A Review on Automated Systems for Deformation Detection in Glasses

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Abstract – *Glass defect inspection is a tedious task to accomplish because of its brittle and transparent nature. The coatings and types of glasses increases the need to provide different mechanisms according to their texture. In many glass industries the quality inspection of glasses is done manually with a help of human experts. However, automatic inspection should be employed in order to improve the accuracy of defect detection as manual techniques may increase the risk of false alarms according to psychology of the examiner. In this review, proceeding from different researches in the field, various machine vision systems and laser-based systems is elaborated which can be used for preferred inspection in glass industries.*

Key Words: glass products, defect detection, machine-vision system, laser-based system, image processing

1. INTRODUCTION

Glass surfaces are generally categorized into nine types with respect to various ingredients and additions present along with them. They are soda glass, colored glass, plate glass, safety glass, laminated glass, optical glass, Pyrex glass, photochromatic glass and lead crystal glass. The deformations in them may be scratches, dusts, foreign material, low contract defects, spots, holes, bubbles and dirt. The automatic defect detection mechanisms have greatly reduced the risk of manufacturing damaged products. The application of the system has made a great impact in customer satisfaction and procuration of mentioned industrial glass products in the market. The various methods provide an effective method to determine the detriments in the glasses. Furthermore, these prevalent technologies have grown rapidly overtime and provides an insight to number of problems arise during the inspection of glass materials and remedy to remove them. As known, Quality inspection is the important pace of the glass manufacturing and they act as a basic bridge between all B2B as well as B2C communications and it take a great deal to classify the various types of defects. The proposed work has elaborated the sections of machine vision systems and laser based systems by various researchers. However, surface may differ and so the technique for inspection will also differ. Therefore, the objective survey aims to provide information about various machine-vision systems using a variety of technologies that are prevalent in the market.

2. AUTOMATED VISUAL INSPECTION

The glass inspection systems are, equipped with all commonly used interfaces for offline and inline use at every step of the production process chain, not only for quality control, but also for a means of optimizing the processes themselves. Machine vision (MV) is the technology and methods used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance, usually in industry. In combination machine vision systems and laser based system for glass inspection provides a robust, precise and accurate detection of deformations at the surface of number of glass materials

2. SURVEY

2.1 Laser Based Systems

In 2009,[1] Mr.Ono et al proposed a system for detecting structural defects in synthetic silica glass. It uses an ArF/KrF excimer laser to obtain sample along with a spectrometer working at an X-ray frequency. Electron multiplier charged couple device, and a monochromator are used to capture the photoluminescence. The electron spin resonance and photoluminescence are compared with the absorption coefficient. The fabrication measures are consolidated and plotted as a curve for easier reference. However, the system needs to be understood in detail in order to detect the surface deformations of the glass.

In 2010,[2] Mr ono et al also proposed a system for Laser induced Structural Defects in Highly Transparent Synthetic Silica glasses which address the problem of optical durability with the aid of in-situ photoluminescence (in-situ PL) and differential absorption (in-situ DA) measurement systems to reveal the defects repaired by ions involved in the process such as hydride or hydroxide. The creation and anhelation mechanisms proposed in the system acts as an important breakthrough in order to produce silica glass with improved optical durability. But, its

necessary to understand the scenario and set up the parameters according to our inspection criteria

2.2 Machine Vision based systems

In 2009,[3] Francesco Adamo et al uncovers a prototype for automatic glass inspection system using electronics and two CCD area scan camera. The major steps provided by the system viz., calibration of camera, reference image acquisition and analysis of defects are satisfying the fundamental aspects of the system. For instance, they have considered an inspection technique for satin glass along with image processing and customised user interface that could uplift the knowledge about defect to the person who is examining the product. Thus, the system provides a reliable and cost-effective solution for the glass industry. At the same time the position of the glass in the inspection module must be taken into account before examination.

In 2013,[4] Jaina George et al proposed a system with three configurations namely feeding unit, vision processing and sorting unit. The method detects small defects in non-uniform intensity and low contrast images and it is rather robust with respect to changes of the glass type and to other operating conditions. Image filtering is done by applying high pass, low pass, median, Weiner and gaussian filters. The filtering provides an enhancement to the image and improves its accuracy. The primary objective of the system is achieved by using fuzzy logic in order to determine the results from unsupervised data. The PSNR value provides clarity obtained by various filters and compared. Thus, the correlation between original and noisy image from the data is addressed in the system which automatically improves its efficiency.

In 2016,[5] Ming Chang et al constructed an optical inspection platform for surface defect detection in touch panel glasses. The main components of the machine vision system are a set of hardware and software components intended to produce high performance computing. For instance, in order to achieve high speed processing, the system utilizes a GPU computing setup along with CPU for improved efficiency. The illumination source which contains an LED acts as a corner stone in the identification of defects. The input raw image is subjected to histogram equalization, binarization and labelling of images which are a part of image processing techniques. The speed of examination is extremely high and the labelling is done more accurately. To recapitulate the system provides a far better speed, accuracy and labelling rather than any other systems taken into examination.

In 2017,[6] Fu Li et al proposed a detection method based on connectivity domain characteristics of the glass bottle was presented for glass bottle defects with a help of machine vision system accompanied by ring led setup, camera and equipment for performing examination in bottles. The pre-processing eradicates the noise in image during acquisition and gaussian filter is applied to provide more insights in the image data. The system infers three deformations namely big crack, small crack and bubble treatment in order to enrich the quality of the glass bottles. They have achieved absolutely high accuracy in inspection making the visual inspection system a truly economical machine.

In 2018,[7] Jia li et al formulated a machine vision detection method for automatic, real-time and accurate realization of glass scratch defect analysis and qualification, which has marked its accuracy in robot engineering and its applications. The CCD camera is used to capture the illuminated image of the glass with the help of LED lights embedded in the system. The image processing undergoes thresholding, vote detection and edge detection in the machine. The processed image is subjected to finding the measurement of width and height of the scratch using the below formula

$$Length = \sqrt{(bottom - \text{top})^2 + (right - left)^2}$$

And the qualification criteria can be fixed by the examiner. Thus, the system provides both practical as well as theoretical values that can be used for inspection by the system.

3. CONCLUSION

On comparing the laser based and machine vision systems for inspection the laser system involves a large set of parameters to be understood and applied accordingly, but in case of machine vision systems they are more robust, more accurate and can be applicable to variety of glass products. The paper aims to provide a generalized overview of about seven machines that are prototyped, as well as marketed in order to provide people with more flexibity of choices. All the machines used for defect detection varies certainly in its visualization method, construction and plethora of parameterising. In Future more applications involving other materials such as metals can be surveyed in order to produce extensive study details about the defect detection

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