Quality Improvement and Automation of a Flywheel Engraving Machine

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Abstract - This paper portrays about the Inspection of a Flywheel (mechanical component) through Sensors based innovation and furthermore Automation of the Flywheel Engraving Machine. In manufacturing a Flywheel, Boring operation is done using VMC Machine for fitting the crank shaft. After boring, the Internal Diameter must be Inspected, Categorized (as A,B,C,etc.) and after that it is to be Engraved on the flywheel by an Engraving or Etching machine. These operations are done manually only. This Manual Inspection of internal diameter, Categorization of flywheel and Manual assembly for engraving has prompt to numerous errors and dismissal of products in the market. To redress these issues, we have outlined a module by which every one of these operations are automated and controlled utilizing a Micro-controller which can be introduced with the machines in the industry effectively. Along these lines, we can get a High Quality, Standardized product, reviewed and manufactured through automation at a sensible cost. Mechatronics systems are implemented in the industry for its betterment.

Key Words- Automation, Engraving Machine, Sensor based Inspection, Quality Improvisation in Manufacturing, Mechatronics systems.

1. Introduction

In manufacturing a flywheel, the assembling procedure is carried out in a step-by-step manner. The last stage is to make opening (hole) for assembling the crank shaft. This opening is made utilizing VMC Boring machine. The opening must be smooth, impeccable and corresponding to the diameter of the shaft to fit in it. The Internal diameter of the flywheel, after boring is inspected physically, utilizing an Air gauge meter. Upon inspection, if the digital value is achieved, then the item can continue advance for next operation. Now, based on the Internal Diameter, the flywheel is categorized as A,B,C,etc. And then it is to be engraved on the flywheel. This is done manually, which has prompt parcel of mistakes and low standard item. To eliminate these deformities, we have composed a minimized module to investigate the flywheel I.D. and to automate the flywheel assembly for a perfect engraving. This module can be introduced to the machine effortlessly and in this way enhances time traverse, quality, efficiency and productivity.

The micro controller is programmed to control the entire operation. Sensors are used to inspect the Internal Diameter of the flywheel. Pneumatic drives and control are used to assemble the flywheel for engraving. Accordingly, the whole procedure is under electronic supervision and control, to lessen errors.

2. Related Works

A robust automation assembly, an exact and productive technique for the inspection of completed assemblies. This algorithm is trained on synthetic pictures created utilizing CAD model of various segments of the assembly. The algorithm can detect errors by examining real images of the assembled product. Image processing plays a major role in this process. Thus inspection is carried out. [1]

This work presents improvement of a model for the programmed engraving machine. The proposed framework is controlled utilizing PC, by setting drawing for imprint. Built model comprises of XYZ coordinates table (working region), where XY for position in the engraving region and Z axis for setting up little driller. Arduino board has been picked as a controller.

Developments of the machine are generated by stepper motors. The controller takes the coordinates and converts them to the signals for the motors that move grind to the given position and engrave the desired drawing. Finally, device capable of etching the desired drawing that is set by the user was obtained. [2]

This paper aims at the automation of feeding, clamping and retrieval process to carry out the manual job. In light of the obliges the parts are composed, collected, assembled and tested. Upon testing, the subsystems are considered significantly. Micro controller is utilized to control the whole procedure. Process duration was recorded to be as 18 seconds only. The framework is utilized for an engraving machine. [3]

In this paper, they built up a multiscale stochastic picture model to depict the presence of a complex three-dimensional object in a two-dimensional monochrome picture. This formal picture model is used as a part of conjunction with Bayesian Estimation Techniques to perform computerized review. The model depends on a stochastic tree structure in which every hub is an essential subassembly of the three-dimensional object. The information related with every hub or subassembly is demonstrated in a wavelet domain. We utilize a quick multiscale seek method to process the successive MAP (SMAP) estimate of the unknown position, scale factor, and 2-D rotation for each subassembly. The results of this search determine whether or not the object passes inspection. [4]

Visual assembly inspection can give a minimal effort, exact, and effective answer for the automated assembly inspection issue. The execution of such an assessment framework is heavily dependent on the arrangement of the camera and light source. This displays new algorithms that uses the CAD model of a completed assembly for placing the camera and light source to enhance this process.This general-purpose algorithm utilizes the component material properties and the contact information from the CAD model of the assembly, along with standard computer graphics hardware and physically accurate lighting models, to determine the effects of camera and light source placement on the performance of an inspection algorithm. [5]

A software architecture for engraving machine control system based on hierarchical finite state machine and multithread programming. Interactive sequence diagram and dataflow chart are depicted in detail for manual and programmed operation mode, which provides a consistent and flexible way to construct CNC control system. [6]

3. Proposed Work

In the proposed methodology, the last machining procedure is to be automated and the item should be error free and of high standards. We are building up a module which can be effortlessly introduced to the working machine. The module includes 2 phases of operation.

3.1. [Operation 1] Inspection of Bored Flywheel:

The flywheel after boring is to be checked for correctness. Being a manual operation, this process might be skipped or at times inspected wrongly. This may lead to error in production. To eliminate this, we set the first operation is to be the inspection of I.D. of Flywheel using electronic modules.

Air gauge meter and Sensors are used to check the Internal Diameter of the bored flywheel. The output of these air gauge and sensor inspection results are to be sent to the Micro controller. The micro controller, only upon receiving both the outputs allows the process to continue to next stage. If not the process stops by this stage and continues only after the inspection outputs are received.

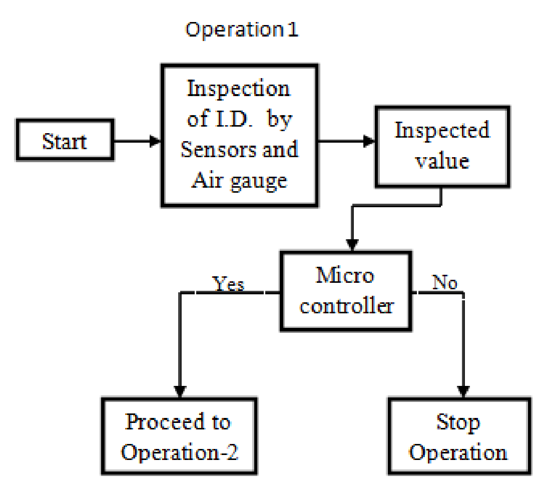

Figure 3.1 Block Diagram for Operation 1

3.2. [Operation 2] Automation of Flywheel Engraving Machine:

For engraving to be done, the Internal Diameter of the flywheel is to be measured. Based on the values of internal diameter, the flywheels are categorized as A,B,C,etc. with a minor difference of about few microns variances. These categories are to be engraved in the corresponding flywheels. This is also done manually. Thus our module automates these operations too. Upon proceeding from operation 1, the flywheel is to be assembled for engraving. To start the engraving machine, 3 outputs are necessary.

i. Output from Operation 1 (Inspection of Bored Flywheel) ;
ii. Proximity sensor output for checking the availability of flywheel over the bed ;
iii. Output from I.D. categorization (A,B,C,etc.).

Only if all these outputs are received by the micro controller, the process of engraving starts. Even if any one output is not received, the operation does not proceed. Upon receiving the three outputs, the Micro controller sends signals to the Pneumatic cylinder and drives to move the piston thereby making the flywheel to reach the engraver tool , and then engraving is done and the flywheel returns. Limit switches are used to limit the extension and retention of the piston.

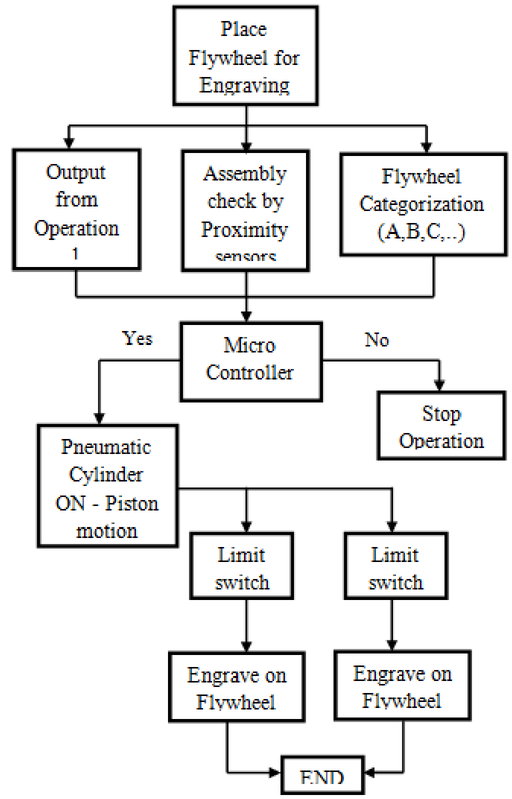

Figure 3.2 Block Diagram for Operation 2

Thereby, we can obtain a completely automated, perfect engraving machine for a flywheel.

4. Experimental results

The proposed module has been checked through simulation for efficiency. Operation 1 is analyzed using LABVIEW software, while the analysis for Operation 2 is done in FESTO FluidSim (Pneumatics) simulation software. The results are as follows.

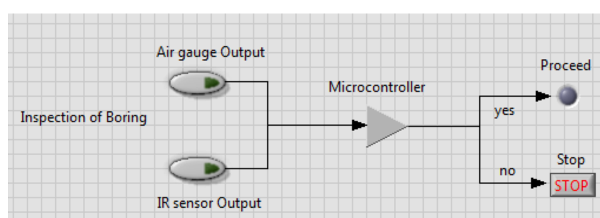

Figure 4.1 LABVIEW- Operation 1 - No output received

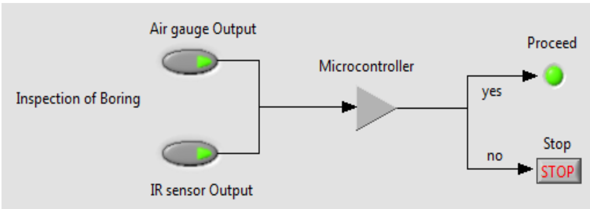

Figure 4.2 LABVIEW – Operation 2 - Outputs received and Proceeded

As per our desired condition, during Operation 1 (Inspection of bored flywheel) only if both outputs from Air gauge and IR sensor are received by the Micro controller, the process may proceed. If not, the process stops with an alarm. This is explained in above images of Labview Simulation.

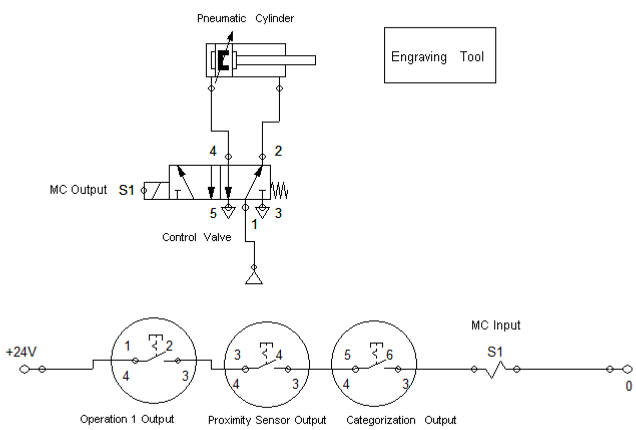

Figure 4.3 FLUIDSIM - Operation 2 - No Outputs received and No Piston motion

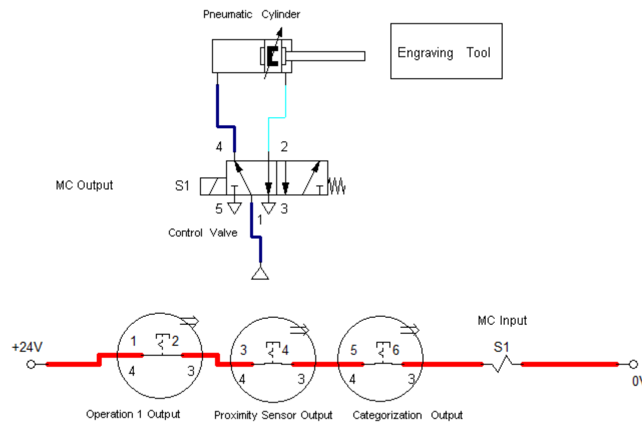

Figure 4.4 FLUIDSIM – Operation 2 – Outputs received and Piston moved

For Operation 2 (Automation of Flywheel Engraving Machine), the process starts only after receiving all 3 outputs. The Micro controller after receiving these outputs, sends signals to the cylinder for piston to move within programmed limits. The above are screenshots of simulation in Festo FluidSim Pneumatics software.

5. Conclusion

The purpose of this work is to enhance the Quality of the manufactured flywheel in all possible means. The errors occurring due to manual inspection and assembling are deeply analysed and corresponding solutions are drafted, designed and implemented in the industry. Inspection methodology is improved and the assembly for engraving machine is also automated. A Mechatronics system has been implemented in the industry at a reasonable cost and highly benefited. Error occurrence has been put down to a minimal level. High quality and standardized product is gained from our module.

References

[1] A Multiscale Assembly Inspection Algorithm - IEEE Robotics & Automation Magazine (Volume: 3 , Issue: 2, Jun 1996) by K.W. Khawaja, A.A. Maciejewski , D.Tretter ,USA.

[2] Design of Automatic Engraving Machine Controlled via Computer - ICECCO- 2015 The Twelve International

Conference Electronics Computer and Computation by Selim Guvercin, Rassim Suliyev, Gulnur Tolebi , Kazakhstan.

[3] Design and Fabrication of Automatic Material Handling System for Engraving Machine- ICAMME-2014 International Conference on Advances in Manufacturing and Materials Engineering by S.K. Harisha, Mahantesh Biradar, B. Vitthal Uppar, R.S. Kulkarni.

[4] A Multiscale Stochastic Image Model for Automated Inspection – IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL.4, NO.12, DECEMBER 1995 by Daniel Tretter, Charles A. Bouman, Khalid W. Khawaja, and Anthony A. Maciejewski.

[5] Camera and Light Placement for Automated Assembly Inspection - IEEE International Conference on Robotics and Automation 4:3246 - 3252 vol.4 · May 1996 by K.W. Khawaja , Anthony Maciejewski , Daniel Tretter , C.A. Bouman.

[6] Design and Implementation of Engraving Machine Controller - 2010 International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), on 13-14 March 2010 by Lin Yang, Tianliang Hu , Chengrui Zhang , Key Lab. of High Efficiency & Clean Mech. Manuf., Shandong Univ., Jinan, China.

[7] Modern Assembly of Flywheel - IEEE Aerospace and Electronic Systems Magazine (Volume: 13, Issue: 8, Aug 1998) by J.G. Bitterly , US Flywheel Systems, USA.

[8] An intelligent robot for flexible quality inspection - IEEE International Conference on Information and Automation (ICIA), 2016 by Martin Kefer, Jihuan Tian - Corporate Research Center, ABB (China) Ltd., Shanghai, China.

[9] Imaging sensor and imaging algorithms for quality inspection of flexible materials – IEEE Sensors Applications Symposium (SAS), 2016 by Maik Rosenberger, Chen Zhang, Mike Bartmuß, Gunther Notni - Department of Quality Assurance and Industrial Image Processing, Ilmenau University of Technology, Ilmenau, Germany.

[10] Automation and control of a multi-sensor measuring system for quality inspection of technical surfaces - 13th International Conference on Control Automation Robotics & Vision (ICARCV), 2014 by Alexander Keck, Oliver Sawodny - Institute for System Dynamics (ISYS), University of Stuttgart, P.O. Box 80 11 40, 70511 Stuttgart, Germany.

[11] Quality inspection of engraved image using shape-based matching approach - 4th International Conference On Mechatronics (ICOM), 2011 by Norazlina Binti Ahmad, Marizan Bin Sulaiman, Muhamad Khairi Bin Aripin - Faculties of Electrical Engineering Universiti Teknikal Malaysia Melaka Melaka, Malaysia.

[12] A New Method for Automatic Quality Inspection of Glue-Line - ICIECS International Conference on Information Engineering and Computer Science, 2009 by Shuai Chen - Shenyang Inst. of Autom., Chinese Acad. of Sci., Shenyang, China and Mingxiu Lin - Coll. of Inf. Sci. & Eng., Northeastern Univ., Shenyang, China.