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(54) SYSTEM FOR OPERATING A UTILITY VEHICLE AND METHOD FOR OPERATING SUCH

(57) A system for operating a utility vehicle (10) is disclosed. The system comprising: a work tool (14), a sensing system (12); a controller (52), including a computing device having a processor and a memory (53), the controller (52) operatively coupled to the sensing system (12), wherein the controller (52) receives a first sensing signal from the sensing system (12), where the first sensing signal comprises an image with an accumulation of a material generated by the work tool (14) engaging the material while traveling along a first guidance path (22) which creates a first area traversed; and generates a second guidance path (24), by the controller (52), based on the first signal, where movement along the second guidance path (24) creates a second area traversed to overlap a portion of the first area traversed causing the work tool (14) to interact with the accumulation of the material. Further, a method of operating a utility vehicle (10) is disclosed.

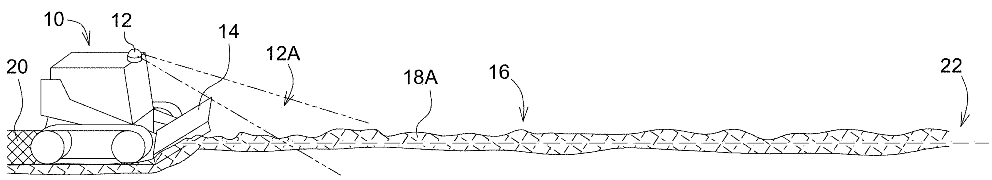

FIG. 1A

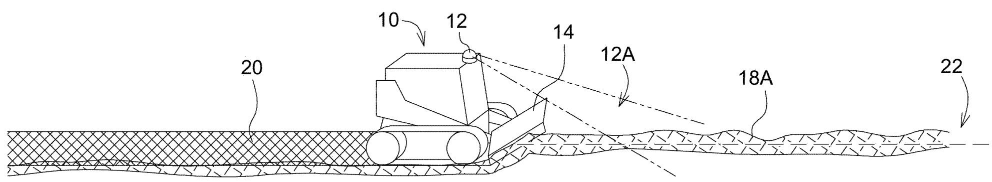

FIG. 1B

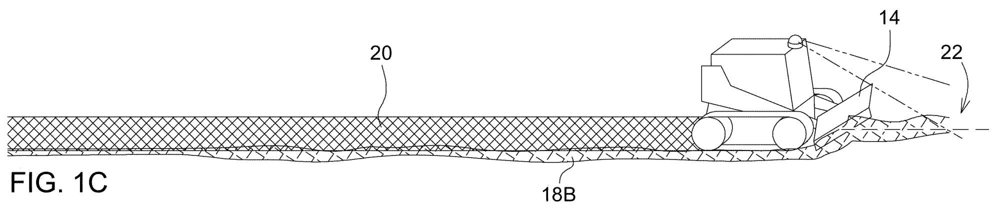

FIG. 1C

Processed by Luminess, 75001 PARIS (FR)

Description

[0001] The present disclosure relates generally to utility vehicles and more specifically to efficient navigation of utility vehicles during grading of surfaces

[0002] Moving materials across a surface often generates excess material from the end of a work tool (e.g., a blade). Following paths of the excess material on later passes across a work site can be difficult and tiring for an operator. Solutions to better manage capturing and/or leveling the excess material on a subsequent pass would be useful.

[0003] According to an aspect of the present disclosure, a system for operating a utility vehicle, the system can comprise a work tool, a sensing system, a controller, including a computing device having a processor and a memory, the controller operatively coupled to the sensing system, wherein the controller receives a first sensing signal from the sensing system, where the first sensing signal comprises an image with an accumulation of a material generated by the work tool engaging the material while traveling along a first guidance path which creates a first area traversed, generates a second guidance path, by the controller, based on the first signal, where movement along the second path creates a second area traversed to overlap a portion of the first area traversed causing the work tool to interact with the accumulation of the material.

[0004] According to another aspect of the present disclosure, a utility vehicle including a path following system can comprise a sensing system coupled with the utility vehicle, where the sensing system monitors a surface near the utility vehicle, a controller, including a computing device having a processor and a memory, the controller operatively coupled to the sensing system, where the controller receives a first sensing signal from the sensing system, where the first sensing signal comprises an image with an accumulation of a material generated by a work tool engaging the material while traveling along a first guidance path, and generates a second guidance path, by the controller, based on the first signal, where movement along the second path creates a second area traversed to overlap a portion of the first area traversed causing the work tool to interact with the accumulation of the material.

[0005] According to yet another aspect of the present disclosure, a method of following a path, can comprise monitoring a surface by a sensing system, receiving a first sensing signal from the sensing system, where the first sensing signal comprises an image with an accumulation of a material generated by the work tool engaging the material while traveling along a first guidance path which creates a first area traversed, generating a second guidance path, by the controller, based on the first signal, where movement along the second path causes a second area traversed to overlap a portion of the first area traversed causing the work tool to interact with the accumulation of the material.

[0006] Other features and aspects will become apparent by consideration of the detailed description, claims, and accompanying drawings.

[0007] The detailed description of the drawings refers to the accompanying figures.

FIGS. 1A-C are perspective views of a utility vehicle with a work tool moving material while traveling along a first path, consistent with embodiments of the present disclosure.

FIGS. 2A-C are top views of a first area traversed by the work took of FIGS. 1A-C while moving the material while traveling along the first path, consistent with embodiments of the present disclosure.

FIGS. 3A-B are top views of a second area traversed by the work tool of FIGS. 1A-C while moving the material while traveling along a second path, consistent with embodiments of the present disclosure.

FIG. 4 is a schematic diagram that shows the various components of the path following system and apparatus, consistent with embodiments of the present disclosure.

FIG. 5 is a flow diagram that shows the steps of a method for path following, consistent with embodiments of the present disclosure.

[0008] Like reference numerals are used to indicate like elements throughout the several figures.

[0009] FIGS. 1A-C are perspective views of a utility vehicle with a work tool moving material while traveling along a first path, consistent with embodiments of the present disclosure. Fig. 1A shows a utility vehicle 10 with a sensing system 12 and a work tool 14 moving along a surface 16, where the work tool 14 is engaging material 18A along the surface 16. A utility vehicle 10 can be used to move various materials (e.g., dirt, soil, rock, sand, etc.) along the surface 16 at a work site.

[0010] The utility vehicle 10 can include the work tool 14 that can be used to move a material 14 along the surface 16 including preparing the surface by grading the surface 16. In FIGS. 1A-C, the utility vehicle 10 is a skid steer loader as a representative example. Any utility vehicle that is used to move material along a surface, especially those used for grading, could be considered here (e.g., a dozer, compact track loader, a wheel loader, a, etc.). After the utility vehicle 10 has passed over the surface 16 while moving material with the work tool 14 the traveled area can be considered a first area traversed 20A.

[0011] The surface 16 can include a row of material 18A (i.e., an accumulation of material, a linear pile) where the accumulation of material 18A is generally higher than other portions of the surface 16 (i.e., there is a pile or mound of material on the surface 16). The accumulation of material 18A can be generated by work being done to the surface by the utility vehicle 10 and/or other vehicles. The accumulation of material 18A can be referred to as a windrow (i.e., a windrow of material) similar to a windrow of hay cut in a field and arranged in a line to dry before being formed into bales.

[0012] As the utility vehicle 10 moves along the surface 16, there can be more material in the accumulation of material 18A compared to areas of the surface 16 adjacent to the accumulation of material 18A). As the utility vehicle 10 moves along, the work tool 14 (i.e., a blade, a bucket, or other similar work tool used to grade a surface) can gather (i.e., catch, contact, etc.) the accumulation of material 18 and smooth it (i.e., grade it, spread it, level it, etc.).

[0013] The utility vehicle 10 can be initially moving along a first guidance path 22 as the blade 14 engages the accumulation of material 18A and create the first area traversed 20A. The first guidance path can be a path generated by a path guidance system (not shown in FIGS. 1A-C, see FIG. 4 and related discussion) or by a path generated by manual operation of the utility vehicle 10 by an operator.

[0014] As the utility vehicle 10 encounters the accumulation of material 18A and grades the surface 16, the sensing system 12 can be used to identify the accumulation of material 18A. The sensing system 12 can have an area of detection 12A that is positioned to include an area ahead of the utility vehicle and ahead of the blade 14 as shown in FIGS. 1A-C. The sensing system 12 can generate an image of the accumulation of material 18A, and then send a sensing system signal (i.e., a first sensing signal) to a controller (not shown in FIGS. 1A-C, see FIG. 4 and related discussion).

[0015] The controller can then, based on the image, generate a second guidance path (now shown in FIGS. 1A-C, see FIGS. 3A-C and related discussion) and send a signal (i.e., a second signal) to a path guidance system to generate a second guidance path (not shown in FIGS. 1A-C, SEE FIGS. 3A--C and related discussion) to either assist the operator in directing the utility vehicle 10 (e.g., by providing information on a display, using alerts (e.g., icons, sounds, etc.)) or by controlling movement of the utility vehicle 10 through autonomous controls.

[0016] FIGS. 2A-C are top views of the first area traversed by the blade of FIGS. 1A-C while moving the material while traveling along the first path, consistent with embodiments of the present disclosure. As the utility vehicle 10 moves along the surface 16 along the first guidance path 22 and grades the accumulation of material 18A, the blade 14 is often angled to allow for excess material from the accumulation of material 18A to spill off an end of the blade 14 as shown in FIGS 2A-C. This material coming off the end of the blade 14 can then form a second accumulation of material 18B.

[0017] FIGS. 3A-B are top views of a second area traversed by the work tool of FIGS. 1A-C while moving the material while traveling along a second path, consistent with embodiments of the present disclosure. After moving along the first guidance path 22 and creating the first area traversed 20A, the utility vehicle 10 (not shown in FIGS. 3A-B) with blade 14 can move along a second guidance path 24 creating a second area traversed 20B where the second guidance path 24 causes the blade 14 to overlap a portion of the first area traversed 20A to include the accumulation of material 18A. Using the sensing system (now shown in FIG. 3A-B, see FIGS. 1A-C) the utility vehicle 10 can engage the accumulation of material 18A as it grades surface 16.

[0018] As the utility vehicle 10 moves along the second guidance path 24, the blade 14 can again be angled to allow for excess material from the accumulation of material 18A to spill off an end of the blade 14 which generates the accumulation of material 18B, as shown in FIGS 3A-B. This process can be repeated on subsequent passes to engage each accumulation of material as the surface 16 is graded.

[0019] FIG. 4 is a schematic diagram that shows the various components of the path following system and apparatus, consistent with embodiments of the present disclosure. A path following system 50 can include a controller 52, a memory 53, a sensing system 12 (e.g., a vision system), a path guidance system 54, a vehicle control system 56, and a display 58, and.

[0020] The sensing system 12 can monitor a surface 16 in an area proximate the utility vehicle 10 such as the area ahead of the blade 14 that is in the path of travel of the work tool 14. The sensing system 12 can capture images of the surface 16 which can include images of the accumulation of material 18A as the work tool 14 engages the material 16.

[0021] The sensing system 12 can then send a sensing system signal (i.e., a first sensing signal) based on the images to a controller 52. The controller 52 can, using software routines stored in memory 53, based on the images, generate a second guidance path (now shown in FIG. 4, see FIGS. 1A-C, 2A-B, and 3A-C and related discussion) and send a signal (i.e., a second signal) to a path guidance system 54 to generate a second guidance path (not shown in FIGS. 1A-C, See FIGS. 3A-C and related discussion) to either assist the operator in directing the utility vehicle 10 (e.g., by providing information on a display, using alerts (e.g., icons, sounds, etc.)) and/or by controlling movement of the utility vehicle 10 through the engine control system 56. This could, in some instances, include autonomous operation using an appropriate system.

[0022] The controller 52 can be operatively connected to the sensing system 12, the memory 53, the path guidance system 54, the vehicle control system 56, and the display 58 and. The vehicle control system 56 can include, for example, a transmission control unit 56A and an engine control unit 56B. The transmission control unit 56A can be used to control a transmission of the utility vehicle 10 and the engine control unit 56B can be used to control an engine of the utility vehicle 10.

[0023] The sensing system 12 can include an apparatus to view an area ahead of the utility vehicle (see FIGS. 1-3) including an accumulation of material (e.g., the accumulation of material 18A/18B, etc.). The sensing system 12 can capture images of and/or information about the accumulation of material 18A/18B using a sensing device such as a camera (e.g., a stereocamera), a radar, a lidar, or other similar devices. The sensing system 12 can be used to determine differences between the accumulation of material and a surface 16 adjacent to the accumulation of material. Information about a location of the accumulation of material can be used to determine a path of travel of the utility vehicle 10.

[0024] Using images and/or information from the sensing system 12, the path of travel of the utility vehicle can be generated to follow a path that follows the accumulation of material.

[0025] An electronic processor is provided and configured to perform an operation providing a guidance path (e.g., using the sensing system 12 to generate the guidance path 22) by displaying information to an operator regarding the guidance path and/or using control systems on the utility vehicle 10 to control a direction of travel of the utility vehicle based on the guidance path created using input from the sensing system 12

[0026] . The electronic processor may be arranged locally as part of the utility vehicle 10 or remotely as a remote processing center (not shown). In various embodiments, the electronic processor may comprise a processor, a microprocessor, a microcontroller, a controller (e.g., controller 52), a central processing unit, a programming logic array, a programmable logic controller, or other suitable programmable circuitry that is adapted to perform data processing and/or system control operations. The electronic processor executes or otherwise relies upon computer software applications, components, programs, objects, modules, or data structures, etc. Software routines resident in the included memory (e.g., memory 53) of the electronic processor or the memory are executed in response to signals received.

[0027] The computer software applications, in other embodiments, may be located in the cloud. The executed software includes one or more specific applications, components, programs, objects, or sequences of instructions typically referred to as "program code." The program code includes one or more instructions located in memory and other storage devices which execute the instructions which are resident in the memory, which are responsive to other instructions generated by the system, or which are provided by an operator interface operated by the user (e.g., located in the operator cab or at a remote location in in the operator cab). The electronic processor is configured to execute the stored program instructions.

[0028] FIG. 5 is a flow diagram that shows the steps of a method for path following, consistent with embodiments of the present disclosure. A method of path following 70 can include a step 72 of monitoring a surface by a sensing system, a step 74 of receiving, by a controller, a first signal from the sensing system, where the first sensing signal comprises an image with an accumulation of a material on the surface generated by a work tool engaging the material while traveling along a first path, a step 76 of generating a second path, by the controller, based on the first signal where the second path overlaps the first path causing the work tool to interact with the accumulation of the material on the surface.

[0029] The method can further comprise a step 78 of determining a projected path of travel following the accumulation of material (e.g., accumulation of material 18A/B), and/or a step 80 of displaying the projected path of travel following the accumulation of material (e.g., accumulation of material 18A/B), and/or utilizing the projected path of travel in automation and operator interface features.

[0030] As used herein, "e.g." is utilized to non-exhaustively list examples and carries the same meaning as alternative illustrative phrases such as "including," "including, but not limited to," and "including without limitation." Unless otherwise limited or modified, lists with elements that are separated by conjunctive terms (e.g., "and") and that are also preceded by the phrase "one or more of" or "at least one of" indicate configurations or arrangements that potentially include individual elements of the list, or any combination thereof. For example, "at least one of A, B, and C" or "one or more of A, B, and C" indicates the possibilities of only A, only B, only C, or any combination of two or more of A, B, and C (e.g., A and B; B and C; A and C; or A, B, and C).

[0031] Those having ordinary skill in the art will recognize that terms such as "above," "below," "upward," "downward," "top," "bottom," etc., are used descriptively for the figures, and do not represent limitations on the scope of the disclosure, as defined by the appended claims. Furthermore, the teachings may be described herein in terms of functional and/or logical block components and/or various processing steps. It should be realized that such block components may be comprised of any number of hardware, software, and/or firmware components configured to perform the specified functions.

[0032] Terms of degree, such as "generally", "substantially" or "approximately" are understood by those of ordinary skill to refer to reasonable ranges outside of a given value or orientation, for example, general tolerances or positional relationships associated with manufacturing, assembly, and use of the described embodiments.

[0033] While the above describes example embodiments of the present disclosure, these descriptions should not be viewed in a limiting sense. Rather, other variations and modifications may be made without departing from the scope and spirit of the present disclosure as defined in the appended claims.

Claims

1. A system for operating a utility vehicle (10), the system comprising:

   a work tool (14),
   a sensing system (12);
   a controller (52), including a computing device having a processor and a memory (53), the controller (52) operatively coupled to the sensing system (12), wherein the controller (52)

      receives a first sensing signal from the sensing system (12), where the first sensing signal comprises an image with an accumulation of a material generated by the work tool (14) engaging the material while traveling along a first guidance path (22) which creates a first area traversed;
      generates a second guidance path (24), by the controller (52), based on the first signal, where movement along the second guidance path (24) creates a second area traversed to overlap a portion of the first area traversed causing the work tool (14) to interact with the accumulation of the material.

2. The system of claim 1, wherein the controller (52) is further configured to guide, by the controller (52), a utility vehicle (10), along the second guidance path (24) using a path guidance system (54).

3. The system of claim 1 or 2, wherein the work tool (14) comprises a blade or a bucket.

4. The system of one of the claims 1 to 3, wherein the controller (52) is further configured to display, on a display (58), information related to the second guidance path (24).

5. The system of one of the claims 1 to 4, wherein the sensing system (12) comprises one or more of a stereocamera, a radar, and a lidar.

6. The system of one of the claims 1 to 5, wherein the accumulation of the material comprises a linear pile of the material generated by a movement of the work tool (14) during motion of a utility vehicle (10).

7. The system of one of the claims 1 to 6, wherein the first guidance path (22) is generated by an operator in close proximity of time to the second guidance path (24).

8. The system of one of the claims 1 to 6, wherein the first guidance path (22) is generated by a path guidance system (54).

9. A method of operating a utility vehicle (10), comprising:

   monitoring a surface (16) by a sensing system (12),
   receiving a first sensing signal from the sensing system (12), where the first sensing signal comprises an image with an accumulation of a material generated by the work tool (14) engaging the material while traveling along a first guidance path (22) which creates a first area traversed;
   generating a second guidance path (24), by the controller (52), based on the first signal, where movement along the second guidance path (24) causes a second area traversed to overlap a portion of the first area traversed causing the work tool (14) to interact with the accumulation of the material.

10. The method of claim 9, further comprising displaying, on a display (58), information related to the second guidance path (24).

11. The method of claim 9 or 10, further comprising guiding, by the controller (52), a utility vehicle (10), along the second guidance path (24) using a path guidance system (54).

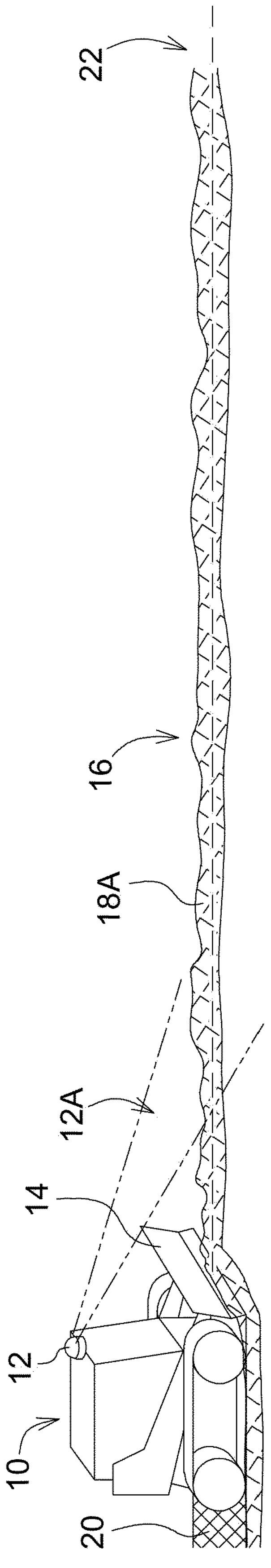

FIG. 1A

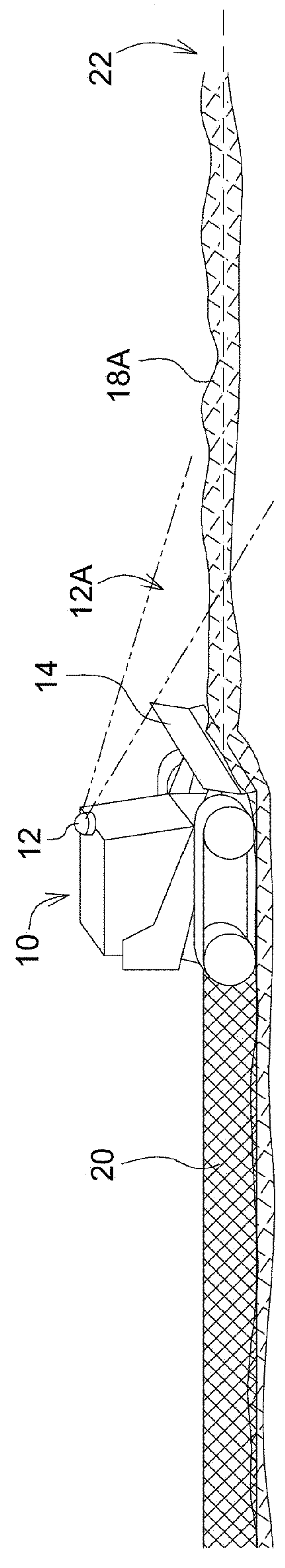

FIG. 1B

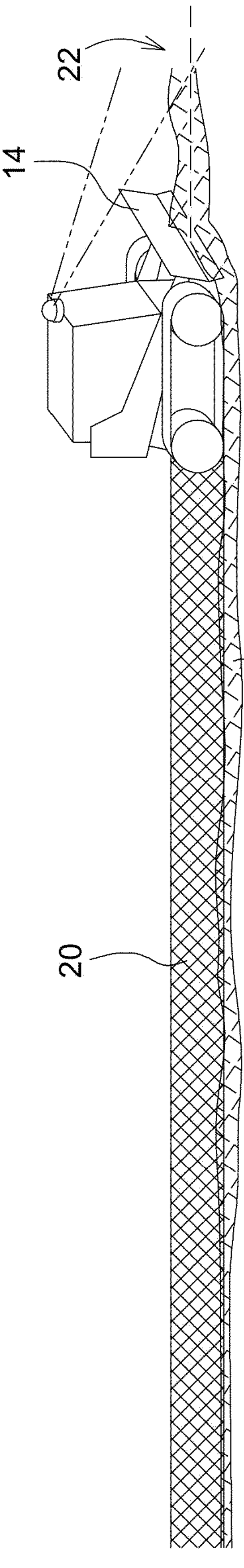

FIG. 1C

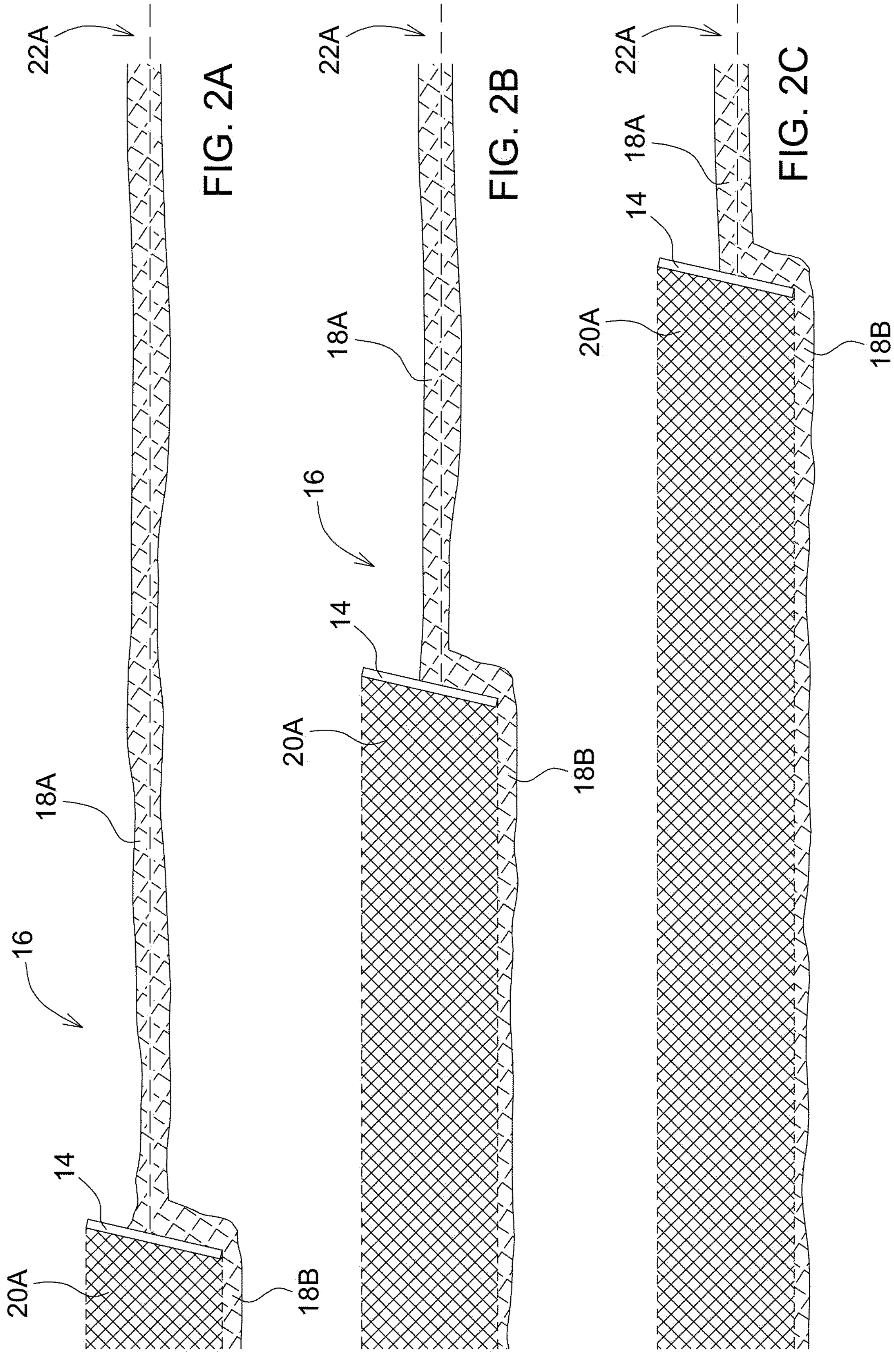

FIG. 2A

FIG. 2B

FIG. 2C

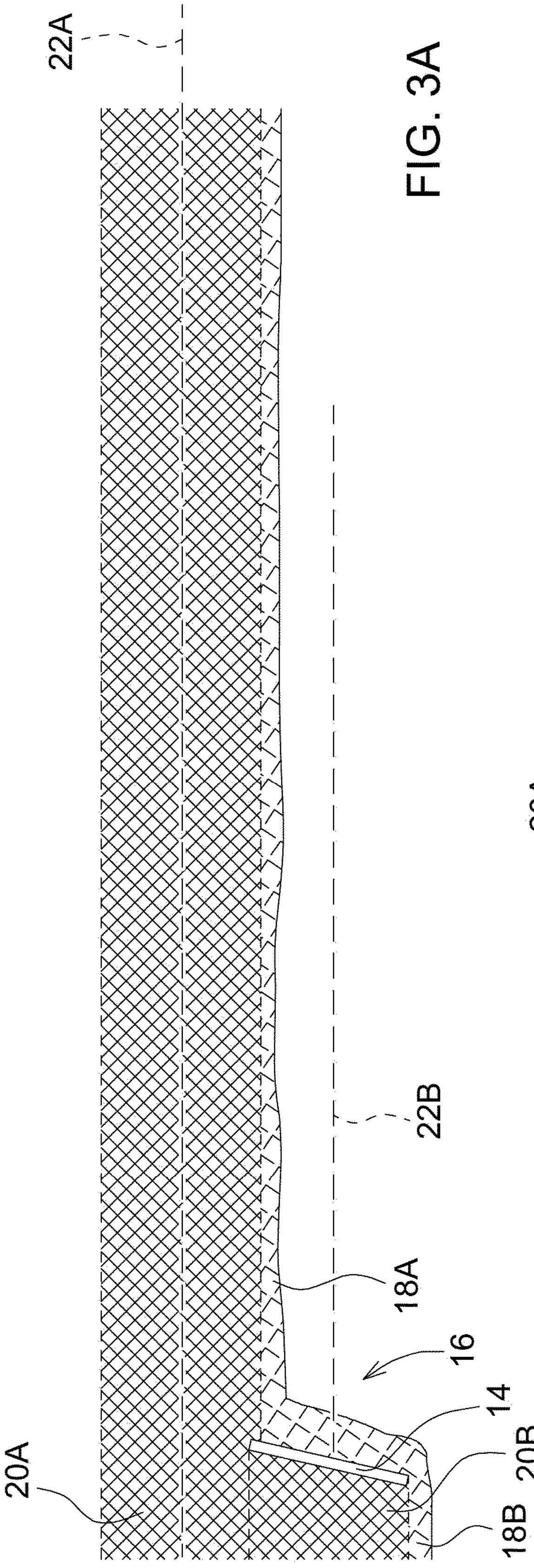

FIG. 3A

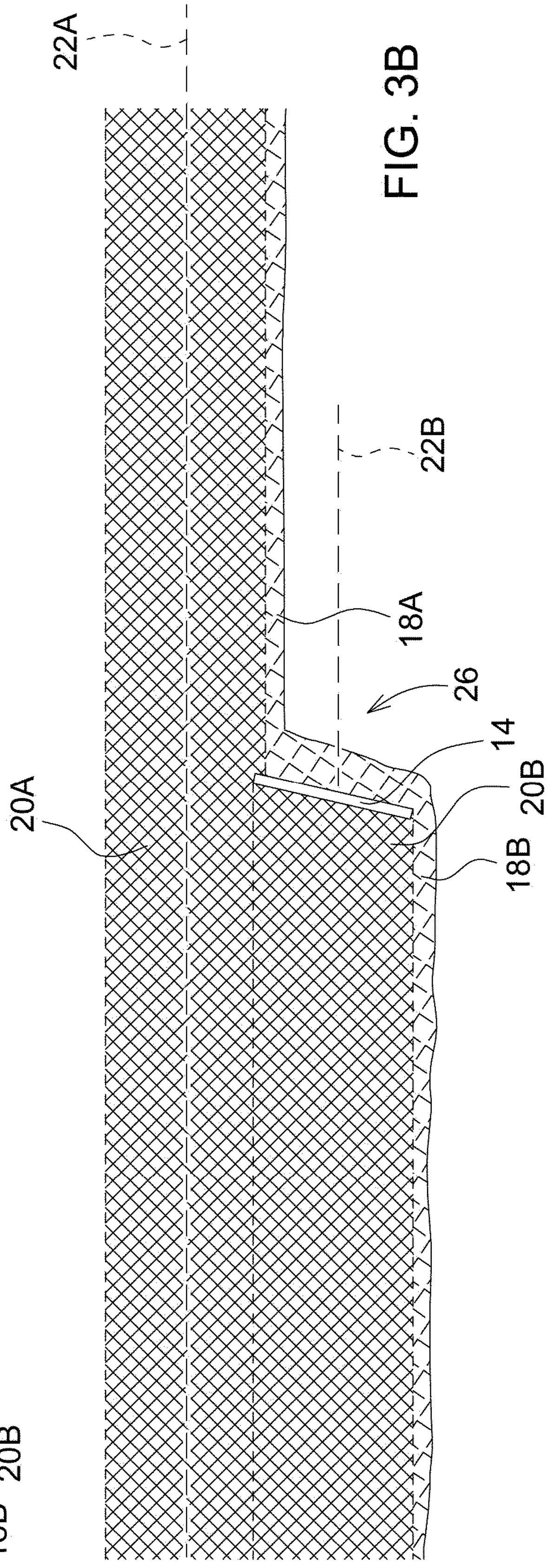

FIG. 3B

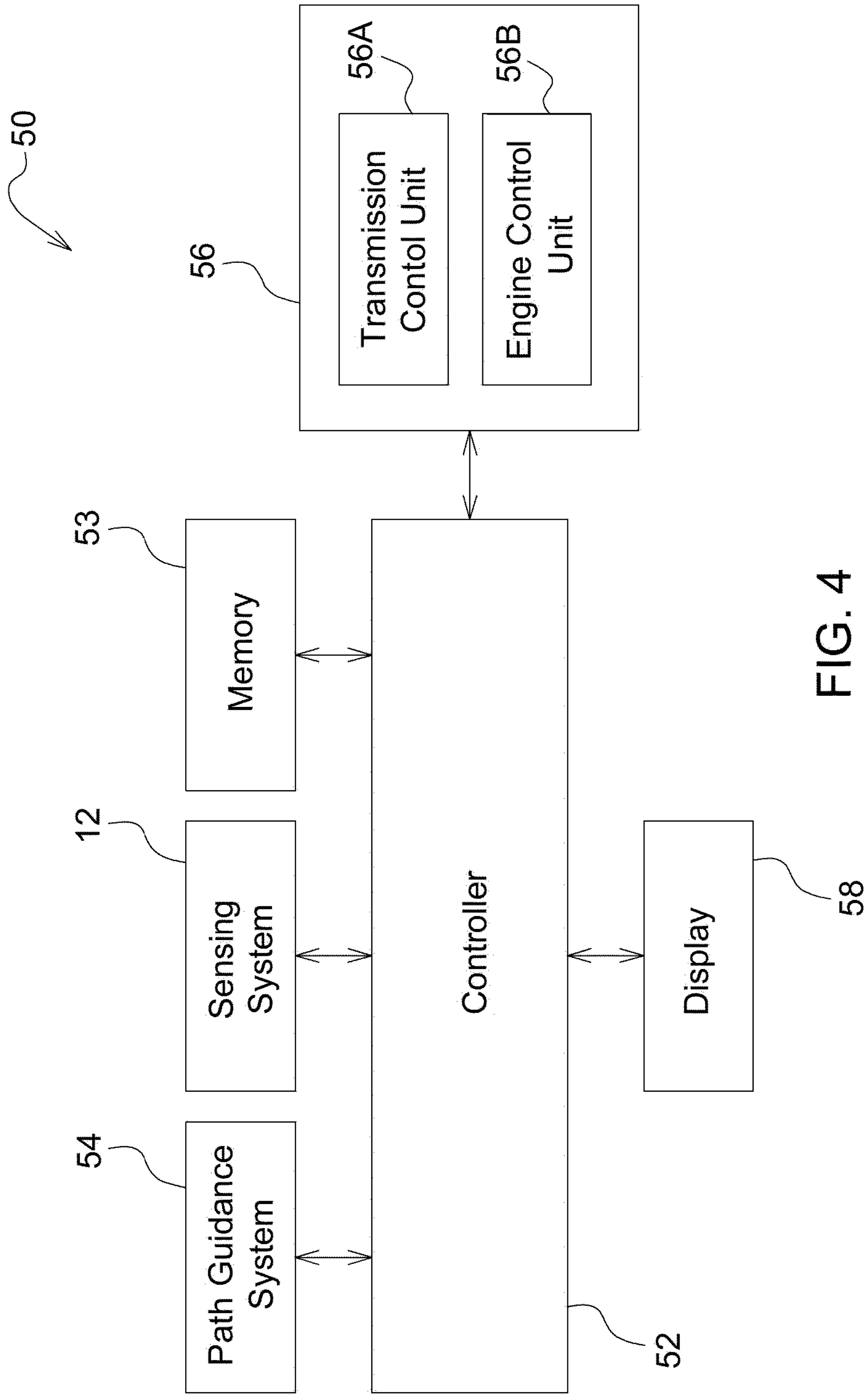
50
56
56A
Transmission Contol Unit
56B
Engine Control Unit
53
Memory
12
Sensing System
54
Path Guidance System
Controller
52
Display
58

FIG. 4

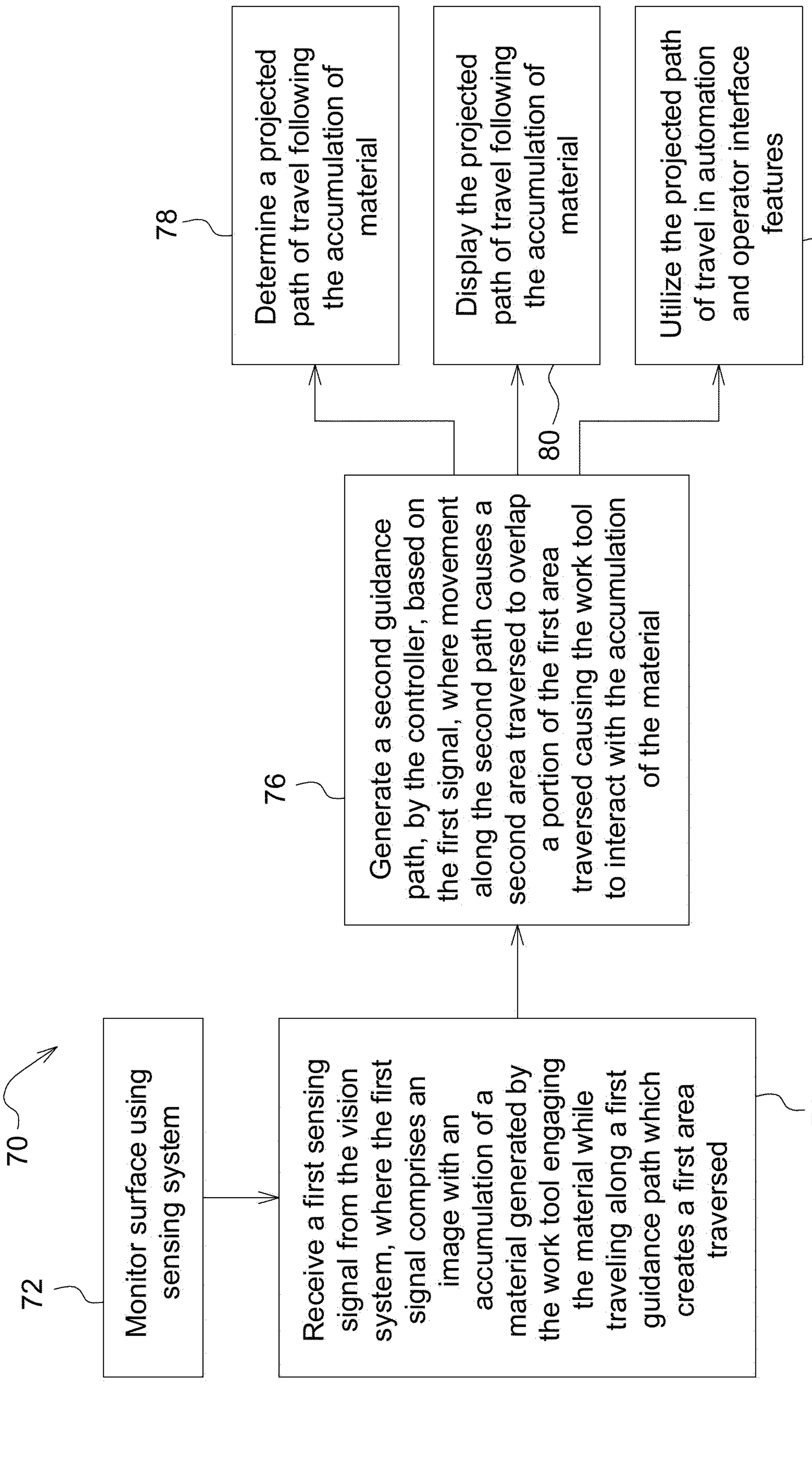
70
72
Monitor surface using sensing system
74
Receive a first sensing signal from the vision system, where the first signal comprises an image with an accumulation of a material generated by the work tool engaging the material while traveling along a first guidance path which creates a first area traversed
76
Generate a second guidance path, by the controller, based on the first signal, where movement along the second path causes a second area traversed to overlap a portion of the first area traversed causing the work tool to interact with the accumulation of the material
78
Determine a projected path of travel following the accumulation of material
80
Display the projected path of travel following the accumulation of material
82
Utilize the projected path of travel in automation and operator interface features

FIG. 5