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Industrial Inspection: A Machine Vision Approach

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***Abstract*—** Industrial inspection is an important task for any manufacturing sector. In this paper, the role and importance of inspection has been highlighted. Now a day's machine vision system is helping for improving the quality of inspection, particularly in analysing the error in any manufacturing system. The different stages of inspection have been illustrated in this paper. The salient feature of this paper is to analyse the working principle of machine vision system for inspecting the quality of a product in manufacturing domain. A framework for improving the quality, safety, and reliability of the product due to the new emerging technology has been suggested in this paper. The paper also throw some light on design of machine vision system and suggest some future development which will leads towards the automatic visual inspection in the domain of manufacturing system.

***Keywords*—** Industrial inspection; machine vision; manufacturing.

I. INTRODUCTION

Nowadays organisation expects good and high quality products. So most of the industries for improving their quality they implement the process of machine vision. Currently every industry want to improve their quality, productivity and reduce costs, for that they are using inspection based on machine vision (Malamas *et al.* 2003).By using this system we can identify the errors in Inspection which is non-destructive techniques and an inexpensive. Traditionally, human experts have performed visual inspection and maintain good quality. Even humans can do better job than machines. But in many cases humans are slower than the machines and get tired quickly. Moreover human take time to develop their skills on industrial training so that they become experts. Most of the time, error occurred by experts while doing inspection to overcome that automated visual inspection provides innovative solution to the industrial automation (Newman and Jain 1995).

II. DEFINITION OF INSPECTION

Inspection is the process in which we measure the features of specific part such as surface finish, assembly integrity and geometric dimensions. Inspection is a quality control process but it is different from testing task like stress analysis.

A. Inspection Stages

We have three stages for inspection. First is input, also called as receiving or incoming inspection. Secondly, process inspection and last one is output inspection which is also known as product inspection shown in Fig 1. In receiving in this section, we check the sufficient amount of material required for use in assembly and determine the quality of the raw material to check whether it is acceptable or not. Process inspection examines the output of an intermediate work stage and is useful for determining, if the operation at stage was performed in a specified tolerance or not and the working assembly process is in control. It also allows some adjustments to be made for tool wear and prevents non-conforming material for being used in a later production stages. Output in section is the last executive inspection (Mital *et al.* 1998). This process is done at the end of the assembly or manufacturing stages so that we can decide the product is acceptable or not. In last stage, we also collect the statistical information which helps in long term in assembly process, and with the help of this we can find that which tool is need to be replaced or which part is required for maintenance.

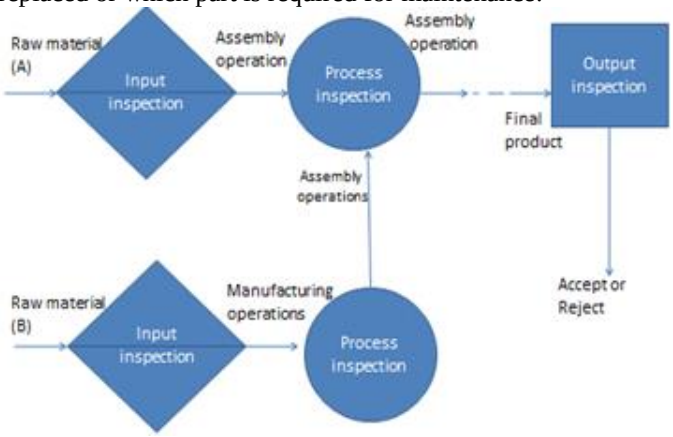

Fig. 1. Showing several stages of production & inspection.

III. MACHINE VISION DESIGN

In machine vision design several tasks are conceivable like image acquisition, processing, segmentation and pattern recognition. In a vision system image acquisition is transform into an optical image data into numerical data's array, and then manipulated by the computer. Fig 2. shows block diagram of machine vision system. We have different systems and subsystems of the process. Here big rectangle consist of sub systems while other parts for gathering information are represent in small rectangles in Fig 2. We can see that the light is coming from the source and optical image is created by in image sensors. Digital camera, image arrays are ultimate signals which are formed from electrical signals which are converted from optical image. Typically, cameras either area scan or line scan elements are used which gives significant advantages. For light detection in camera system, we use charge coupled device (CCD) sensor. While utilizing this

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digitized image we can perform various tasks like pre-processing, segmentation and feature extraction. At this stage we are done with the interpretation and classification of image and will be considered, with the scene description and we interact with the actuation operation which is going to perform. For a better image taking we adjust actuation sub-system, so that we original scene with the help of interaction lop.

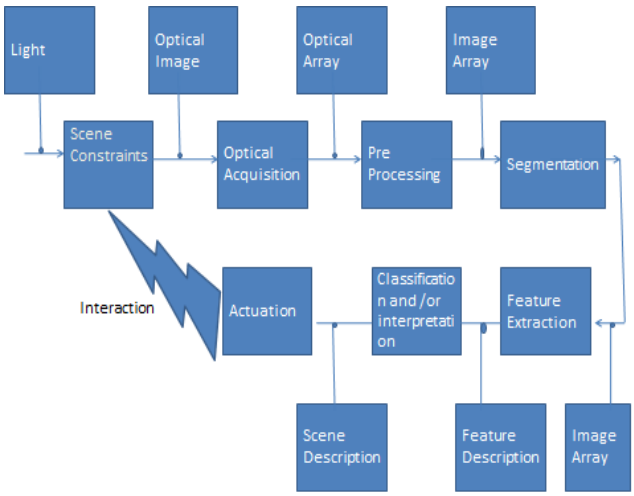

Fig. 2. Block diagram of Machine system (Adopted from Golnabi and Asadpour 2007).

A. *Operation in Machine Vision System*

The following functions are performed by visual system. An object with in an object group is recognizing the image acquisition and analysis. The source irradiations light that fall on the screen and the image sensor generate. The digitalization, representation of image data and image sensing is involved in this process. The process where modification and preparation of pixel value of digital image is done to produce more suitable form for successive operations is image processing .The image processing operations performed are shown in Table 1. Segmentation does partition of an image into considerable regions that are similar to part or the object into scenes. Image contain an unknown object that is being identified, being a part of individual group with the number of available object group is referred by pattern classification.

Table I. In image processing general operations are performed

S.No.	Point operation	Global operation	Neighborhood operation	Geometric operation	Temporal operation
1.	Brightness modification	_	Image smoothing	Display adjustment	Fame-based operations
2.	Contrast enhancement	_	Image sharpening	Image wrapping	–
3.	Negation and thresholding	–	–	Magnification and rotation	–

IV. Industrial Applications

We can describe the application of machine vision system in four parts namely visual inspection, process control, part identification and robotic guidance and control mechanisms. The most important task of the machine in this field is for atomized visual inspection. The machine is concerned to recognize that the parts are manufactured according to specify attributes. Automated visual inspection (AVI) part identification have measure role in automation task but they don't contribute much in the flexibility in manufacturing. But it can be achieved by version system the process control and robotic guidance.

A. *Automated Visual Inspection*

AVI is only used for the inspection and does not increase the flexibility of manufacturing line. But now a day's usage of this system is increased rapidly. This system is used in various purposes like to check the quality, gauging and measurement. The common application of AVI is to measure the area of small gap in gauging, measuring the object dimensions, analysing the crack formation. Reliable checking in food industry, automotive plants and other various production lines is done with the help of vision system (Cromwell 1993). The pharmacological and medical product is inspected by machine vision system. Due to these inspection method the reliability and speed of production line is increasing day by day. For example, in aerospace industry, self-teaching and self - calibrating techniques is used by vision based robot which gives the report that rivet punch in the airplane metal sheet gives very high accuracy.

B. *Process Control*

By using process control we can do better analysis, tracking, control and issuing documents for different types of applications. By applying vision system we can do better job in monitoring production process. It provides us on-line inspection and for the pharmaceutical, biomedical, lumber production, and metal finishing it provides imaging options and help in the automotive production assembly lines. The vision system has various successful operations for tracking tasks and process control. The common example of process control is check display pixels of biomedical image, measuring the accuracy of missile flights with alignment.

C. *Part Identification*

In a vision system the most important application is part identification. The automotive castings, unloading and identifying of parts are important applications. The common example of identification application is gridding and sorting.

D. *Robotic Guidance and Control*

Different robots require a different guiding system which is based on automation process. The processes like alignment and adjustments are also required for smart guidance systems (Edwards 1990). By using smart sensors we can determine the position in the welding or other process by the guidance of robotic action which is performed. Various applications in guidance and control are placement and alignment of

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automotive windscreen in aero scope application with high precession part-mating.

V. Conclusion and Future Work

The paper conclude with the importance of inspection in the industry and describe the increasing demand of machine vision technology with various stages with the help of which we can do industrial vision inspection with 100% accuracy (Koniar *et al.* 2014). We have a good reasons for utilizing this vision system, we get the reliable products, improvement in safety, quality improvement these are machine vision system key points supporting it . Economically it is helpful for the industry it is a crucial factor because it gives minimum error and we having less wastage. In final words, machine visions for the new generation have two satisfy key points: first is implementation on physical parameters and computational methods. The second point is representation of image with high quality with full accuracy. In addition, we have highlighted the future development of the machine vision system.

In the recreational world market, it is desirable for employee to use automation techniques so that production line get improved rapidly and get high efficiency result. The ultimate goal is that in every organization we furnished with vision system so that machines are able to do hard tasks like by getting the image of complicated assembles (Vernon 1991). With the help of machine vision we can reduce the work as well as labour cost in the production scheme.

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