US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication	20250265838
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	Bjorklund; Jani et al.

SYSTEM AND METHOD FOR A FORESTRY VEHICLE

Abstract

A system for measuring and analyzing a forest area, comprising at least one stereo camera, a camera control unit, a computing unit to receive data from the stereo camera and to compute the received data and to calculate and determine information based on the data, a display unit, configured to display the results to an operator of a forestry vehicle, the system being configured to be integrated in a forestry vehicle, wherein the information is any one of the following, the shape of a tree or stem, the type of tree, the bark or surface of a tree or stem, irregularities of a tree or stem, diameter of a tree or stem, density or basal area of a working area of the forestry vehicle.

Inventors: **Bjorklund; Jani (Tampere, FI), Palmroth; Mikko (Tampere, FI)**

Applicant: **Deere & Company** (Moline, IL)

Family ID: **1000008487041**

Appl. No.: **19/052891**

Filed: **February 13, 2025**

Foreign Application Priority Data

EP	24158456.4	Feb. 19, 2024

Publication Classification

Int. Cl.: **G06V20/10** (20220101); **A01G23/00** (20060101)

U.S. Cl.:

CPC **G06V20/188** (20220101); **A01G23/00** (20130101);

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. § 119 to European patent application EP 24158456.4, filed on 19 Feb. 19, 2024, the disclosure of which is incorporated herein by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure generally relates to a system and method for a forestry vehicle.

BACKGROUND OF THE DISCLOSURE

[0003] Mobile work machines, in particular, forestry equipment and forestry machines, e.g. harvesters and forwarders, have an articulated boom and a tree stem processing tool at the tip of the boom. The tool can be e.g. a harvester head, a felling head, a harvesting and processing head, or a log grapple equipped with a sawing apparatus. The tool can be used e.g. to cut standing trees, to process felled trees or to grab objects, such as logs or tree stems. When using such a tool with power-driven operation, it is operated under the control of an operator of the work machine.

[0004] The mobile work machines comprise an articulated boom assembly with the tool attached to a boom tip of the boom assembly. Such tools handle heavy load, that may comprise a load of soil or logs or raw material. Usually, such booms are controlled by hydraulic actuators that are driven by hydraulic pressure from one or more pumps. The pumps are usually powered by the primary power source of the vehicle.

[0005] The stem processing tool or harvester tool comprises several movable knives that are used to grab the log/tree with the harvester tool. These knives are hydraulically actuated and controlled by the computing unit mounted on the harvester tool. Once the tree is grabbed with the harvester tool, a saw blade, usually at a bottom side of the harvester tool, is activated to cut the tree/stem. After the cutting process the tree will fall over, only being fixated in the harvester tool by the knives closed around the stem. Usually, within the harvester tool, feeding wheels are activated to pull/push the stem through the harvester tool and the knives, so that bark/branches are removed, and the log/stem is cut up into log pieces of determined size.

[0006] The forestry vehicle may be used for thinning operations in a certain forest area. One purpose of thinning is to reduce the number of trees that are near each other. The proximity may lead to reduced growth of the trees and thus less timber generation. The trees would stagnate in growth. Thinning is based on the basal area calculation of the trees, which is a function of the tree diameters in a height between **1** and **3** meters above the ground in a certain working area and the overall forest area, resulting in a number that gives an indication of the available timber at that time and about the current state of the standing trees, i.e. current growth state, tree health.

[0007] Thinning may depend on the age of the standing trees in the work area, the type or specimen of trees present and the current state of the trees, i.e. damages, pest infestations, fungi infestations, relative distances of the trees with each other, different growth rate of neighboring trees.

[0008] The operator may measure the tree basal area manually and calculate the basal area index. Based on the results, the operator may manually select trees based on experience, which requires knowledge of the specimens and the possible occurring circumstances, i.e. present infestations, damage, and judgment of distances of neighboring trees. Depending on the individual operator experience, the thinning results may differ.

[0009] The thinning operation is time consuming for the operator having to leave the vehicle and process manual measurement of the trees in various terrain and weather conditions. There are also intentions to facilitate tree density measurement by drones, or small flying aircraft devices. Yet, correct measurement is often not possible, due to the foliage of the trees, branches in the fly path, terrain obstacles and weather conditions.

[0010] It is an object of the present disclosure to overcome the disadvantages.

SUMMARY OF THE DISCLOSURE

[0011] The disclosure is a system for measuring and analyzing a forest area, comprising at least one stereo camera, a camera control unit, a computing unit to receive data from the stereo camera and to compute the received data and to calculate and determine information based on the data, a display unit, configured to display the results to an operator of a forestry vehicle, the system being configured to be integrated in a forestry vehicle, wherein the information is any one of the following, the shape of a tree or stem, the type of tree, the bark or surface of a tree or stem, irregularities of a tree or stem, diameter of a tree or stem, density or basal area of a working area of the forestry vehicle.

[0012] The system enables the automated detection of trees in the field of view of the stereo camera. The system processes the camera data and identifies and evaluates the trees regarding the basal area, the tree type or specimen, the tree shape and tree status such as infestations or damages. The system may determine trees which are deemed to be felled and present the result on the display to the operator. The determination for felling is based on the planned final tree density or basal area. Further the system determines the trees depending on identified damages or small shape, or nearness to other trees. The system may present the operator with visual aid which trees are optimal for felling regarding the thinning operation. The operator may remain in the vehicle cabin and is able to decide the trees for the felling process without the requirement to leave the cabin and is able to do so in a timely manner without the time required to facilitate the measurements. thumb button or switch may be adjustable in relation to the handle part.

[0013] In a further embodiment the diameter of the tree may be measured in 1,3 meters above the ground.

[0014] Use according to the nomenclature of the basal area definition advantageously enables the operator to achieve comparable thinning results within the work team and within the work area or forest area. The results are further comparable to other forest areas, enabling a thinning standard in the forestry industry.

[0015] In a further embodiment the system may be adapted to exchange data with a database.

[0016] The tree positions, tree type, status may be exchanged with a database. This may be a production database and advantageously enables the operator to aggregate tree data for future work processes and to homologize the data between different forestry vehicles. The database may display the data of the thinning process or other tree data for additional work processes related to the forest area.

[0017] In a further embodiment the system may be adapted to detect trees in the working area to determine a tree density or basal area, and to compare the detected density or basal area with a planned density or basal area, and to display the deviation to the operator.

[0018] The system may calculate a present tree density form the camera data and compare the result with a planned or intended tree density. The result may be displayed to the operator indicating the work progress or the intended work area for ongoing felling work. The operator is relieved from manual calculations reducing the possibility for error and the work load of the operator.

[0019] In a further embodiment the computing unit may use a pixel based or object-based method.

[0020] The computing unit is enabled to identify the trees or stems in the camera data feed and able to determine the related tree parameters and display these to the operator on the display.

[0021] In a further embodiment the system may identify individual trees, which are either damaged or not straight or to be felled to reach the planned density or basal area.

[0022] The analysis of the camera data may detect irregular tree shapes. The trees may be not in a straight shape or may be damaged. Such trees may be difficult to detect for the operator depending on the conditions of the work area. The system may detect these irregularities and alert the operator to the tree condition.

[0023] Another embodiment includes a method to measure and analyze a forest area, comprising at least one stereo camera, a camera control unit, a computing unit to receive data from the stereo camera and to compute the received data and to calculate and determine information based on the data, a display unit, configured to display the results to an operator of a forestry vehicle, the system being configured to be integrated in a forestry vehicle, wherein the information is any one of the following, the shape of a tree or stem, the type of tree, the bark or surface of a tree or stem, irregularities of a tree or stem, diameter of a tree or stem, density or basal area of a working area of the forestry vehicle, wherein the method uses a pixel based or object-based method to compute the camera data.

[0024] The method advantageously enables the automated detection of trees in the field of view of the stereo camera. The system processes the camera data and identifies and evaluates the trees regarding the basal area, the tree type or specimen, the tree shape and tree status such as infestations or damages. The system may determine trees which are deemed to be felled and present the result on the display to the operator. The determination for felling is based on the planned final tree density or basal area. Further the system determines the trees depending on identified damages or small shape, or nearness to other trees. The system may present the operator with visual aid which trees are optimal for felling regarding the thinning operation. The operator may remain in the vehicle cabin and is able to decide the trees for the felling process without the requirement to leave the cabin and is able to do so in a timely manner without the time required to facilitate the measurements.

[0025] Other features and aspects will become apparent by consideration of the detailed description and accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** depicts a view of a common forestry vehicle, i.e. a harvester;

[0027] FIG. **2** displays a tool for the vehicle, i.e. a harvester head;

[0028] FIG. **3** shows the visualization of the system from a camera picture;

[0029] FIG. **4** shows the visualization of the system derived from a positional determination.

[0030] Before any embodiments are explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The disclosure is capable of other embodiments and of being practiced or of being carried out in various ways. Further embodiments may include any combination of features from one or more dependent claims, and such features may be incorporated, collectively or separately, into any independent claim.

DETAILED DESCRIPTION

[0031] FIG. **1** shows a forest harvester vehicle **10**. It comprises usually of a front and rear chassis which are articulated and a driver cabin **30** for the operator. The vehicle **10** has boom assembly **12** to which a timber working device **20**, e.g. a harvester head is attached. The boom assembly **12** is able to rotate and to tilt, and to extend and to rotate the timber working device **20** by the arrangement of the individual booms. For the felling and processing of a tree into logs, the operator extends and maneuvers the boom assembly **12** so that the harvester head **20** can close the upper and lower knives **22**, **70** around the tree stem. The operator cuts the tree with the integrated saw blade **28** so that the stem falls over and is held at the lower end with the knives **22**, **70** of the harvester head **20**. In a next step the drive system **72**, consisting of the feeding arms **24** holding the feeding wheels **26** is operated so that the feeding wheels **26** by their gripping surface pull or push the stem through the harvester head **20** from the upper **22** to the lower knives **70** so that the stem can be cut into logs of predetermined length, controlled by the drive system **72**.

[0032] When the feeding wheels **26** transport the stem through the harvester head **20**, the knives **22**, **70** need to maintain a close grip to ensure the stem stays within operational parameters and is kept safely inside the harvester head **20**. Also, the knives **22**, **70** are used to remove branches and bark from the stem. This leads to the difficulty that a tight grip may remove the branches easily but will at the same time increase the friction of the stem and thus increase the workload on the drive system **72** which can lead to damages to the surface and a loss of quality.

[0033] The shape of the stem is also an important factor in that a bend or curved shape will require a constant adaption of the grip of the knives **22**, **70**, leading to a longer processing time and reduced productivity. The grip may also damage the stem and reduce the wood quality. Damaged trees that are processed may undergo further damage during processing as the wood may have cracks in the stem which can further increase during the processing. Broken branches may complicate the processing as the removal by the knives **22**, **70** may require more grip force and as stated above may result in more damage to the stem.

[0034] The system comprises a stereo camera **40** that may be attached to an outside of the cabin **30** or on the vehicle **10**. The camera **40** is connected to a camera control unit **50** that may be used to give commands to the camera **40**, i.e. turning the camera **40** or changing the settings or data feed. The stereo camera **40** is connected to a computing unit **60** which receives the camera data feed and computes the data to identify singular trees in the surroundings of the vehicle. The computing unit **60** is enabled to identify the tree types, the diameter of the stems, the distance of the trees to the camera center point or to the boom assembly base point, the shape of the trees and damages of the trees and the bark. The computing unit **60** is connected to a display unit **61** inside the cabin **30** to display the information to the vehicle operator. Further details of the display unit **61** and the information received from the data feed will be stated in connection with FIGS. **3** and **4**.

[0035] The harvester head **20** of the present disclosure is shown in FIG. **2**. It comprises a base frame **76** which is extending along a feeding axis and a movably fixed tilt bracket **74** which is attachable to the boom assembly **12** of the vehicle **10**. The frame **76** contains all necessary parts and devices to ensure the operation of the harvester head **20**, such as the computing unit, hydraulic hubs, hydraulic lines, hydraulic motors and hydraulic valves. It further comprises movable arms **24** rotatably holding the feeding wheels **26** so that these can be pushed against the stem surface. In a vertical direction, above the feeding wheels **26** are the upper knives **22** and below are the lower knives **70** which are controlled by hydraulic actuators usually but may also be controlled by electric actuators or motors. At the bottom of the frame **76** the saw blade **28** is placed below the lower knives **70**.

[0036] During cutting operation, the upper and lower knives **22**, **70** are closed around the stem. The harvester head **20** may only have upper **22** or lower knives **70**, this does not change the operation procedure. Further, the harvester head **20** may have more than two feeding wheels **26**, such as four, which also does not alter the process or use of the present embodiment.

[0037] FIG. **3** depicts a view **90** of the stereo camera **40** which is received and interpreted by the computing unit **60** and transmitted to the display unit **61**. The view can be an overlay over a real feed from the stereo camera **40** or can be a separate view only showing computed information to the operator. The view comprises the identified tree stems **100**, **110** in relation to a determined viewpoint. The viewpoint can be selectable and can be set as the base point of the boom assembly **12** or as the operator position. In the current example of FIGS. **3** and **4** the base point of the boom assembly **12** is selected. The trees are shown in vertical lines, representing the outer contour of the stem. The lines can have different color to support easy identification on the display unit **61**. The stems are shown in perspective whereas close objects appear larger and may also hide or overlap objects in the background, such as shown with the stem **100** on the right center position.

[0038] The computing unit **60** may identify the tree type and display the corresponding data next to the stem **100**, **110** in an info field **105**, **115**. The computing unit **60** may identify the stems by an index number i. The view may show the diameter of the stem and a radial distance to the base of the boom assembly **12**. The view may also generate an indicator if the stem is out of reach of the boom assembly **12** in the current vehicle position. The view may also indicate a tree damage in the info field **105**, **115**.

[0039] As another example the tree **110** is shown as out of range so that the operator has an

indication that the vehicle **10** must be moved to reach that tree.
[0040] The basal area and thinning value may be displayed in a separate screen or on the same screen, view, depending on the identified tree or stem diameters by the stereo camera **40**.
[0041] FIG. **4** shows a range-oriented view **130** where the identified trees are displayed in a centered field around the boom assembly base point or any selected point of view. The view **130** allows to determine trees in relation to their distance to the vehicle **10** represented in the center point. The trees are numbered by their index “I” so that the operator can advantageously identify the different positions. Depending on the reach of the used boom assembly **12** the reach setting can be changed. View **130** may also display the tree density of basal area of the trees in the vicinity.
[0042] The system advantageously enables the operator to make decisions which are based on the current forest or work area conditions and relieves the operator to assume or rely on experience.
[0043] The computing unit may include, or be associated with, a processor **350**, a computer-readable medium, a communication unit, data storage such as a database networks, and a user interface having a display and/or user interface tools by which an operator may input instruction to the computing unit.
[0044] The computing unit described herein may be a single computing unit having all the desired functionality, or it may include multiple computing units wherein the described functionality is distributed among the multiple computing units. A data storage may generally encompass hardware such as volatile or non-volatile storage devices, drives, memory, or other storage media, as well as one or more databases residing thereon.
[0045] The computing unit of the forestry vehicle may in some embodiments further receive inputs from and generate outputs to remote devices associated with a user via respective user interface, for example, a display unit with a touchscreen interface. Data transmission between, for example, a machine control system and a remote user interface may take the form of a wireless communication system and associated components as are conventionally know n in the art. In certain embodiments, a remote user interface and vehicle control systems for respective work machines may be further coordinated or otherwise interact with a remote server or other computing device for the performance of certain operations in a system as disclosed herein.
[0046] Various “computing unit” operations steps, or algorithms as described in connection with the computing unit or in connection with alternative but equivalent computing devices or systems can be embodied directly in hardware, in a computer program product such as a software module executed by the processor, or in a combination of the two. The computer program product can reside in RAM memory, flash memory, ROM memory, EPROM memory,
[0047] EEPROM memory, registers, hard disk, a removable disk, or any other form of computer-readable medium known in the art. An exemplary computer-readable medium can be coupled to the processor such that the processor can read information from and write information thereto. In the alternative, the computer-readable medium can be integral to the processor. The processor and the computer-readable medium can reside in an application specific integrated circuit (ASIC). The ASIC can reside in a user terminal. In the alternative, the processor and the computer-readable medium can reside as discrete components in a user terminal.
[0048] The term “processor” as used herein may refer to at least general-purpose or specific-purpose processing devices and/or logic as may be understood by one of skill in the art, including but not limited to a microprocessor, a microcontroller, a state machine, and the like. A processor can also be implemented as a combination of computing devices (e.g., a combination of a digital signal processor (DSP) and a microprocessor), a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.
[0049] Various features are set forth in the following claims.

Claims

1. A system, to be integrated in a forestry vehicle, for measuring and analyzing a forest area, the system comprising: at least one stereo camera; a camera control unit configured to give commands to the camera; a computing unit configured to receive a data from the stereo camera and a processor on the computing unit, the processor having program instructions to compute the received data and to calculate and determine an information based on the data, wherein the information includes at least one of the the shape of a tree or stem, the type of tree, the bark or surface of a tree or stem, irregularities of a tree or stem, diameter of a tree or stem, density or basal area of a working area of the forestry vehicle; and a display unit configured to display the information to an operator of the forestry vehicle.
2. The system of claim 1, wherein the diameter of the tree measured is between one and three meters above the ground.
3. The system of claim 1, wherein computing unit is further configured to exchange data with a database.
4. The system of claim 1, wherein the computing unit is further configured to detect trees in the working area to determine a tree density or basal area, and to compare the detected density or basal area with a planned density or planned basal area, and to display a deviation to the operator.
5. The system of claim 1, wherein the computing unit is further configured to process a pixel based or object-based method.
6. The system of claim 1, wherein the computing unit is further configured according to identify individual trees, which are either damaged or not straight or to be felled to reach the planned density or basal area.
7. A method of measuring and analyzing a forest area from a forestry vehicle, the method comprising commanding at least one stereo camera with a control unit;, receiving a data from the stereo camera by a computing unit; calculating and determining by a processor on the computing unit, the processor having program instructions for pixel comparison when calculating and determining the data; displaying the information on a display associated of the forestry vehicle; wherein the information includes at least one of the shape of a tree or stem, the type of tree, the bark or surface of a tree or stem, irregularities of a tree or stem, diameter of a tree or stem, and density or basal area of a working area of the forestry vehicle.
8. The method of claim 7 wherein the diameter of the tree measured is between one and three meters above the ground.
9. The method of claim 7 further comprising exchanging data with a database.
10. The method of claim 7 further comprising: detecting trees in the working area; determining a tree density or basal area; comparing the detected density or basal area with a planned density or planned basal area; and displaying a deviation to the operator.
11. The method of claim 7 further comprising identifying individual trees, which are either damaged or not straight or to be felled to reach the planned density or the planned basal area.