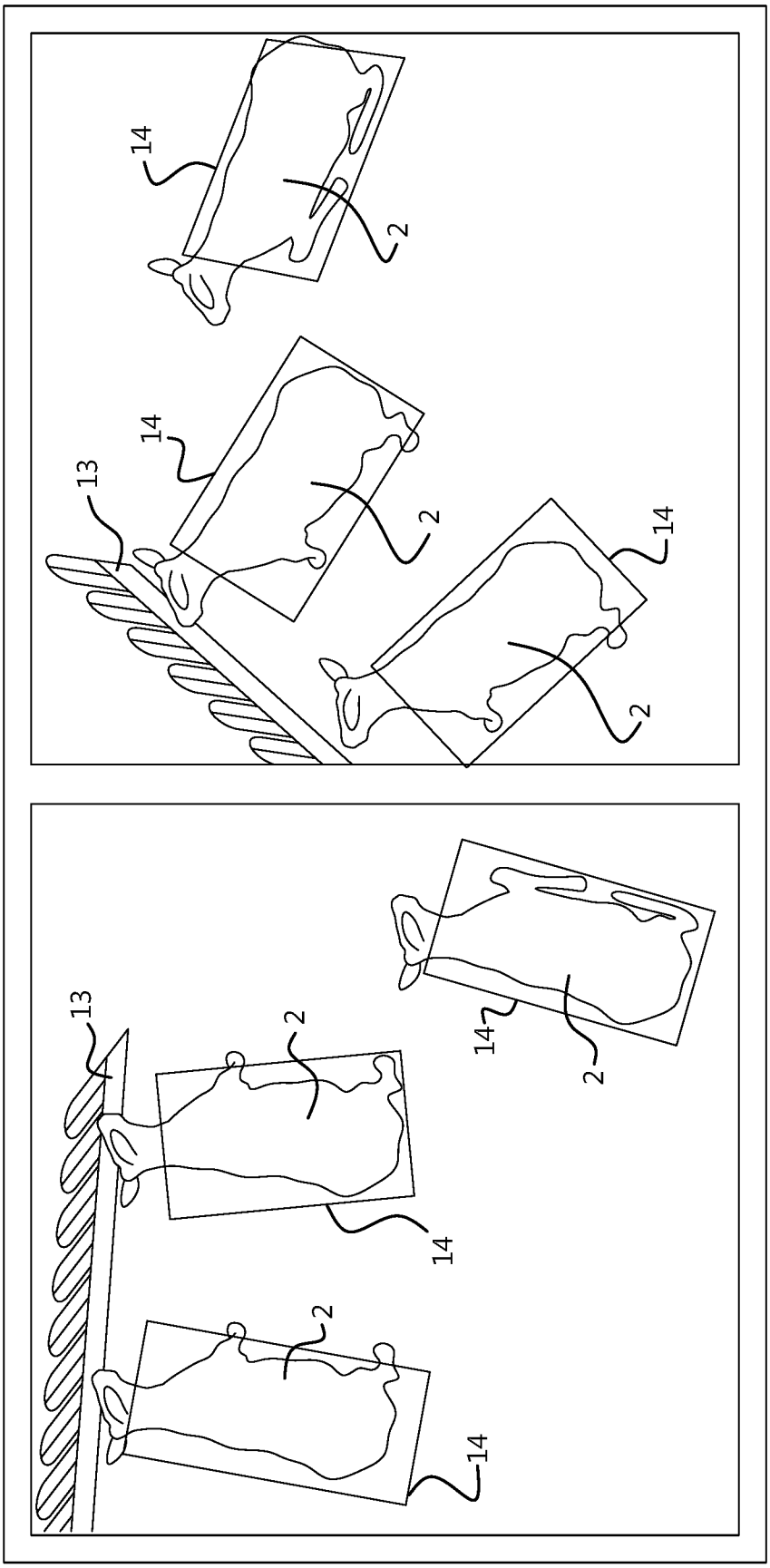
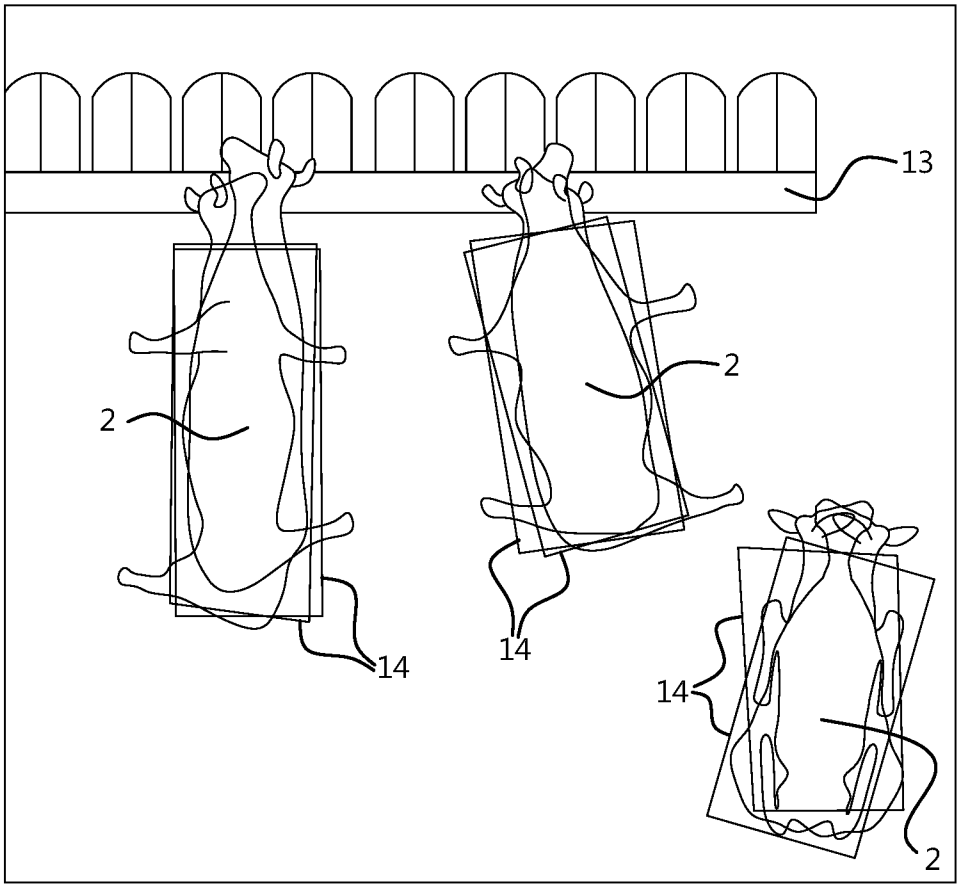


Fig. 3B



# SAMENWERKINGSVERDRAG (PCT)

## RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

| IDENTIFICATIE VAN DE NATIONALE AANVRAGE | KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE |
|---|---|
| | |
| Nederlands aanvraag nr.<br>**2031623** | Indieningsdatum<br>**19-04-2022** |
| | Ingeroepen voorrangsdatum |
| Aanvrager (Naam)<br>**Lely Patent N.V.** | |
| Datum van het verzoek voor een onderzoek van internationaal type<br>**03-09-2022** | Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.<br>**SN81972** |
| **I. CLASSIFICATIE VAN HET ONDERWERP** (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven) | |
| Volgens de internationale classificatie (IPC)<br>**Zie onderzoeksrapport** | |
| **II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK** | |
| Onderzochte minimumdocumentatie | |
| Classificatiesysteem | Classificatiesymbolen |
| **IPC** | **Zie onderzoeksrapport** |
| Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen | |
| | |
| **III.** ☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES** (opmerkingen op aanvullingsblad) | |
| **IV.** ☐ **GEBREK AAN EENHEID VAN UITVINDING** (opmerkingen op aanvullingsblad) | |

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
**NL 2031623**

A. CLASSIFICATIE VAN HET ONDERWERP
**INV. A01K29/00**
**ADD.**

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
**A01K**

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
**EPO-Internal, WPI Data**

C. VAN BELANG GEACHTE DOCUMENTEN

| Categorie ° | Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages | Van belang voor conclusie nr. |
|---|---|---|
| A,D | WO 2018/174812 A1 (BMP INNOVATION AB [SE])<br>27 september 2018 (2018-09-27)<br>in de aanvraag genoemd<br>* alineas [0020] - [0040]; figuren 1-3 *<br>----- | 1-6 |
| A,D | EP 3 335 551 A1 (FARMIC AB [SE])<br>20 juni 2018 (2018-06-20)<br>in de aanvraag genoemd<br>* alineas [0023] - [0057]; figuren 1-12 *<br>----- | 1-6 |

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

| Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid | Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type |
|---|---|
| **18 november 2022** | |

| Naam en adres van de instantie | De bevoegde ambtenaar |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | **Pacevicius, Matthias** |



Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

**NL 2031623**

| In het rapport genoemd octrooigeschrift | Datum van publicatie | Overeenkomend(e) geschrift(en) | Datum van publicatie |
|---|---|---|---|
| **WO 2018174812 A1** | **27-09-2018** | **CA 3057059 A1** | **27-09-2018** |
| | | **EP 3599841 A1** | **05-02-2020** |
| | | **SE 1750356 A1** | **25-09-2018** |
| | | **WO 2018174812 A1** | **27-09-2018** |
| **EP 3335551 A1** | **20-06-2018** | **GEEN** | |

# WRITTEN OPINION

| File No. | Filing date *(day/month/year)* | Priority date *(day/month/year)* | Application No. |
|---|---|---|---|
| SN81972 | 19.04.2022 | | NL2031623 |

International Patent Classification (IPC)
INV. A01K29/00

Applicant
Lely Patent N.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

| | Examiner |
|---|---|
| | Pacevicius, Matthias |

# WRITTEN OPINION

## Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

## Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty | Yes: | Claims | 1-6 |
| | No: | Claims | |
| Inventive step | Yes: | Claims | 1-6 |
| | No: | Claims | |
| Industrial applicability | Yes: | Claims | 1-6 |
| | No: | Claims | |

2. Citations and explanations

**see separate sheet**

## Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Reference is made to the following document:

D1: WO 2018/174812 A1 (BMP INNOVATION AB [SE]) 27 september 2018 (2018-09-27) in de aanvraag genoemd

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1 D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses:

Een veehouderijsysteem, waarbij een groep dieren (210, 310) vrij in een gebied (200, 340) kan bewegen, het systeem omvattende bewakings- en analysemiddelen (320, 330) ingericht voor het herhaaldelijk genereren van beelden en het verzamelen van data daarvan met betrekking tot de dieren (210, 310) in het gebied (200, 340), de bewakings- en analysemiddelen omvattende een veelvoud aan camera's (320, 330) zodanig aangebracht dat ze gezamenlijk geschikt zijn voor het bewaken van hoofdzakelijk het hele gebied (200, 340) vanaf boven, de bewakings- en analysemiddelen omvattende voorts beeldverwerkingsmiddelen, geschikt voor het overeenstemmen van dieren (210, 310) welke zich in het zichtveld van meerdere camera's (320, 330) bevinden, waarbij de beeldverwerkingsmiddelen hiervoor ingericht zijn voor:

- het detecteren van ten minste één silhouet van een dier (210, 310) in een eerste beeld van een eerste camera (320, 330) en in een tweede beeld *(§[0029])* van een tweede camera (320, 330);

- het definiëren van een dieromschrijvingsrechthoek om elk diersilhouet in elk beeld *(implicit)*;

~~- het detecteren of elk betreffende dier staat of ligt;~~

~~- het toepassen op elk dieromschrijvingsrechthoek van een eerste projectie op een beeldcombinatievlak in het geval het dier staat en van een tweede projectie op het beeldcombinatievlak in het geval het dier ligt;~~

~~- combineren van de geprojecteerde dieromschrijvingsrechthoeken van het eerste beeld van het eerste camera en van het tweede beeld van het tweede camera in het beeldcombinatievlak;~~

~~- identificeren van identieke dieren in het gecombineerde beeld door het vergelijken van de geprojecteerde dieromschrijvingsrechthoeken in het beeldcombinatievlak.~~

2 The subject-matter of claim 1 therefore differs from this known D1 in the following method steps and is therefore new:

- detecting whether each animal in question is standing or lying down;

- applying to each animal bounding box either a first projection onto an image stitching plane in case the animal is standing, or a second projection onto the image stitching plane in case the animal is lying down;

- stitching the projected animal bounding boxes of the first image of the first camera and of the second image of the second camera in the image stitching plane;

- identifying identical animals in the stitched image by comparing the projected animal bounding boxes in the image stitching plane.

3 The problem to be solved by the present invention may be regarded as how to improve a monitoring and analyzing system such as to guarantee a proper matching of animals registered in the fields of view of different cameras.

4 The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step for the following reasons:

In D1, when multiple cameras are used, an animal moving from the field of view of one camera to the field of view of a next camera has to be matched in the camera images in order to be able to track the animal in question reliably, but there is no more specific disclosure thereof, except "by using e.g. image recognition technology" ([0029]).

D1 is silent about stitching images together. Also, D1 neither discloses nor suggests to add a step of detecting whether each animal in question is standing or lying down.

Therefore, D1 is neither concerned with the problem solved by the present application ("To get accurate projections of detected objects on the floor, different projections are needed for different heights, as a larger pixel displacement correction is needed for detected objects that are higher"), nor does it disclose the solution proposed in claim 1 ("detecting whether each animal in question is standing or lying down and then either applying to each animal bounding box a first projection (with a large correction) onto the image stitching plane in case the animal 2 is standing, or a second projection (with a small correction)"), and the skilled person would not find any inventive in the disclosure of D1 for combining all the features of claim 1.

5 Claims 2 to 6 are dependent on claim 1 and as such also meet the requirements of novelty and inventive step.

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