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Development of combined deburring and inspection system

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ABSTRACT: *Automation is a step beyond mechanisation, to increase productivity and to improve the quality. Automated manufacturing systems operate in the factory on the physical product to perform operations such as processing, assembly, inspection, or material handling and sometimes accomplishing more than one of these operations in the same system. One of the strategies for the automation is combination of operations which involves, reducing the number of distinct production machines or workstations through which the part must be routed. This is accomplished by performing more than one operation at a given machine, thereby reducing the number of separate machines needed. Some of the combination of operations performed on one system like processing and assembly, processing and material handling, assembly and material handling, material handling and inspection is done in recent past. But very little work is done on combination of operations such as processing and inspection on same system. This paper addresses combination of operations like deburring and inspection on same system.*

I. INTRODUCTION

Burrs are caused by many machining process including milling, drilling, turning, and broaching. Edge finishing like deburring, blending during manufacturing is important because of the following reasons-
Sharp edges may pose personal hazardous, since they can cause injuries to worker.
Part mating may be more difficult due to clearance restriction caused by burrs
And to enhance part appearance.

Deburring is performed at the final stage of manufacturing, where parts have their highest added value, quality control is absolute necessity. Despite this requirement, even in today's most fully automated factories it is still a common sight to see dozens of worker manually chamfered parts produced by CNC machines.
Edge finishing is typically performed manually using two methods-
Hand held power tools with brushes, abrasive tips, or rotary files.
And manual files and knives.

The technique employed with these tools is not well documented and inspection of this deburred edge is not quantitatively defined, typically the worker runs the finger over the edge to inspect the work. Improving both the efficiency and quality of deburring is a major concern. Deburring is labour intensive and can represent a significant portion of the expense of manufacturing machined parts. In addition, deburring is frequently a dirty, noisy, and undesirable job and high turnover in terms of personnel. Training personnel in proper deburring technique is costly and this, coupled with high turnover rate adds to the overall expense of the deburring. Variation in skill level of deburring personnel causes variation in the quality of the part. Errors encountered in the deburring operation which causes the part to be scrapped are costly, as the part is near the end of its manufacturing cycle. Automatic deburring operation has been investigated for number of years as a solution to this problem. Deburring is performed at the final stage of manufacturing, where parts have their highest added value, so inspection is absolute necessity.

II. INSPECTION

Quality control and part inspection are key processes in the lifecycle of a product. These processes are able to verify product quality and can provide essential feedback for enhancing other processes. No change is made to product during inspection, in order to increase its value. Time and resources are spent on these processes, without a gain in profit. The advantage of quality control and inspection is that customer loyalty through product integrity may be sustained. The disadvantage of this process is that even though the lead-time is increased, the product may not be sold at higher price, since no value has been added to it. The reduction of the time spent on these processes is than attractive concept to manufacturer. So, automatic inspection system is developed for inspection along the edges of the square work part. Automatic inspection system, mainly based on camera- computer technology has been investigated for the sensory analysis of square work part. Computer vision includes the capturing, processing and analysing images. Computer vision systems are largely employed for automatically controlling or analysing processes. Computer vision system benefits from specially designed image processing software to perform such task, therefore image processing plays a very crucial role in their performance.

Image processing is to sharpen, minimizes the effect of degradation and reduces the amount of memory to store the image information. Image processing pertains to the alteration and analysis of pictorial information. Digital image processing is the use of computer algorithm to perform image processing on digital images.The basic operations performed in a digital image processing systems include : Image acquisition, storage, processing, communication and display.

III. AIMS AND OBJECTIVE

Following are the objectives being identified to achieve by developing prototype model of computer assisted combined deburring and inspection system-

To combine, deburring and inspection operation on one system.

To save the non processing time.

To develop the system with low cost automation

IV. LITERATURE REVIEW

Automation of surface finishing operations such as deburring, grinding operation is an active area of investigation in the manufacturing industry. These operations constitute a significant portion of effort and money in manufacturing industry. Research towards automation has focused in many directions from integration of two operations to development of an intelligent system. Deburring is performed at the final stage of manufacturing, where parts have their highest added value, so inspection is absolute necessity. Manual inspection is error prone and highly dependence on skill labour. Automatic inspection is best choice in industries, and image processing is increasingly used today. Following are the literature regarding the finishing and inspection operation.

An automatic deburring for the case of hole on a free curved surface on the basis of CAD data, using an industrial robot. As a chamfered tool, a rotary-bar driven by an electric motor is mounted to the arm of the robot having six degrees of freedom in order to give an arbitrary position and attitude to the tool. The robot control command converted from the deburring path is transmitted directly to the robot. From the experimental results, the system is found effective to remove a burr along the edge of hole on a workpiece with free curved surface [1].

A complete dynamic model that describes the dynamic behaviour of the robot for surface finishing tasks is considered. A complete surface finishing task is divided into three phases (free motion phase, transition phase, and constrained motion phase) depending on the location of the robot end-effector with respect to the constraint surface. Stable control algorithms are developed for each phase. Emphasis is given to the transition phase and constrained motion phase, where surface finishing takes place. In the constrained motion phase , the robot model include both the tangential force that is due to material removal and normal force to keep the robot end-effector on the surface. By doing this improved performance of the proposed control strategy is occurred when compared with others [2].

To automate the deburring, an industrial robot is used to handle and hold workpiece in front of developed tool station. The tool station is fixed on a worktable has positioning actuators. A file driven by air reciprocating actuators as a deburring tool. To detect positioning and dimensional errors of workpiece, an image of the objective part is taken by camera. The tool station can compensate the errors and chamfer the objective edge based on the calculated positioning information [3].

Using automated path generation, robotic deburring of aero-engine components is done. The core of the system is a set of algorithms capable of fitting and generating the required robot path relative to the feature to be profiled. The incorporation of an MXS sensor and mathematical algorithms allowed precision chamfers to be generated inspite of part tolerances, fixturing errors and robot positional accuracies. The approach developed also eliminates the need for precise location of the part in an expensive fixture and needs nly simple low cost clamps to hold the workpiece [4].

An automated deburring procedure using a robot manipulator is considered for the removal of burrs in the presence of robot oscillations and bounded uncertainties in the location of the robot end-point relative to the part. Compliant tool holders provide the normal and tangential forces for deburring[5]. In another approach robotic deburring of two dimensional part with unknown geometry covering two problems-tracking the part contour, and control of metal removal process. The tacking control employs the force measured by this force sensor to find the normal to part surface. While the deburring algorithm uses another set of contact force to develop a stable metal removal [6].

An adaptive fuzzy hybrid position/force controller, which can update fuzzy rules to compensate for robot dynamics along with the force dynamics induced by contact between a cutting tool and a part's edge, and can identify the actual desired contact force in deburring operation[7].A framework integrates all steps of robotic implementation: trajectory programming for efficient burr removal, contact evaluation and definition of control parameter, and finally the online trajectory control. The path control module combine two sensor signal acoustic emission and power consumed by deburring head motor. The fusion of these signal results in new control parameter Fast abrasive power(FAP) which maintain reliability of power signal[8].

A system consists of a back drivable, two degree of freedom micro-manipulator that can be mounted to a robot, a machine tool or a parallel kinematic machine. The controller design is based on event-driven and process-based control methodologies. As a result, the cycle time and need for tedious programming is reduced, and the controller is very effective in yielding improved finishes on parts involving corners and complex contours [9].A second generation automated deburring system is consists of an offline programming interface which allows complex deburring trajectories to be developed from CAD data without the need for robot teach programming. These trajectories are downloaded to a real time controller, which coordinates the motion of a position controlled robot with an actively compliant deburring tool [10].In another advanced deburring and deburring system, a feature based process planning system generates the deburring and deburring paths based on parameters and edges selected by a manufacturing engineer from solid model CAD definition of part. Simulation of the paths as well as collision detection is performed before the generated toll paths are downloaded to the robot/machine tool, and finishing tool. It uses active force control in tool to control stiffness of tool normal to and tangential to the chamfer edge [11].

Inaccuracy results from both imperfect sensors and imperfect models of machine, this imperfection may be nonlinear or drift and changes with time, making their prediction difficult. Incorporating sensors like thermocouple, force transducer to aid in the prediction of imperfection or to perform appropriate measurements, greatly improves the accuracy [12].

Industry needs automated inspection because in manufacturing process uncertainties like defects, orientation error, tolerances etc. exists which can be solved by automated inspection. High speed, high accuracy image processing system is developed for automatic visual inspection of cylindrical parts. This system is realised by original simultaneous processing algorithms which provide both the detection of defects and the development of 2-D image formed from many 1-D signals, obtained through line scan camera grabbing on feed objects directly while they are moving[13]. The development of an Automated Visual Inspection (AVI) system for weaving defect detection based on image processing and recognition algorithms. The neural network approach seems to be an effective tool for classifying the weaving defect [14]. The machine vision system for automatic inspection of defects in textured surfaces has been developed. It aimed to solve the problem of detecting small surface defects which appear as local anomalies embedded in a homogeneous texture of textile fabrics and machined surfaces [15].

Computer vision has been for detection of defective packaging of tins of cigarettes by using image processing and morphological operation. The identified objects are used to the defect detective packages in the cigarette packing industries. Algorithm is correctly identifying individual cigarettes and the paper spoons handles in 500 images and then classifying the resulting cigarettes tins as either acceptable or defective[16].

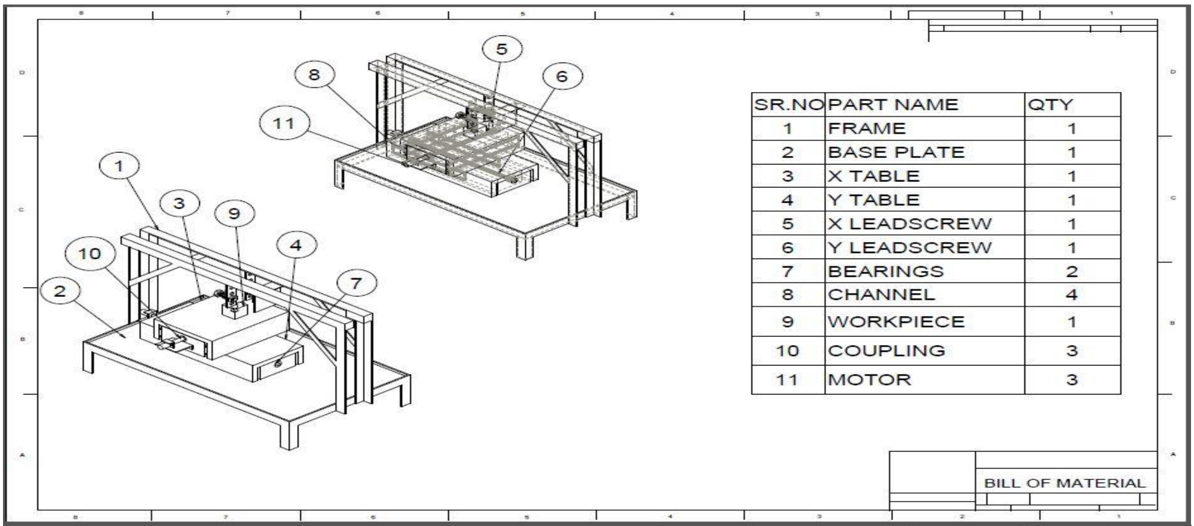
Inspection process planning system, which include the task-decomposition, knowledge-based and some hybrid inspection process planning systems. The tolerance feature analysis, accessibility analysis, clustering algorithm, path generation and inspection process simulation are tested and a prototype of inspection process planning system that includes corresponding five functional modules about these techniques have been built up[16]. Novel methodology for reverse engineering of complex, free form surfaces, based on the integration of measurement information from 3D vision sensor and coordinate measuring machine (CMM). Reconstruct the CAD model of objects of complex geometry with high accuracy and at the same time, rapidly exploiting the advantage of deriving from the use of both optical and mechanical sensors with minimum of human intervention. The combination is performed at the level of measurement information, within a module for the intelligent aggregation of information from optical and mechanical sensors [18].

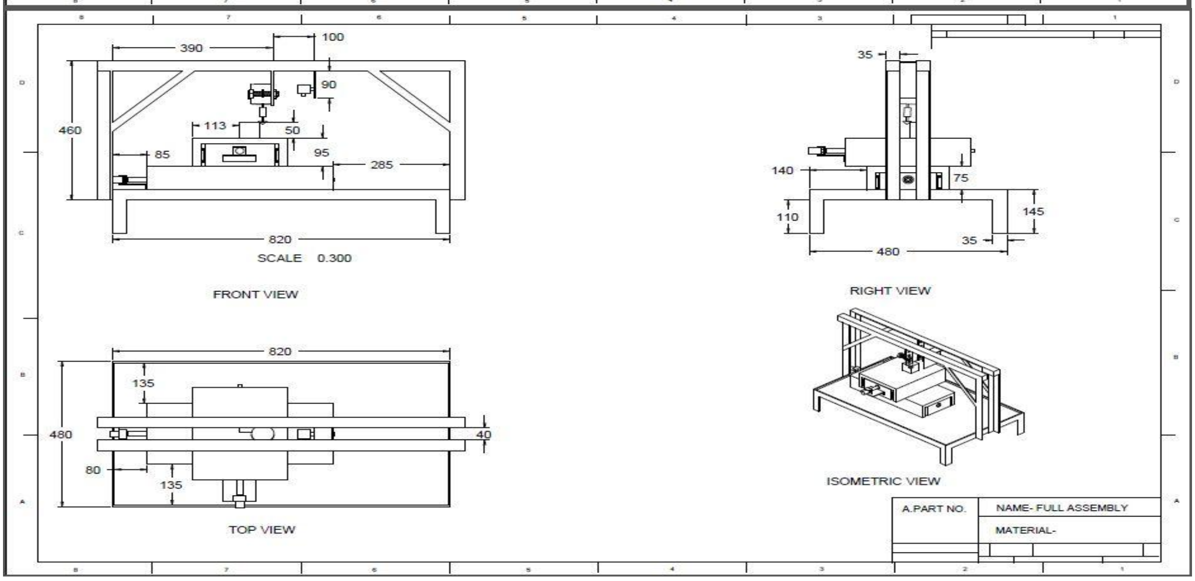
V. CONCLUSION

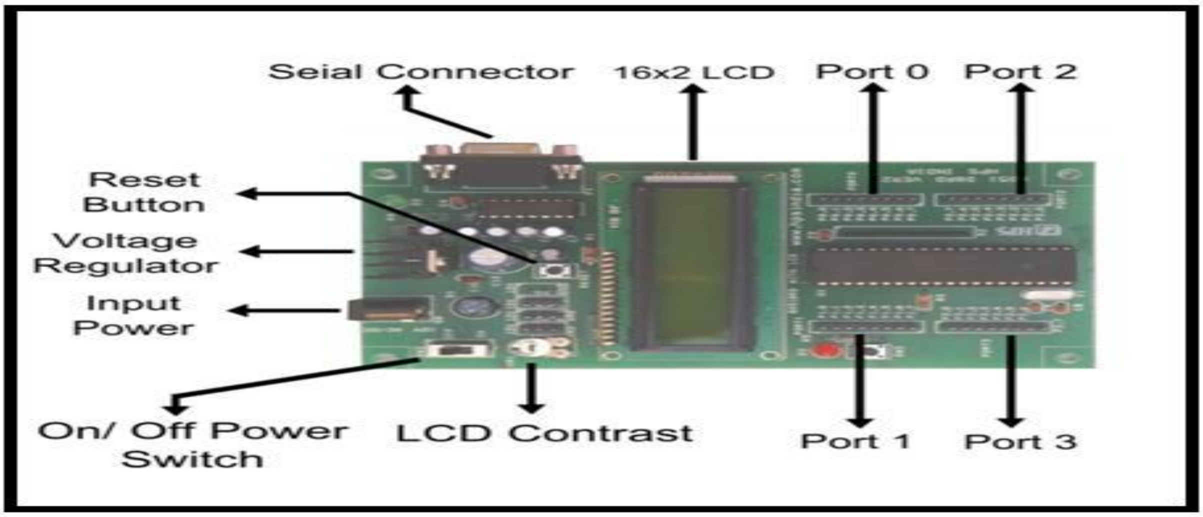
The review of literature as carried out helps in identification of some potential research regarding the areas of robotic surface finishing operations and automatic non contact inspection of defects. Very little work is done on automatic deburring system without using robots. It is observed that although several approaches for accomplishing the above mentioned deburring and inspection tasks have been proposed by researcher in the existing literature, research is required in some critical issues, such as integration of surface finishing and inspection operation on same system.

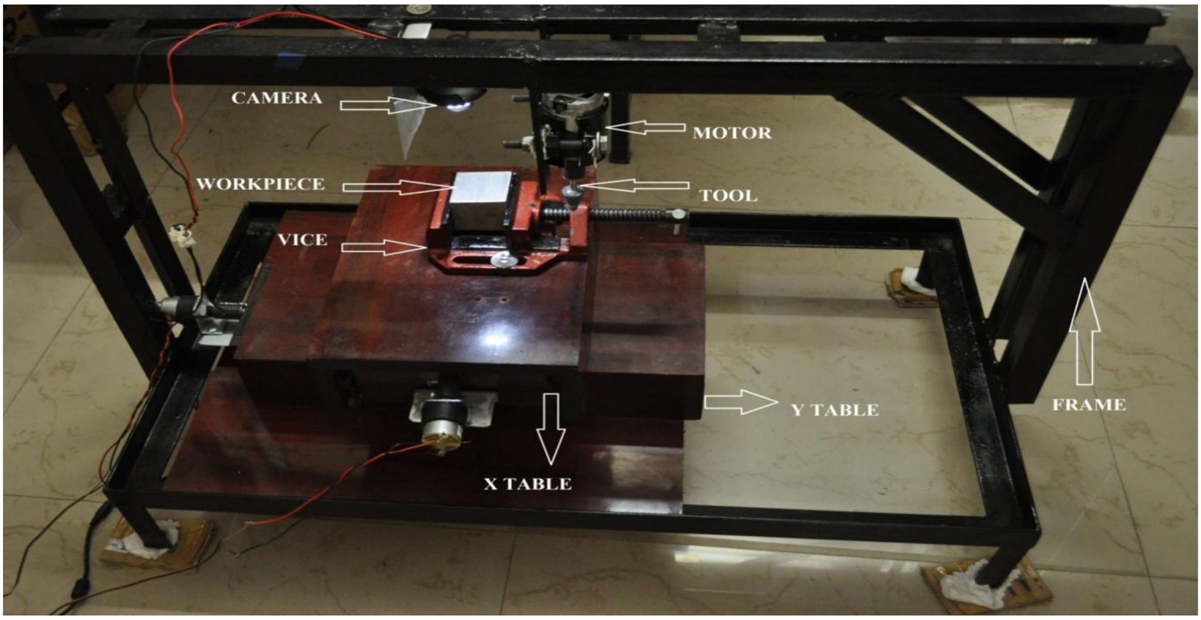
VI. FUTURE WORK

Data acquisition of RPM and Deflection.
Data storage and programming for analysis
Development of interface to display the results
Experimentation : In order to have double compliance machining, deburring is planned for rectangular shaped parts made of low carbon steel, high carbon steel, stainless steel, aluminum, copper and brass
Analysis of experimental data using Image Processing and MATLAB
Analytical support to be given to justify experimental findings.









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