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Computer aided length estimation of coconut fibre

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Abstract

The length of coconut fibre is the main key factor considered for export market. Naturally fibres exits as cross and curve fibres which creates difficulties in taking length measurements. Further, existing methods consume more time. The main objective of this study is to develop an automatic system, which is capable of estimating the length of coconut fibre efficiently and accurately. The system is developed based on image processing techniques. Image taken from a webcam is processed first, and then the processed image is scanned pixel by pixel from the starting point to the end point of fibre. Scanned pixels are stored in an array. The procedure is repeatedly applied for all fibres in the image. Finally the average fibre length is computed through the system and in the testing process, these values were compared with real lengths. The system was tested with single fibres, multiple fibres, and multiple fibres cross one another. Test result indicated that the system functions effectively and reliably.

Keywords: Coconut Fibre, Image Processing, Automatic System, Length Measurement.

Introduction

Coconut, which is known as tree of life in Sri Lanka has wide range of domestic and commercial uses. Common domestic uses of coconut are as a cooking ingredient and sometimes as firewood too. Commercial uses include furniture industry, timber, exportation of coconut fibre and fibre allied products. Common fibre allied products are rugs, brushes, brush carpets and decorative items, etc. According to the Central Bank report (2006), Sri Lanka earns foreign exchange of 71million US$ by exporting coconut fibre. The length of a coconut fibre is the key factor that has to be considered at the export market since it is the primary quality parameter. Therefore, the exporter has to maintain consistent length of fibres which are packed for exportation. Currently the sample measurement of coconut fibre is done manually, which consumes lot of labour and time. The main focus of this research is to develop a system to automatically estimate the average length of coconut fibre.

According to the literature, the direct measurement method is the common technique utilized in fibre length evaluation (Chin *et al.,* 1988; Arroyo & Avalos 1989). Richard (1986) described various methods of fibre length measurements used in fundamental studies of wood properties and pulp quality control. Methods described include direct measurement of cells from microscopic images through the optical and laser scanning methods. However, for commercial purposes, these particular methods are not economical.

Jules *et al.* (2004) investigated the effects of fibre length and orientation on elastic properties with the help of software. They have employed statistical functions to obtain the fibre length and orientation distributions. They have used Monte-Carlo simulation to identify each fibre a length and in plane & out of plane orientation values. The measurement of fibre orientation angle is also very important factor that has to be considered. The fibre orientation angle can be measured precisely as much as the fibre aspect ratio is small (Kima & Lee, 2007). Nguyen *et al.* (2008) developed a methodology to predict the elastic properties of long-fibre injection-molded thermoplastics. They have shown that it is essential to obtain an accurate fibre orientation distribution and a realistic fibre length distribution to accurately predict the composite properties.

Fischer and Eyerer (1980) presented a computer based measuring strategy to determine spatial orientation of short glass fibres from the cross-section of single fibres. Zak *et al.* (2000a) have developed a method to estimate three-dimensional fibre orientation distribution and fibre length in short-fibre. However, it has been developed only for 3D analysis which cannot be calibrated for cross fibres. As we know that Coconut fibre naturally form cross fibres, the method developed by Zak *et al.* (2000a) cannot be replicated for the practical uses with coconut fibres. In addition to the above fact, it does not find the length of a long fibre as well. Furthermore, this system takes a longer time to generate output results on fibre length as the processing time required for a 3D image which is lengthy. By considering the time consumed problem mentioned above, the system proposed by current project only deals with 2D model which could generate the output results more efficiently. A methodology proposed by Zak *et al.* (2000b) utilizes a rule-of-mixtures model where effects of the fibre orientation and fibre length distributions were used in the prediction model. The effectiveness of the proposed estimation methodology was demonstrated by the

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comparison results of experimental and model-based predictions.

Objectives

The general objective of this research project is to develop an efficient and precise system to measure the average length of coconut fibre samples. It includes following two specific objectives. 1. To investigate the advantages and disadvantages of the existing methods and 2. Develop an accurate and user friendly length estimation system.

Proposed system

The proposed system needs a computer programme, which is the outcome of this research. The suggested automatic system measures the length of individual coconut fibres and calculates its average value of the selected sample of coconut fibres. The system comprises of a webcam, a white board, a glass surface and a personal computer (PC) with suggested programme (Fig.1). A sample of Coconut fibres is kept on the glass surface below the webcam connected to the PC. In the

Fig.1. Instrument Structure

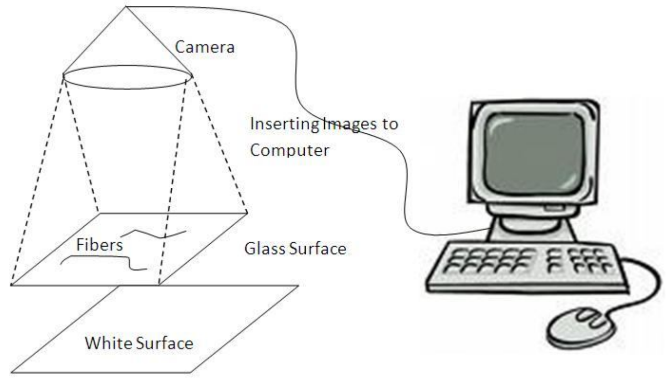
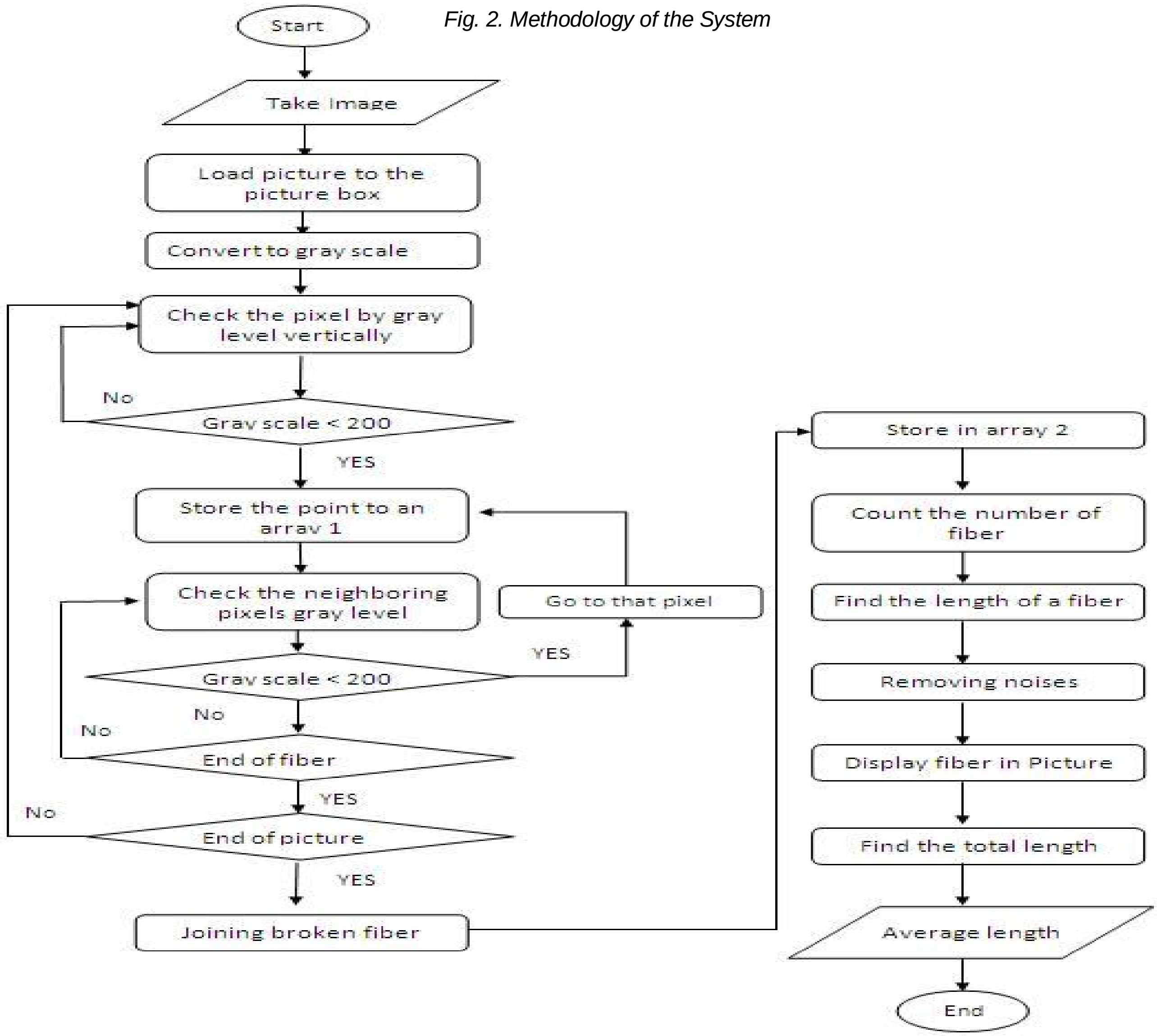


Fig. 2. Methodology of the System



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proposed system the image taken from webcam is loaded to a system and calculates the total length and average length of fibres by using image processing techniques.

Methodology

The length of coconut fibres is one of the quality parameters that have to be maintained by the industrialists in coconut fibre industry. Therefore, it is needed to measure the length of fibres more accurately and efficiently. This research develops a system that would measure coconut fibre length accurately and efficiently. The measurement of the average length of fibre is carried out in several steps. The overall process is depicted in Fig.2.

Extraction of the fibre image from the background (glass surface) is the first task of the process. Thus, a fibre needs to be scanned by a camera or a scanner and then the image has to be transferred to the system and display in a picture box. Subsequently, the picture box is scanned vertically to identify a dark point of the fibre meanwhile the scanned pixel is converted to a gray level and checked to see if it is a dark point or otherwise. This would be accomplished by image processing techniques. If the scanned pixel is a dark point, then the vertical scan is stopped and the scanning is made along the fibre until the end point is reached. When the end point is reached, the vertical scanning will be started from the initial point of the fibre. This procedure is repeated until the picture box is completely scanned.

Steps of the method

The system has been designed to identify the fibre string and it estimates the length of each fibre and finally calculates the average length. In order to accomplish this task the system is divided into several parts as follows.

User interface: A simple user interface is designed to facilitate the insertion of image to the system and to display the scanned fibre.

Insert fibre image to the picture box of system: System should have facilities to identify fibres. Therefore, it is required to insert the image into the system. Then the picture box is inserted into the system which is the scanning area for fibres. Fig.3 displays a sample of coconut fibres which is ready to scan.

Fig.3. A sample of coconut fibres

Check the gray level vertically with the meaning of identifying a dark point: To proceed with further operations, the system should be able to differentiate the fibre from the background. In order to achieve this, the system is developed to extract dark points from the background. First step is the scanning of the picture box vertically. Then the first point (0, 0) of picture box is converted to a gray scale. If the pixel is not a dark point (gray level > 200), the vertical scanning is done until the next dark point of the picture box is reached. Through this procedure, the first dark point is obtained from the image and sent to an array. This data is saved as *x, y* coordinate values. After that, the vertical scanning is ceased temporally and scanning is made along the dark points which are identified as the fibre. After the next dark point along the fibre is scanned, the system converts previous dark points into white color to avoid rescanning of that particular point again as a dark point. On the completion of the above run, the scanning will be started vertically once again from the temporally ceased dark point. This process is carried out until the next dark point is detected, and the new ceased point is identified as the starting point of next fibre.

Verify the neighboring pixel gray level: The initial point of the fibre is first scanned and then the scanning is made until the entire fibre is covered. Generally 3×3 and 5×5 masks are reported to be used in similar situations. In this system, 5×5 a mask is used to find out next dark point of the fibre.

Identification of an end point of the fibre: The system can identify the end point of the fibre because all the points near the end point become white when the reading of the fibre is complete. If it is not an end point scanning neighboring pixel for the dark points is continued. If it is an end point of the fibre then the system starts to scan the picture box again from start point of previous fibre vertically. Pixel values near the end point are shown in Table 1.

Table 1. End of a fiber (In gray scale 255 = white, 0 = black)

255	255	255
255	0	255
255	255	255

Start from new fibre: Start from new fibre is same as “identification of dark points”. After the end part of the fibre is reached, it automatically starts to go though picture box vertically and finds out new dark points to go through the fibre again.

Scan full image for fibres: After reaching the end of the picture box, the scanning process is terminated.

Calibrating the system: Normally,1280×768 resolution is used because the system has initially been calibrated to

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work with the given settings. Web camera is focused on the length of ½ m to calculate the length of fibres.

Fig. 4. Graphical depictions of relevant values between actual and system values for single fibre using system

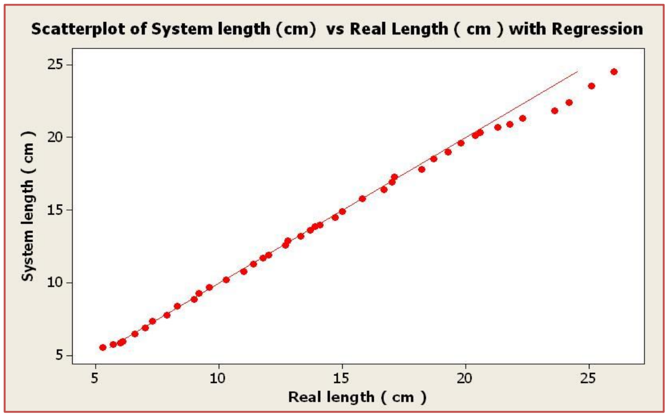
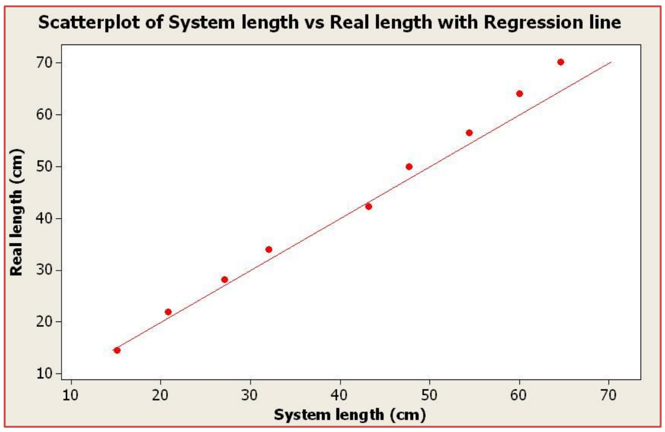


Fig. 5.Graphical depictions of relevant values between actual and system values for cross fibre using system.



Going through cross fibre: The coming direction is stored in a variable and go through dark points witch attached to stored direction. And as well if dark point is over with this direction the stored direction is changed and store new direction in the privies mentioned variable. Then the system always addicts to go through the same direction which is come from, then although a cross fibre is reached, system go through the direct line until the end of fibre is encountered.

*Joining broken fibre***:** The start point and the end point of the fibre are stored in an array. Then every even position is taken as the end point and the odd position is taken as the start point. After that the nearest point is obtained, which belongs to initial or end point of each and every fibre.

*Count the number of fibres***:** In order to identify number of fibres, a specific method is used. When the scan is over, the values of a counter is increased by one unit. The values of the counter are taken as the total number of fibres scanned.

Calculating length of fibres: Using an array, the system can calculate the length of the fibre. The distance between two pixels is calibrated using a known fibre length for a particular resolution power of the computer.

*Removing noises***:** Noises are referred as small fibres which are less than 2cm. Such fibres are removed while calculating length of fibres.

Display identified fibres in a picture box: After identifying fibres and removing the noises, fibres will be displayed in another picture box for user identification.

Find average fibre length: The system has been designed to find the average fibre length by dividing total fibres length by number of fibres. Finally the average fibre length is displayed.

Testing data and redesign the system: The lengths calculated manually and the results obtained through the system were compared. If there was a difference, the system would again be calibrated with the resolution of the system. Some noises (dust) have to be removed from the image to find out a better answer.

Results & discussion

In this section, the outcome of the project will be presented and important points are discussed. The system was developed step by step. First step was to insert an image which includes one fibre. Then that image is converted into gray scale in order to identify dark points by scanning the image. After go through the fibre, a dark point is inserted into an array. The next step was to insert the image of two fibres, cross fibres and scan fibre, to find the length. Then web cam facility is inserted into the system and calibrates colors which are for better resolution. Then fibres are scanned through the web cam and the result is displayed as a average fibre length.

Testing data is divided into two types, (a) Single fibre and (b) Cross fibre (Multiple fibres). Fig.4 displays the graphical comparison between the actual length and computed length values though the system for single fibre. These results indicate that our system is capable of estimating the lengths of fibres accurately and efficiently. Fig.5 displays the graphical comparison between the actual length and computed lengths for cross fibres. Table 2 displays the comparison between the actual length and computed length values though the system for fibres.

Table. 2. Comparison of manual method and the developed system

	Real	Manual	System
Time (Minute)	-	10	2
Average Length (cm)	17.7	14.3	16.6

Where

Real: Consider 100 fibres and measure length of fibres carefully using ruler.

Manual: Length of 100 fibres using ruler by workers with normal situation.

System : Length of 100 fibres by the developed system.
Time: In the system, time measurement for 20 set of fibres each having 5 fibres is considered whereas in the manual method, 100 fibres were taken in to account in this measurement.
Average Length : Average length of 100 fibres in centimeter.
The deviation of the manual method was checked by following formula.

$$\text{Manual Method Deviation} = \left\{ \left(\frac{\text{Manual length}}{\text{Real length}} \right) * 100 \right\}$$

Manual Method Deviation = 80.79 %
The deviation of the system method was checked by following formula.

$$\text{System Method Deviation} = \left\{ \left(\frac{\text{System length}}{\text{Real length}} \right) * 100 \right\}$$

System Method Deviation = 93.78 %

Further, according to data of Table 2, time taken by the develop system is less than the manual time. When the previous method and the proposed system are compared, the proposed system provides more user friendly, accurate, and efficient working environment. So this system is more useful for coconut industry when exporting coconut fibres.

Conclusions and future work

The Automatic measurement of average fibre length system can be used to estimate average fibre length more accurately and more efficiently considering time and man power. Compared to existing method, the Automatic measurement of average fibre length system is better tool in estimating the average length for following reasons.1) For the model studied within this research, this system gives results consuming less time than existing programe.2) This system gives more accurately and efficient average fibre length measurement and 3) Image processing technique can successfully be used to developed automatic system that overcomes limitations in traditional system.

Accuracy of the estimation can be improved by increasing equipment arrangements. Current system calculates fibres length by neglecting the thickness of fibre. As per the industrial requirement, it is suggested to develop a system that could measure the thickness and uniformity of coconut fibre as well.

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