

WOOD LOADING VOLUME ESTIMATION

FIELD OF INVENTION

- 5 The invention relates to a method for processing images. More particularly, the invention relates to a method for determining volume of one or more wood stacks.

BACKGROUND OF THE INVENTION

- 10 The conventional method of determining volume of woods is through placing the woods into a water tank. The volume of the submerged woods can then be determined through Archimedes principle by measuring the volume of overflowed water caused by the submerged woods. This method is well known to person skilled in the art and it is relatively accurate per se. Nevertheless, this method can be difficult or impossible to be
15 carry out under certain weather conditions such as winter condition or raining condition. Furthermore, the maintenance fee of the water tank can be expensive and time consuming as the water tank tends to accumulate dirt from the woods. In addition, the submerged woods would need time to be dried up before they can be further processed. As a result, computer vision systems have been developed to replace such method.

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- For instance, international application WO 2016024242 A1 discloses a log scanning system and method for scanning a log load. Each individual log in the log load may have an ID element with a unique log ID data on at least one log end face. The system has a handheld scanner unit for free-form scanning by an operator over a load end face
25 of the log load. The scanner unit has a depth sensor configured to capture a series of depth images of the load end face and a texture sensor configured to capture a series of texture images of the load end face during the load end face scan. The system also has a data processor(s) that receives and processes the depth and texture images captured from the scan. The processor(s) are configured to fuse the depth images or depth and

texture images into a data model of the load end face, determine log end boundaries of the individual logs visible in the load end face by processing the data model, process the texture images to identify and decode any ID elements visible in the scan to extract individual log ID data, and generate output data representing the log load based on the
5 determined log end boundaries and extracted log ID data.

Another US Patent No. US 20110298889 A1 discloses an administration method of a lumber. An outer appearance of a lumber is photographed to obtain an image data, and a three-dimensional coordinate model of the lumber is created from the image data.
10 Then, a minimum diameter and a length of the lumber are obtained from the three-dimensional coordinate model to calculate a mass volume of the lumber. Further, an edge surface pattern appearing on an edge surface of the lumber is extracted from the image data. After various processes are applied to the lumber, an edge surface pattern is recorded to create an edge surface pattern data. A history data, in which histories of
15 the various processes are accumulated, and the edge surface pattern data are correlated and recorded, is constructed. Accordingly, when the edge surface pattern is compared with the edge surface pattern data, it is possible to trace the histories of the various processes.

20 Nevertheless, these methods would require either additional depth sensors or capturing the entire outer appearance of the wood log to calculating a mass volume of the wood log. The add-on of depth sensors would incur additional cost to the system and the capturing of the entire outer appearance of the wood log can be difficult or even impossible as the wood logs are usually stacked in a container. Accordingly, it would
25 be desirable to provide an inventive method that overcomes the abovementioned drawback. This invention provides a solution to the problem.

SUMMARY OF INVENTION

One objective of the invention is to provide a method for determination of volume of one or more wood stacks from one or more images captured by any type of image capturing devices.

In one aspect of the invention, there is provided a method for determining volume of one or more wood stacks, the method comprises capturing one or more images of the wood stacks; processing the one or more images to obtain a mean width, a mean height, and a conversion factor of each wood stack; and determining the volume of each wood stack applying the mean width, the mean height, the conversion factor, and one or more user predefined dimension values of each wood stacks to a predetermined formula; wherein the conversion factor is obtained by the steps of: selecting a region of interest from the capture images to filter out backgrounds; converting the filtered images from Red Green Blue, RGB images into Hue, Saturation and Value, HSV images; applying one or more image processing techniques to reduce present of noise in the HSV images; converting the HSV images to binary images via a thresholding technique; calculating number of white and black pixels within the binary images; and obtaining the conversion factor by calculating a ratio of white and black pixels to eliminate empty gaps between woods within each wood stack.

Preferably, the mean width can be obtained by the steps of: selecting a region of interest from the captured images to filter out backgrounds; converting the filtered images into binary images via a thresholding technique; obtaining contours from the binary images; determining centroid and extreme points of each contour; selecting boundary points representing widths at different regions of each wood stack; calculating distance between two boundary points of a same horizontal plane to obtain width in pixel for each region; calculating width in meter using a pixel per metric ratio for each region; and averaging the widths of each region to obtain the mean width.

Preferably, the mean height can be obtained by the steps of: selecting a region of interest from the captured images to filter out backgrounds; converting the filtered images into binary images via a thresholding technique; obtaining contours from the binary images;
5 determining centroid and extreme points of each contour; selecting boundary points representing heights at different regions of each wood stack; calculating distance between two boundary points of a same vertical plane to obtain height in pixel for each region; calculating height in meter using a pixel per metric ratio for each region; and averaging the heights of each region to obtain the mean height.

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Preferably, the region of interest can be selected by the steps of: identifying a reference object from the captured images; selecting start and end points of the reference object from the captured images; calculating a distance between the start and end points; calculating pixels per metric; and defining a colour range to separate the wood stack
15 from background.

Preferably, the thresholding technique can be coupled with a machine learning algorithm or a neural network algorithm to select one or more optimum parameters for producing binary images that can best differentiate the wood stack from the background or empty gaps between woods.
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Preferably, the volume of each wood stack can be determined by multiplying a predefined length, the mean width, the mean height and the conversion factor of the respective wood stack.

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One skilled in the art will readily appreciate that the invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiments described herein are not intended as limitations on the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawing the preferred embodiments from an inspection of which when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

10 **Fig. 1** is a block diagram illustrating an overview of a method for determining volume of one or more wood stacks.

Fig. 2 is a block diagram illustrating a process flow of determining mean width and mean height of each wood stack.

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Fig. 3 is a block diagram illustrating a process flow of determining conversion factor for each wood stack.

DETAILED DESCRIPTION OF THE INVENTION

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The invention will now be described in greater detail, by way of example, with reference to the drawings.

Fig. 1 illustrates an overview of a method for determining volume of one or more wood stacks. Although the method is being described for use in determining volume of the wood stacks, it should be understood that the method can also be applied to determine volume of any other elongate structures such as pipe stacks or pile stacks. In step **110**, an image capturing device can be used to capture one or more images of the wood stacks. The image capturing device can be a digital camera used for capturing static

images or videos. It should be understood that the digital camera can be easily replaced by a handheld smartphone with integrated high-resolution camera. The images are preferably coloured images or at least within visible light spectrum. Preferably, an image taken from transverse ends of a particular wood stack, where the cutting surfaces
 5 of the woods are exposed, can be used to measure the width and height of the wood stack, whereas an image taken from longitudinal ends of the wood stack can be used to measure the length of the wood stack. In preferred embodiment, the wood stacks are captured alongside with a reference object. The reference object is of a known dimension and such known dimension can be used as a reference to minimize or
 10 eliminate the need of ground truth measurements.

In step **120**, the captured images are processed to obtain mean width, mean height, and conversion factor of each wood stack. Further details of the image processing shall be discussed in a later section. In step **130**, dimension information such as a length of each
 15 wood stack is obtained from a user. In step **140**, an amount of wood stacks is obtained from the user. The steps **130** & **140** can be estimated in an automated manner by similar image processing techniques used in step **120**. In step **150**, the volume of each wood stack is determined by applying the mean width, the mean height, the conversion factor, and the user inputted information of each wood stack to a predetermined formula.
 20 Preferably, the volume of each wood stack is calculated by the following formula (1):

$$\text{Final Volume (V)} = \text{Input Length (L)} \times \text{Mean Width (W)} \times \text{Mean Height (H)} \times \text{Conversion Factor} \text{ ----- (1)}$$

25 In step **160**, a total volume of all the wood stacks is calculated by summing up volume of each wood stack.

Referring to **Fig. 2**, a process flow of determining the mean width and the mean height is illustrated. In step **210**, the captured images are retrieved for image processing.

- Preferably, the images are captured from the transverse end of the wood stacks. In step **220**, the user selects a region of interest from the captured images to filter out backgrounds. Preferably, the selection of the region of interest comprises the steps **221** to **225**. In step **221**, the reference object is identified from the capture images. Such reference object can be but is limited to a metal pipe that is placed alongside with the wood stack. In step **222**, the user selects start and end points of the reference object from the captured image. In step **223**, a distance between the start and end points is calculated using an algorithm. Such algorithm can be any known formula for calculating Euclidean distance, Manhattan distance, Minkowski distance or Hamming distance. In step **224**, ratio of distance between the points and the known length of the reference object will be used to calculate pixels per metric. In step **225**, colour ranges that define the wood stack section are used to isolate the foreground and background so that the wood stack can be differentiated from the background.
- In step **230**, the filtered images are converted into binary images via a thresholding technique. The thresholding technique is suitable to be implemented because the woods have a distinctive colour and thresholding technique can produce close to real time results for the volume determination of the wood stacks. For other types of trees, crops or elongate structures, multitude of machine learnings or neural networks can be implemented to select optimum parameters to produce a binary image that best describes the stack. In step **240**, contours are obtained from the binary images. Preferably, a contour of the largest size is obtained by joining all points along boundaries of the same colour. In step **250**, centroid and extreme points of each contour is determined to calculate an area of a boundary field and other spatial information of the image moment. From here, steps **260** to **263** are deployed to determine the mean width and steps **270** to **273** are deployed to determine the mean height.

In step **260**, boundary points representing widths at different regions of each wood stack are selected. Preferably, the left and right most points at a top, centre and bottom regions

- of the largest contour are selected. The selection of points can be manually conducted by user. In step **261**, distance between two boundary points of a same horizontal plane is calculated to obtain width in pixel for each region. In step **262**, width in meter of each region is calculated using the pixel per metric calculated in step **224**. In step **263**, the
- 5 widths of each region are averaged to obtain the mean width of the wood stack. In step **270**, boundary points representing heights at different regions of each wood stack are selected. Preferably, the top and bottom most points at a left, centre and right regions of the largest contour are selected. The selection of points can be manually conducted by user. In step **271**, distance between two boundary points of a same horizontal plane
- 10 is calculated to obtain height in pixel for each region. In step **272**, height in meter of each region is calculated using the pixel per metric which is calculated in step **224**. In step **273**, the heights of each region are averaged to obtain the mean height of the wood stack.
- 15 Referring to **Fig. 3**, a process flow of determining conversion factor for each wood stack is illustrated. In step **310**, the captured images are retrieved for image processing. Preferably, the images are captured from the transverse end of the wood stacks. In step **320**, the user selects a region of interest from the captured images to filter out backgrounds. Preferably, steps **221** to **225** can be implemented for the selection of the
- 20 region of interest. Alternatively, the region of interest can also be defined by drawing a rectangle shape box that contains the wood stack. In step **330**, the filtered images are converted from Red Green Blue, RGB images into Hue, Saturation and Value, HSV images so that further pre-processing techniques can be implemented. The further pre-processing techniques may include but is not limited to extraction, enhancement and
- 25 blurring the value component of the images. In step **340**, the further pre-processing techniques are applied to reduce present of noise in the HSV images. In step **350**, the HSV images are converted to binary images via a thresholding technique. In step **360**, number of white and black pixels within the binary images are calculated. In step **370**, the conversion factor is obtained by calculating a ratio of white and black pixels to

eliminate empty gaps between woods within each wood stack.

The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred
5 form with a degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

CLAIMS

1. A method for determining volume of one or more wood stacks, the method comprising:
 - 5 capturing (110) one or more images of the wood stacks;
 - processing (120) the one or more images to obtain a mean width, a mean height, and a conversion factor of each wood stack; and
 - determining (150) the volume of each wood stack applying the mean width, the mean height, the conversion factor, and one or more user predefined dimension values of each
 - 10 wood stacks to a predetermined formula;

wherein the conversion factor is obtained by the steps of:

 - selecting (320) a region of interest from the capture images to filter out backgrounds;
 - converting (330) the filtered images from Red Green Blue, RGB images into Hue, Saturation and Value, HSV images;
 - 15 applying (340) one or more image processing techniques to reduce present of noise in the HSV images;
 - converting (350) the HSV images to binary images via a thresholding technique;
 - calculating (360) number of white and black pixels within the binary images; and
 - obtaining (370) the conversion factor by calculating a ratio of white and black pixels to
 - 20 eliminate empty gaps between woods within each wood stack.

2. The method according to claim 1, wherein the mean width is obtained by the steps of:
 - selecting (220) a region of interest from the captured images to filter out backgrounds;
 - 25 converting (230) the filtered images into binary images via a thresholding technique;
 - obtaining (240) contours from the binary images;
 - determining (250) centroid and extreme points of each contour;
 - selecting (260) boundary points representing widths at different regions of each wood stack;

calculating (261) distance between two boundary points of a same horizontal plane to obtain width in pixel for each region;
 calculating (262) width in meter using a pixel per metric ratio for each region; and
 averaging (263) the widths of each region to obtain the mean width.

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3. The method according to claim 1, wherein the mean height is obtained by the steps of:

selecting (220) a region of interest from the captured images to filter out backgrounds;
 converting (230) the filtered images into binary images via a thresholding technique;

10 obtaining (240) contours from the binary images;

determining (250) centroid and extreme points of each contour;

selecting (270) boundary points representing heights at different regions of each wood stack;

calculating (271) distance between two boundary points of a same vertical plane to

15 obtain height in pixel for each region;

calculating (272) height in meter using a pixel per metric ratio for each region; and

averaging (273) the heights of each region to obtain the mean height.

4. The method according to any one of claims 1 to 3, wherein the region of interest is

20 selected by the steps of:

Identifying (221) a reference object from the captured images;

selecting (222) start and end points of the reference object from the captured images;

calculating (223) a distance between the start and end points;

calculating (224) pixels per metric; and

25 defining (225) a colour range to separate the wood stack from background.

5. The method according to any one of claims 1 to 3, wherein the thresholding technique is coupled with a machine learning algorithm or a neural network algorithm to select one or more optimum parameters for producing binary images that can best differentiate

the wood stack from the background or empty gaps between woods.

6. The method according to any one of claims 1 to 5, wherein the volume of each wood stack is determined by multiplying a predefined length, the mean width, the mean height
- 5 and the conversion factor of the respective wood stack.