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(54) **Machine and method of operating thereof**

(57) A machine (10) may be configured such that at least a portion (30) of the machine prevents or hinders direct visual contact of a machine operator with an area towards which the machine is traveling. The operator

may be positioned on an operator platform (22) that allows him to nevertheless face the approached area where by means for capturing and displaying an image of the area to the operator is provided.

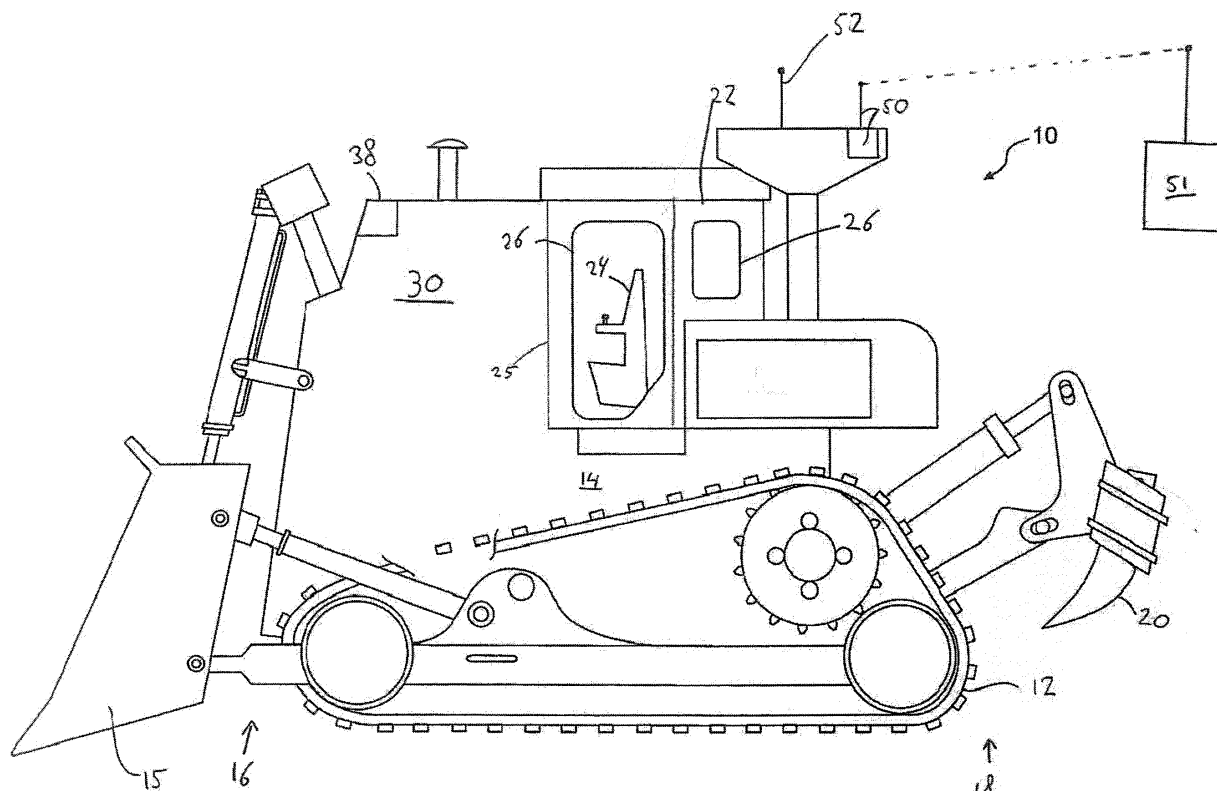


FIG. 1

Description

Technical Field

[0001] The current disclosure relates to a work machine and a method of operating thereof. More particularly, but not exclusively, it relates to a work machine having image capturing and display means.

Background

[0002] Machines such as work machines often use internal combustion engines for propulsion and power supply. Both the machine and the engine are subject to increasingly stringent regulations regarding emissions such as noise or pollutants from the combustion process. Over time the componentry added to machines and engines to deal with the regulations have grown dramatically leaving machine designers little choice but to change machine lay outs. One solution that is often employed is to make more components electrical such that they can be situated remote from the engine as a direct mechanical linkage is no longer required. For example an air conditioning condenser may be roof mounted with an electrically driven fan providing the necessary airflow to cool the refrigerant whereas conventional air conditioning used to employ a mechanically driven. However, such systems have their drawbacks in that they can be expensive due to the need for onboard generators and additional wiring and hoses spanning across the machine. The current disclosure aims to alleviate or overcome some of the disadvantages associated with the prior art.

Summary of the Invention

[0003] In one aspect of the current disclosure a machine may be provided with an operator platform configured to enable an operator to substantially face towards a first area when driving the machine towards the first area. The machine may further be provided with a surface configured such that the surface at least partially prevents an operator from having direct visual contact with the first area, means for capturing a real-time image of at least a portion of the first area and means for displaying a visual representation of the image to the operator.

[0004] In another aspect of the current disclosure there is provided a method of operating a machine. The method includes driving the machine towards a first area, capturing an image of at least a portion of the first area, generating a visual representation of the image to an operator of the machine and presenting the visual representation on a surface interposed between the operator and the first area.

[0005] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0006] Fig. 1 is a schematical representation of a machine in accordance with the current disclosure.

[0007] Fig. 2. is a schematical plan view of a portion of the machine of Fig. 1.

[0008] Fig. 3 is a schematical view of an internal portion of the machine of Fig. 1.

[0009] Fig. 4 is a schematic representation of a method of operating the machine of Fig. 1.

[0010] Fig. 5 is a schematic representation of an extended method of operating the machine of Fig. 1.

Detailed Description

[0011] Referring to Fig. 1, an exemplary embodiment of the current disclosure shows a machine 10 which may be a mobile machine such as for example an earth moving machine like a loader, a dozer, a grader, a scraper, an excavator, or the like. The machine 10 may be provided with wheels or tracks for propelling the machine 10. The machine 10 as shown in the exemplary embodiment of Fig. 1 is provided with tracks 12. The machine 10 may have a body generally designated with the numeral 14. The body 14 may be a single or multi piece frame or may consist of an arrangement made from a variety of members. For example a housing of an engine or driveline component may be designed as a stressed component such that the housing may double up as a structural member of the body 14. The machine 10 may be provided with one or a plurality of implements or loader arms 15 and 20. In one embodiment the machine 10 may for example be provided with a dozer blade at a portion 16 of the machine 10 that may be regarded as a generally front portion. In one embodiment the machine 10 may be provided with an implement or loader arm at a generally rear portion 18 of the machine 10. In the embodiment of Fig. 1 the implement at the rear portion 18 is shown as a ripper.

[0012] A compartment 30 may project generally upwards from the body 14. In one embodiment the compartment 30 may be positioned adjacent to the front portion 16 and in front of an operator platform 22. In one embodiment the compartment 30 may be positioned behind the operator platform 22 and adjacent to the rear portion 16. The compartment 30 may be an engine compartment and may contain a variety of elements (not shown) such as an internal combustion engine, a portion of the driveline, hydraulic pumps, exhaust system components, air-conditioning components and any other components such as for example auxiliaries. Depending on the number and size of elements to be mounted in the compartment 30, the compartment 30 in one embodiment may extend vertically to substantially the same vertical height as the operator platform 22 thereby substantially covering a significant portion of said operator platform 22. Although the compartment 30 may cover a portion of the operator platform 22 by being adjacent to the

operator platform, the operator platform 22 and the compartment 30 may be spaced apart.

[0013] The operator platform 22 may for example be a cab or Roll-Over-Protection-Structure (ROPS) and may project generally upwards from the body 14 and may be provided with an operator area 24 such as a seat or rest and a plurality of machine controls (not shown) to drive the machine 10 and operate machine functions. The machine 10 may be provided with one or a plurality of doors 25 and openings or windows 26 to enable an operator to make visible contact with the area surrounding the vehicle 10. An exemplary internal lay out of the operator platform 22 is shown in Fig. 3. The operator area 24 is for simplicity depicted schematically and positioned approximately centrally on the operator platform 22. Any roof and external structures are omitted for clarity purposes except where specifically mentioned. Machine controls, which for simplicity are not shown, may control the implements 15 and 20 in a conventional manner and may be provided at any desirable position on the operator platform and may for example be incorporated in any arm rests connected to an operator seat. In the embodiment shown in Fig. 3 the compartment 30 is positioned forwardly of the operator platform 22 but it is to be understood that the compartment 30 may be positioned rearwardly of the operator platform 22. In either embodiment it is foreseen that the general direction that an operator would be viewing during at least some portion of operation is in the direction of a surface 34, hence the surface 34 is interposed between the operator area and an area 40 towards which the machine 10 may be approaching.

[0014] The surface 34 may be an area substantially corresponding to that portion of the operator platform 22 which is substantially covered by said compartment 30. The surface 34 may be an external wall surface of the compartment 30. In one embodiment at least a portion or the substantially complete surface area of the surface 34 may be provided with a display 36. The display 36 may for example include a cathode ray tube (CRT) screen, an LCD screen, a touch activated screen, a video monitor or a projection screen. The display 36 may include a plurality of displays and/or information screens. The display 36 may also be positioned between the surface 34 and the operator area 24 whereby the surface area of the display 36 may substantially correspond to the portion of the operator platform 22 which is substantially covered by the compartment 30.

[0015] In one embodiment an image capturing system 38 may be provided for capturing and, if desired, also for processing at least one image of an area such as area 40 which may be generally ahead of a driving direction of the machine 10. The image may be a substantially real-time image and may be a realistic representation of the area 40 so as to present a life-like image to the operator. Such image capturing system may for example include a capturing device such as an optical or infrared camera or any other device that would be able to observe or detect an area such as area 40, e.g. radar or another

electromagnetic responsive means. The image capturing system 38 may include one or more capturing devices that may be directed to different portions. For example, one capturing device may capture the area in the general direction of area 40 and two further capturing devices (not shown) may capture images relating to the boundaries of the implement 14. It is to be understood that the operator may have at least a partial view of the extremities of the implement 14, for example by direct visual contact via the windows 26 in the doors 25.

[0016] Any signal produced by the image capturing system 38 or any subsequently processed signal resulting in the generation of a substantially real-time image may be used as an input for the display 36 so as to present a substantially real-time image of an area towards which the machine 10 is moving to an operator of the machine 10.

[0017] The machine 10 may be provided with a site management system 50. In one embodiment the site management system 50 may provide information regarding actual and desirable site characteristics. In one embodiment the site management system 50 may be in communication with a base station such as a site management station 51. For example, the site management system 50 may include or receive data regarding current soil height, height differential, slopes, types, compaction level, capacity, angles and any other data relating to the soil structure, landscape and site geography. The site management system 50 may also include data regarding a desired site characteristic and desired actions, for example rolling or grading requirements to compact, level, grade, or slope a particular site portion for construction purposes.

[0018] In one embodiment the site management system may include a positioning system 52 such as a local or global positioning system (GPS) to provide the machine 10 with accurate positional data.

[0019] In one embodiment the site management system 50 may automatically operate the implements 15 and 20 to achieve such desired characteristics or it may inform the operator of the desired characteristics. In one embodiment the site management system 50 may automatically operate the machine 10 or the machine may be controlled via a mixture of automatic control via the site management system 50 and operator commands. In any of those embodiments, the site management system 50 may display a representation of actual and desired characteristics on the display 36. In one embodiment at least one of the set of actual and desired characteristics may be overlaid on the substantially real-time image as provided by the image capturing system 38. The display 36 may therefore for example provide a substantially realistic image of the area 40 based on the images captured by the image capturing system 38 whilst simultaneously showing an abstract representation of desired site characteristics based on information provided by the site management system 50. The abstract representation may for example include graphic lines, dots, markers,

numeric and alphanumeric characters and/or indicators desired implement motion or soil characteristics.

[0020] In one embodiment the site management system 50 may be configured to detect potential obstacles based on at least on image captured by the image capturing system 38. For example, the site management system 50 may determine from the imagery that for example an object may be approached which requires the machine 10 to be redirected. The site management system 50 may have stored data in relation to the terrain in which the machine 10 is active and the site management system 50 may display information based on that data on display 36. The information may be combined with the positional data as provided by the positioning system 52. If appropriate it may overlay this data over the substantially real-time images as captured by the image capturing system 38.

[0021] In one embodiment the display 36 may display recommendations for action based on the actual and desired imagery and/or characteristics.

[0022] In one embodiment the display 36 may provide operating data of machine 10. The operating data may for example include fuel level, operating temperature, machine speed, engine speed and efficiency parameters.

Industrial Applicability

[0023] During operation of the machine an operator's view of the area to which the machine 10 may be traveling, for example the area 40, may be at least partially hindered or completely blocked by the surface 34. An operator would therefore not be able to make visual contact with a the area 40 that may be approached by the machine 10 when the machine 10 is driving towards the area 40 even though the operator is substantially facing in the direction of the area 40. To enable an operator to operate the machine properly, the system outlined above enables a method of operating the machine as represented in Fig. 4. During operation the machine 10 may be driving (100) towards a first area 40. The first area 40 may not be visible or only partly visible to the operator 40, but to have some form of information available to him regarding the area 40, the image capturing system 38 may capture (102) a real-time or substantially real-time image of at least a portion of the non-visible part of the first area. A visual representation of the image may be generated (104). The visual representation may be displayed (106) to the operator on a surface interposed between the operator and the first area (40). The operator may therefore experience a substantially realistic and substantially real-time representation of the area 40. As shown in Fig. 5, because the display 36 provides the operator with information via said representation of the area 40, the operator may determine (108) a next course of action based on that information even though he has no direct visual contact with the area 40. In an embodiment where an on-board or off-board site man-

agement system 50 is provided the operator may for example operate the machine based on the substantially realistic and/or spacially accurate and substantially real-time representation of the area 40 whereby the representation displays information about a particular characteristic of the first area 40. The system may further provide an overlay (110) of a desired landscape profile having a desired characteristic. The site management system 50 may for example overlay an abstract representation indicating to the operator where soil needs to be moved or grading needs to take place. Abstract in this context may include a set of lines and/or dots and/or a grid, but also a more realistic image the appearance of which may have been computer generated via estimating the appearance of the landscape having the desired characteristic. An action may then be performed (112) based on the overlaying of the representations. For example, one action may be that the machine (10) may be operated such that the actual characteristic approaches the desired characteristic.

[0024] If for example an operator is grading a terrain, he may be provided with a realistic actual characteristic such as actual soil height and an abstract desired characteristic such as desired soil height. The operator may then decide how and when to adjust the position and/or orientation of at least one of the implements 15 and 16 during one or multiple passes such that the actual characteristic approaches the desired characteristic. The site management system 50 may also indicate if the desired landscape profile has been achieved or how many machine passes are to be expected to achieve the desired profile. The site management system 50 may also provide the operator with cue points for action such that the operator knows exactly when and how to adjust an implement position or orientation. A cue point may for example be an audible or visual signal to the operator. A visual cue point signal may for example be a numeric representation on the display 36 indicating exactly when to lift, lower or tilt an implement and by how much.

[0025] In one embodiment where the display 36 is of a touch-screen variety, the operator may interactively operate, control, monitor or manage the machine 10 by inputting requests for information and/or commands via the touch screen.

[0026] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

LIST OF ELEMENTS

[0027]

- 10 machine
- 12 tracks
- 14 machine body
- 15 front implement
- 16 front portion

18 rear portion
 20 rear implement
 22 operator platform
 24 operator area
 25 doors
 26 windows
 30 compartment
 34 surface
 36 display
 38 image capturing system
 40 area
 50 site management system
 52 positioning system

capturing an image of at least a portion of said first area;
 generating a visual representation of said image to an operator of said machine;
 presenting said visual representation on a surface interposed between said operator and said first area.

Claims

1. A machine comprising:
 - an operator platform configured to enable an operator to substantially face towards a first area when driving said machine towards the first area;
 - a surface configured such that said surface at least partially prevents an operator from having direct visual contact with said first area;
 - means for capturing a real-time image of at least a portion of the first area; and
 - means for displaying a visual representation of said image to said operator.
2. A machine according to claim 1, wherein said visual representation is displayed on a display positioned substantially between said operator area and said surface.
3. A machine according to claim 1, wherein said visual representation is displayed on said surface.
4. A machine according to any of the preceding claims wherein said surface is an external part of an engine compartment.
5. A machine according to claim 1 wherein said machine further includes a machine body and said operator platform projects generally upwards from said machine body, said machine further including an engine compartment projecting generally upwards from said machine body in front of said operator platform thereby substantially covering a portion of said operator platform and forming said surface; and said display has a surface area substantially corresponding to said portion of said operator platform which is substantially covered by said compartment.
6. A method of operating a machine comprising:
 - driving said machine towards a first area;
7. A method according to claim 6 wherein capturing said image and generating and displaying said visual representation substantially happens in real-time.
8. A method according to any of claims 6 to 7 further including determining a next course of action based on the information provided by said visual representation.
9. A method according to any of claims 6 to 8 wherein displaying a visual representation of said image to an operator of said machine includes displaying a realistic representation of an area having a current characteristic.
10. A method according to 9, further including receiving an abstract representation of a desired characteristic of said area; overlaying said abstract representation over said realistic representation; performing an action based on said overlaying of said representations.
11. A method according to 10 wherein performing an action includes operating said machine such that said first characteristic approaches said desired characteristic.
12. A method according to any of claims 6 to 11 further displaying information regarding a cue point for action.

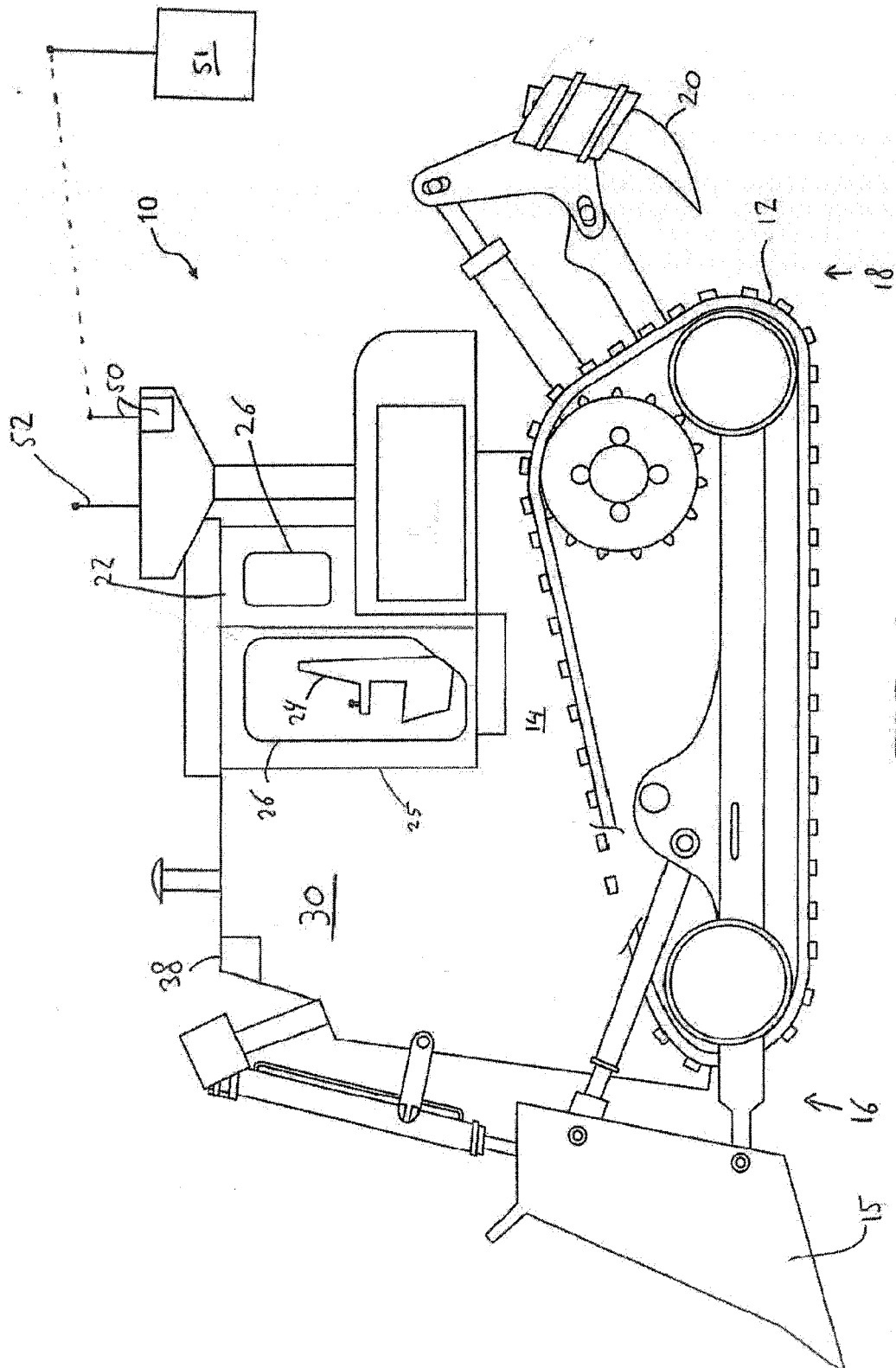


FIG. 1

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Fig. 2

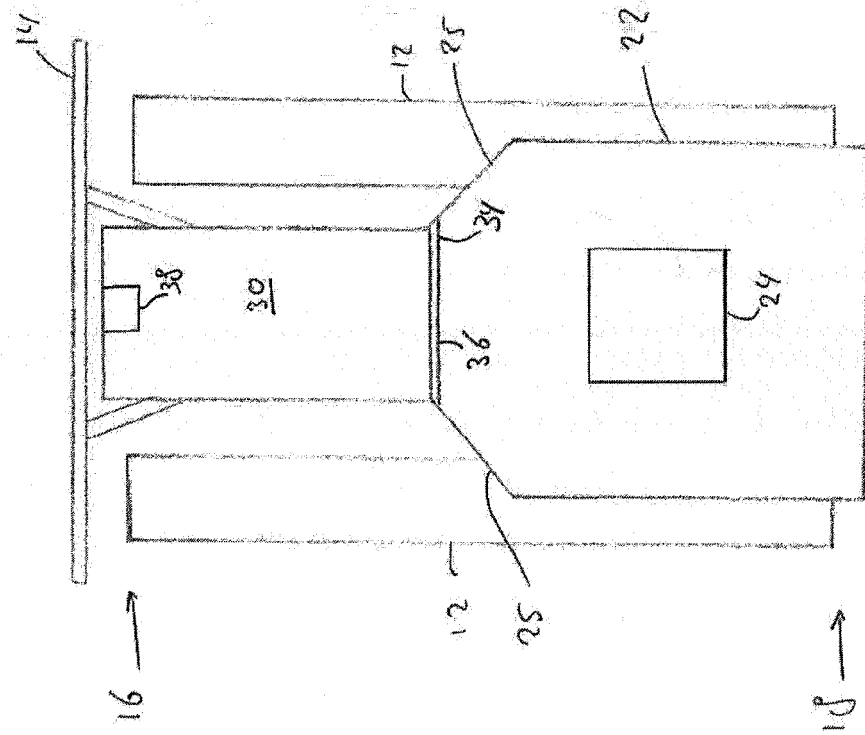


Fig. 3

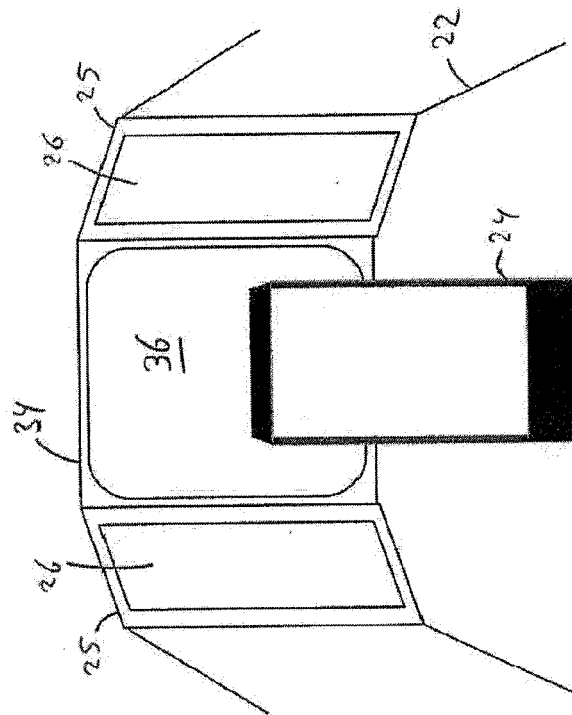


Fig. 4

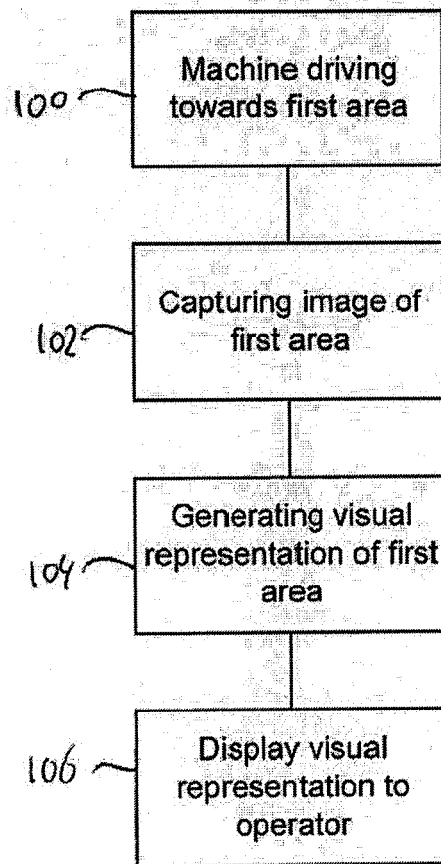
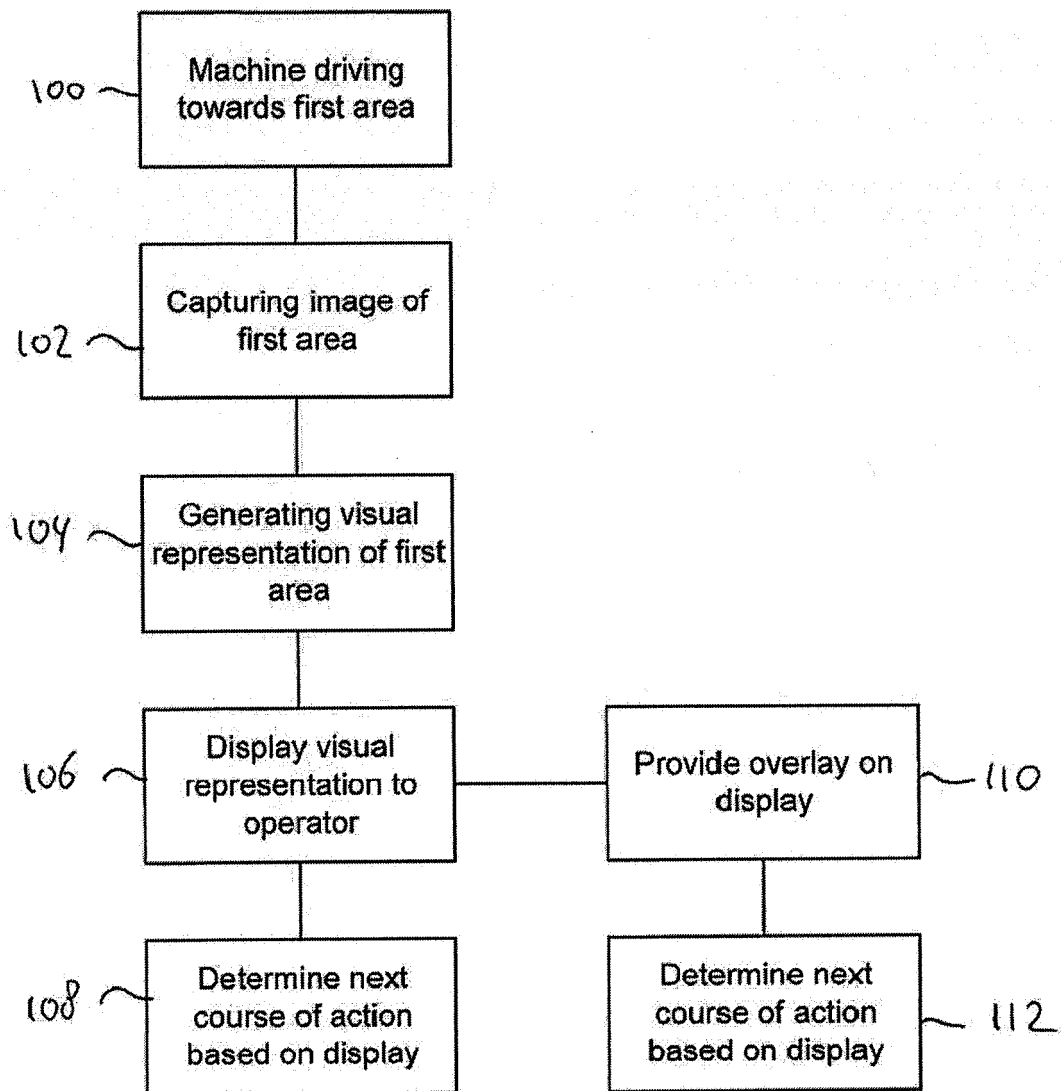


Fig. 5



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 5247

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 July 2008	Examiner Laurer, Michael
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 5247

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Place of search Munich		Date of completion of the search 15 July 2008	Examiner Laurer, Michael
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)



European Patent
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Application Number

EP 07 11 5247

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-2,6,7

1.1. claims: 1-2

directed to a machine comprising:
 an operator platform enabling the operator facing towards a driving direction comprising a first area;
 a surface configured such that said surface at least partially prevents the operator from having direct visual contact with said first area;
 means for capturing a real time image of at least a part of said first area;
 means for displaying a visual representation of said image to said operator;
 wherein the visual representation is displayed on a display positioned substantially between said operator and said surface.

1.2. claims: 6,7

directed to a method of operating a machine comprising:
 driving a machine towards a first area;
 capturing an image of at least a portion of said first area;
 generating a visual representation of said image to an operator of said machine;
 presenting said visual representation on a surface interposed between said operator and said first area;
 wherein the capturing of said image and displaying said visual representation happens in real time.

2. claims: 3-5

directed to a machine comprising:
 an operator platform enabling the operator facing towards a driving direction comprising a first area;
 a surface configured such that said surface at least partially prevents the operator from having direct visual contact with said first area;
 means for capturing a real time image of at least a part of said first area;
 means for displaying a visual representation of said image to said operator;
 wherein said visual representation is displayed on the surface which prevents the direct visual contact;

3. claims: 8-12



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**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 07 11 5247

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

directed to a method of operating a machine comprising:
driving a machine towards a first area;
capturing an image of at least a portion of said first area;
generating a visual representation of said image to an
operator of said machine;
presenting said visual representation on a surface
interposed between said operator and said first area;
wherein information of the visual representation is analysed
in order to determine next course of action or for
displaying a realistic representation of an area having a
current characteristic or displaying information regarding a
cue point for action.

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 11 5247

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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15-07-2008

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