A Review of External Wood Defect Detection

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Abstract — Wood value is strongly related to the quantity, types and sizes of defects that are presented. The defect of wood could be classified either internally or externally. As for the external feature of hardwood logs, it is important as the features will determine the quality and value. This paper discusses on few types of wood defect that will reduce the quality of the wood and the value itself. It will also present on several impressive techniques that are able to apply in detecting external wood defects. This paper also discusses several issues related to the techniques applied.

INTRODUCTION

In industry, quality control makes an important aspect to produce product especially in wood industry. Quality control is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer. This is because the high quality of product would attract client or customer interest to purchase and also increase demand market in local or international market. Therefore, wood industry needs a system efficient and effective to ensure the produce product high quality.

Natural resources such as wood become scarce and very expensive. Maximize the usage and reduce the rejection is a great challenge for the wood industry [1].Based on research from A. Mohamed [2] the title of *Wood-based Industry deserves more attention* explain about the wood-based industry (WBI) has long been an important segment of manufacturing sector, the main driver of economic growth for the country. The industry has undergone major changes over the years, with downstream activities becoming increasingly important. To sustain strong competition, highly demanding markets, producers must focus on quality of their products and best in class efficiency of production process [3]. In light of this, various studies have been done for develop a system suitable and effective for checking the quality of wood that issued from time to time.

PROBLEM STATEMENT

In wood industry, cutting wood into clear blanks of difference sizes would not be such a difficult problem if rough mill employees had all the time see all the defect on the board. Unfortunately, in the real word of rough mills defect on the board must be identified quickly and decision on the cutting up the board also must be made quickly. If error obtain in identified defect are made due time constrain and exhaustion. In fact the full potential value of the board is no realized [4].

At present, humans identify, classify and detect defects in most wood operation to allow cut-up decision to be made. This operation is labor intensive and costly [5]. Defect detection is an important problem in wood quality control process. Cost reduction in production and inspection process is also an important objective for wood manufacturers. This is because the quality inspection process is manually performed by experts. Unfortunately, experts cannot detect more than 60 % of the overall defects in the wood. Like other inspection process, it is depended on workers' experience until now. The development of a flexible, efficient, reliable, and integrated real – time system for industrial application is an essential issue in quality control process for wood manufacturers.

Tradisionally, wood laminate has uses human expert to identify the defect surface wood laminate and made a grading. However, by only using naked eyes to classify it have leads to several problems such as inconsistance grading result and also inaccuracy to identify type of defect. Error in determining a defect and its location , known as operator error increases product cost [6]. Beside that the process of detecting defect and grading is very depending on an expart's opinion.Theree type of operator error were investigate from Buehlmann and Thomas [7]. First when operator marked defect when there was none. Second when operator missed a defect and lastly when the operator marked a defect inside the defective area of the trip that means incorrect marking of a defect within its boundaries.

Beside that, the process that depending human expert are always have problem especially in managing resources. For example ,if a worker is retired,company needs to make another investement to train a new expert in identify defect and classify wood laminate grade.Moreover, traditional method need a huge number of worker and time to made a process done.

To develop prototype for detect defect in the wood, several important aspects should be studied and analyzed. Research based on the nature of the methods and data that form the images of each type of defect to be emphasized is identified. This is to facilitate the determination of the method that will be used in the development of prototypes later.

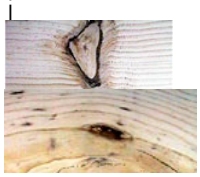
TYPE OF WOOD DEFECT

Wood value is strongly related to the quantity, types and sizes of defects that are present. The defects in wood can be classified such as: defects induced by different irregularities from natural growth patterns (grain deviation, knots, pitch pockets,etc.); and, abnormalities induced by biological attacks of fungi, insects, etc.[8].

Some typical features in hardwood include holes, knots, mineral streak, splits, checks, wane, bird peck, decay, internal voids, and surface stains. Table 1.0 describes on defects class [9].

Table 1: Type of Wood Defect

Bow A curve along the face of a board that usually runs from end to end.	Checking A crack in the wood structure of a piece, usually running lengthwise. Checks are usually restricted to the end of a board and do not penetrate as far as the opposite side of a piece of sawn timber.
Crook Warping along the edge from one end to the other. This is most common in wood that was cut from the centre of the tree near the pith.	Split A longitudinal separation of the fibres which extends to the opposite face of a piece of sawn timber.

Cupping Warping along the face of a board across the width of the board. This defect is most common of plain-sawn lumber.	**Twist** Warping in lumber where the ends twist in opposite directions.
 **Wane** The presence of bark or absence of wood on corners of a piece of lumber.	**Blue Stain** A discoloration that penetrates the wood fibre. It can be any colour other than the natural colour of the piece in which it is found. It is classed as light, medium or heavy and is generally blue or brown.
 **Loose Knot** A knot that cannot be relied upon to remain in place in the piece. Caused by a dead branch that was not fully integrated into the tree before it was cut down.	**Pitch** An accumulation of resinous material on the surface or in pockets below the surface of wood. Also called gum or sap.
 **Tight Knot** A knot fixed by growth or position in the wood structure so that it firmly retains its place in the surrounding wood.	**Machine Burn** A darkening of the wood due to overheating by the machine knives or rolls when pieces are stopped in a machine.
 **Wormholes** Small holes in the wood caused by insects and beetles.	

Defects may be naturally occurring or can be man-made. Natural defects can be due to many reasons such as environmental factors, growth patterns, soil composition, etc. Man-made defects can occur at many points from the felling of the tree, transport, storage, sawing, drying, etc. Although some defects such as knots, or cut off defects such as splits, boards that are heavily twisted, bowed, cupped, or crooked usually are not usable.

TECHNOQUE / TOOLS

Robust Estimation and Filtering Methods

Robust statistics is an important tool that helps improve the analysis of computer data to fine problems in computer engineering. Robust estimation and filtering methods describes several defect detection using 3-D laser-scanned surface topology[10,11]. Robust statistics technique used to fit quadratic curves in the log data and develop new generalized M-estimator. Types of defects usually are associated with a significant surface rise or depression depending on the defect type[11].

This process able to determine there are some of defects such as overgrown knots, rotten knots, holes and removed branches. There are several problems faced inside implement kind of detection process of identifying type of wood defect such as 2-D quadratic curve fitting is a problem in nonlinear regression, the extreme outliers and missing data in the log data cross-sections see figure 1 below. Which are the classical least-squares estimators failed to provide a good fit from such corrupted data set.

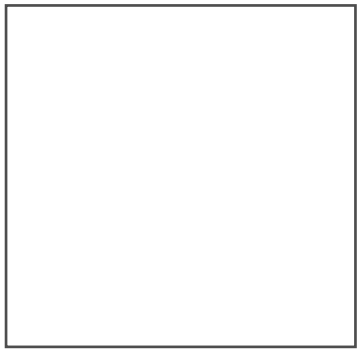


Figure 1 A log data cross-section with outliers marked and with a fitted circle obtained by means of the new robust GM-estimator displayed in continuous line. Shown also is the least squares fit in dashed line.

Non-Segmenting

Non-segmenting defect detection combine with a self-organizing map (SOM) to avoid the problem with adaptive detection technique and to provide an intuitive user interface for classification. The non-segmenting method used for finding the possible defect areas. This method does not try to decompose the image into meaningful regions but make the partitioning regardless of the contents of image. The aim of this method is to avoid the problem encountered with the segmenting method. In segmenting method sometime very difficult to computer understand what constitutes a meaningful segmentation[12]. Examples of the detections produced by a non-segmenting method, using non-overlapped rectangular regions are shown in Figure 2.

Figure 2. Examples of detections produced by a non-segmenting method.

Fuzzy min-max neural network for image segmentation (FMMIS).

The fuzzy min-max neural network for image segmentation (FMMIS) method used to find the minimum bounded rectangle (MBR) for each in the wood board image. The FMMIS method was applied from the 10 categories there are birdseye and freckle, bark and pitch pockets, wane, splits, blue stain, stain, pith, dead knots, live knots and holes (Fig.3).

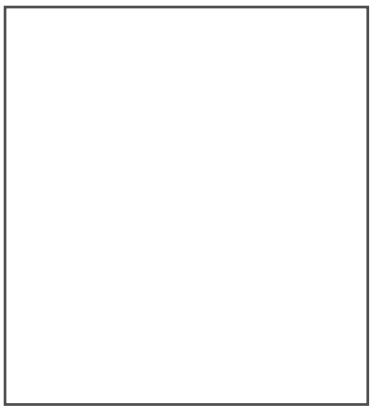
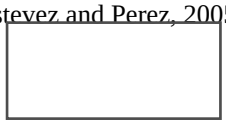


Figure 3.—Image samples of each of the 11 categories considered. In the top row, left to right, birds eye, pocket, and wane; in the second row, left to right, split, blue stain, and stain; in the third row, left to right, pith, dead knot ,and live knot; in the bottom row, left to right, hole and clear wood[13]

The first step in this method is to automatically locate initial pixels called seeds within the defective regions. The seed location determined by an adaptive thresholding method which is based on certain features in wood board image.

Mean color intensity value, and minimum color intensity value ,, of the image for each channel ($t = R,G,B$) are used (Ruz, Estevez and Perez, 2005).A cumulative histogram, H, is constructed as follows



for each $t = R,G,B$

Where n is the intensity level ($0 ? n ? 255$) and is the histogram of the board image for channel t. Ruz,Estevez and Perez [14] has been successfully applied the FMMIS method into wood defect detection where as 95 % rate for defect detection with a false positive rate 6 % on 300 test wood board image with 0.11 s average time processing per

image[6].

Thermographic

Thermographic is a modern production technique to reached a high quality standard at high output rates in wood-based industry. This technique not only able to detect invisible defect within wood based materials but also can used to detect in lumber and engineered wood [15]. Infrared thermography is a fast and non-destructive testing. The speed of heat front dissipates depends on the thermal properties like density and heat capacity.
Active and passive is a two cases in hermography.the defect can be either detected as hot (active) or cold spots (passoce) on the surface. Using passive on-line thernography the following defects could be found :

1. • *Differences in thickness layers of glue*
2. • *Splittings in a particleboard on the upper or lower side*
3. • *Blister between décor paper and carrier material*
4. • *Delaminations of paper*
5. • *Faulty gluing of veneer layers in plywood*
6. • *Defects as well in plywood as in particleboards in the core or in the cover layers.*
7. (P. Meinlschmidt ,2005)

The advantage of termographic technique for detection of defect in wood and lumber take much time and only work in special application.

CONCLUSION

As a conclusion, the best technique to initially detect a defect depends on the defect size which must be found and the size of the structure to be inspected. The FMMIS method used for segmentation image to achive good classification performance. As a consequence FMMIS perform a segmentation very fast is over 0.11s for each segmented wood image. The FMMIS method has been successfully applied to wood defect detection in Ruz,Estevez and Perez [14] achieving a defect detection rate of 95% with false positive rate 6% on 300 test wood image.

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