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Programmable Logic Controller based Mechatronics System for Metrological Inspection of Clevis

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Abstract:In industries, inspection is one of the crucial factors to ensure quality of the product before reaching the market.The objective of this project is to design a Mechatronics system to monitor the dimensions of the product (clevis) using the pneumatics system with the help of Programmable Logic Controller (PLC).The clevis is placed in the clevis holder, which is used to hold the work piece tightly. Then the pneumatic cylinders which are controlled by PLC XE 102 extends and retracts based on the ladder logic diagram. The calibrated gauges are attached in the pneumatic cylinders, if the GO/no GO gauge travels smoothly inside the hole, it can be concluded that the dimensions of the hole is in accordance to the specified standard dimensions. This system improves the dimensional inspection and also eliminates the human errors andcan be done at lower cost.

Keywords:Metrological inspection, Clevis, PLC, Dimensional measurement, Pneumatic system, Pneumatic circuit.

I. INTRODUCTION

Inspection of finished products in manufacturing industries for quality is one of the important factors. It can be done either manually or by using automation. Over the years the demand for high quality, greater efficiency and automated machines has increased in the industrial sector.Finished products require continuous monitoring and inspection at frequent intervals. There are possibilities of errors at measuring and various stages involved with human workers and also the lack of few features of microcontrollers. Thus this project takes a sincere attempt to explain the advantages the companies will face by implementing automation into them. Here we are going to discuss about the automation of a quality inspection process and its advantages over the manual inspection method.

II. LITERATURE SURVEY

Y.S Liu, T.Q Wang, X.Y Ma , Y.P Ning (2011) in their work “Hole straightness measurement ofAutomatic Control System Design” designedan instrument which works based on the principle of the measurement method of straightness error measurement of deep hole, the design technologies of A/D converters, automatic control and computer are used. The instrument can automatically acquire data, the process of acquire data is convenient, fast, safe and the data is reliable. Mohammed J. Islam, Saleh M. Basalamah, Majid Ahmadi, Maher A. Sid-Ahmed (2012) in theirwork “Computer Vision-Based Quality Inspection System of Transparent Gelatin Capsules in Pharmaceutical Applications” designed a computer-vision based system and a digital image obtained by a digital camera would usually have 24-bit color image. The analysis of an image with that many levels might require complicated image processing techniques.They have developed an image processing system using edge-based image segmentation techniques for quality inspection that satisfy the industrial requirements in pharmaceutical applications to pass the accepted and rejected capsules.

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III. METROLOGICAL INSPECTION OF CLEVIS

The product is placed in the fixture. The fixture holds the product in position during the inspection .The Gauges fitted in the pneumatic cylinders extend to check the dimension of the product. Hence the dimensions of the product is verified with standard dimensions. Based on the dimension product is either selected (or) rejected. A device for determining whether or not one or more dimensions of a manufactured part are within specified limits A plug gage is a cylinder designed to check the component tolerance of a hole in a product. The plug gage has been found to be highly accurate, economical and convenient for small hole inspection where a determination is made of compliance with designed limits.

IV. EXPERIMENTAL SETUP

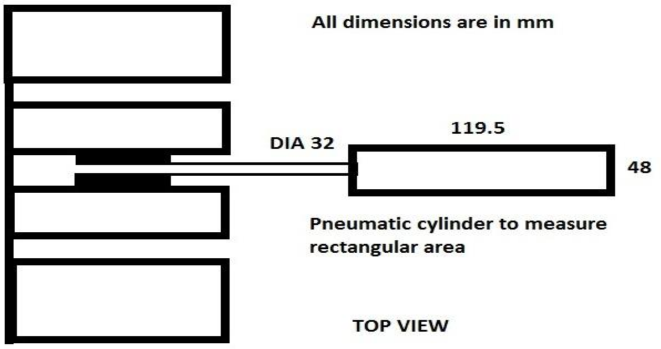

Fig. 1: Top view of experimental setup

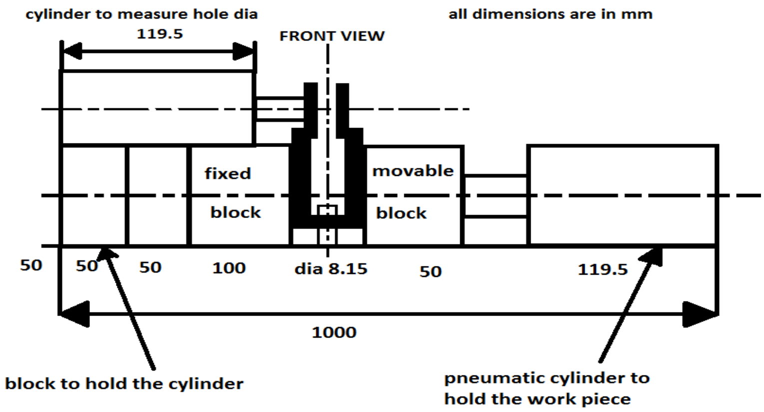

Fig. 2: Front view of experimental setup

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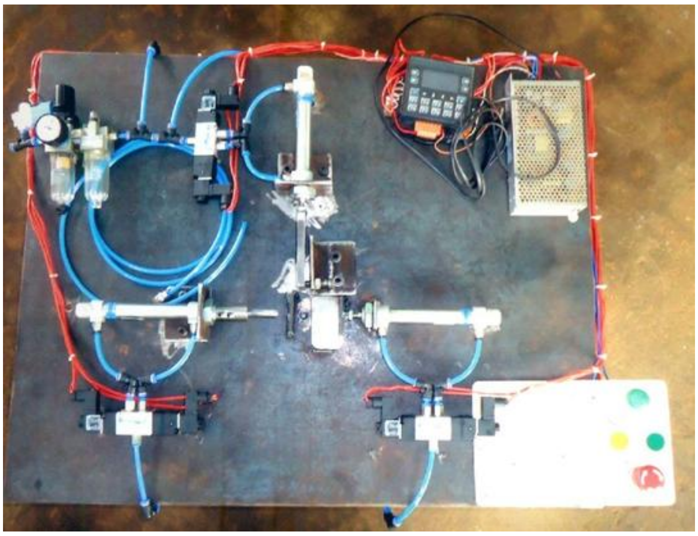

Fig.3: Experimental setup

V. SPECIFICATION OF CLEVIS

Hole Diameter = 10.0 mm; Go Width = 9.8 mm; No-Go Width = 10.2 mm; Length = 43 mm

Fig.4: Clevis

VI. FLOW CHART OF THE PROCESS

The Working of the Automation system is based on control of inspection process using the Programmable LogicController (PLC) and the Pneumatic Circuit.The pneumatic circuit is designed first and then the PLC programming is designed for the pneumatic circuit. Then the interfacing is established between the PLC and the pneumatic circuit. Then the Clevis is placed in the fixture, the pneumatic circuit is actuated to check the dimensions of the clevis. Whenever the inspection is failed, the Clevis is sent for the rework or it is considered as scrap. The Clevis which passes the inspection is only used in automobiles or it is considered fit to use.

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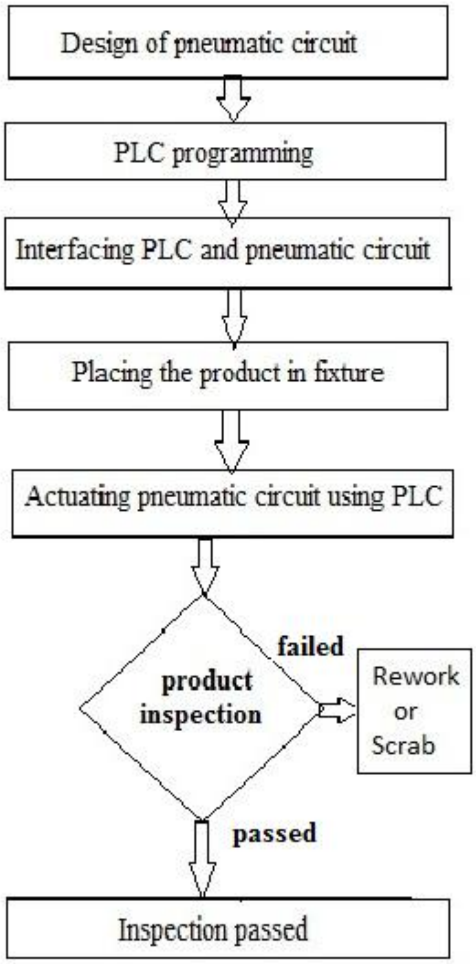

Fig. 5: Flow chart of the process

VII. Sequential Description of Process

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When the cycle start pushbutton is pushed, it actuates the solenoid1.then the cylinder 1 attached with the movable block extends to hold the work piece in position .Thus it acts as a fixture. When the solenoid1 is actuated the timer for the solenoid3 is also activated at the same time. Then the solenoid3 is activated after the pre-set time (1sec) in the timer. Due to the activation of solenoid3 the cylinder2 connected to it gets actuated. Then the cylindrical gauge fixed to it also extends along with it to inspect the quality of the dimension of the work piece. During the same time when the solenoid3 is activated the timer for the solenoid4 gets activated .After the pre-set time in the timer the timer activates the solenoid4.the solenoid4 makes the cylinder2 to retract to its initial position. After the cylinder2 retracts solenoid5 gets activated which extends the cylinder3.then the rectangular gauge attached with the cylinder3 move along with it to inspect the gap in the component. Then the solenoid6 gets activated after the pre-set time to retract the cylinder3, back to its initial position. After the cylinder3 retract the solenoid2 gets activated which retracts the cylinder1 back to its initial position. If the gauges get stuck in the component the stop button can be used to stop the entire process which de-activates all the solenoid valves connected to the PLC. In case of emergency situation the emergency pushbutton is turned on this cut the air supply to the entire system. Thus one cycle of the process is over this is repeated continuously for inspection of each component.

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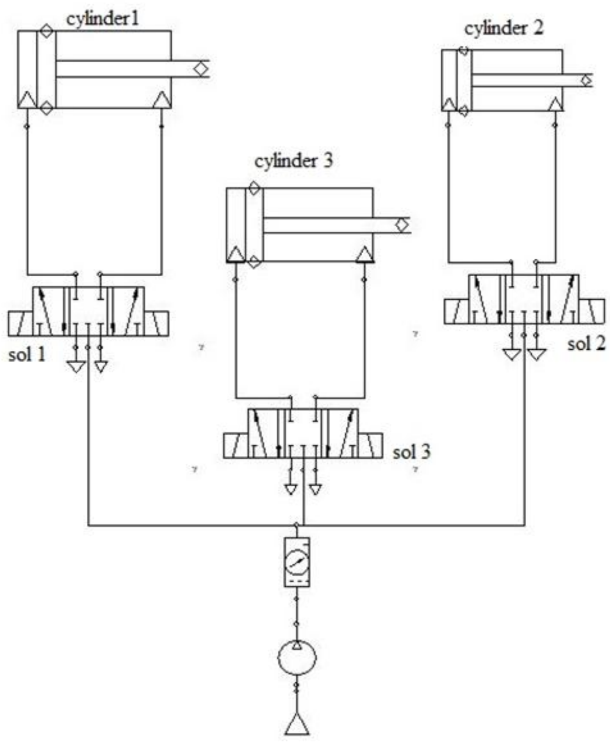

Fig.6: Pneumatic Circuit

VIII. SELECTING A PLC

A PLC is a device used for automation processes in industrial environments. It uses a programmable memory for the internal storage of user-orientated instructions for implementing specific functions such as arithmetic, counting, logic, sequencing, and timing. Input devices and output devices of the process are connected to the PLC and the control program is entered into the PLC memory. The type of PLC used in this project is horner XE102.

IX. FEATURES OF XE102

Bright, graphical LCD display. Display of complex graphical objects including trends, gauges, meters and animations Advanced control capabilities including floating point, multiple auto-tuning PID loops and string handling capabilities CsCAN networking port (optional) for communication with remote I/O, other controllers or PCs Cscape programming software that allows all aspects of the XES to be programmed and configured from one integrated application.

X. LADDER - CONTROLLED SERIAL COMMUNICATION

Using Serial Communication function blocks, both MJ1 and MJ2 support Generic, Modbus Master and Modbus Slave Protocols. In addition, external modems can be connected and accessed using Init, Dial and Answer Modem function blocks.

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XI. INPUTS AND OUTPUTS

The XLe/XLt is a compact unit that contains high density, very versatile I/O. Using the I/O properly requires wiring to the proper terminals, configuring jumpers inside the XLe/XLt unit and configuring Cscape properly. Some I/O configurations require jumper settings to be changed inside the XLe/XLt unit. Examples of these settings are setting positive or negative logic on digital inputs or setting current or voltage on analog inputs. Each XLe/XLt I/O jumper is set to a factory default. There are eight inputs and six outputs used in this PLC controller.

XII. PLC PROGRAMMING

Once the pneumatic system is designed the next step is to create a suitable ladder logic diagram for the inspection of the dimensions of the product. The programming is based on the arrangement of the pneumatic cylinders. The Ladder logic Diagram is a method in which each logical step of the whole process is divided into ladders. The ladders contain the logic in the form of relay, switches and coils through which the program will be executed. The program is done using a software in the computer which will then import the program into the PLC kit through the Interface connection. Apart from the cylinder Arrangement Various Factors are also to be considered for the Programming .They are timing for extension and retraction of the cylinders, Position of the fixtures, pressure level of the cylinders.

XIII. RESULT

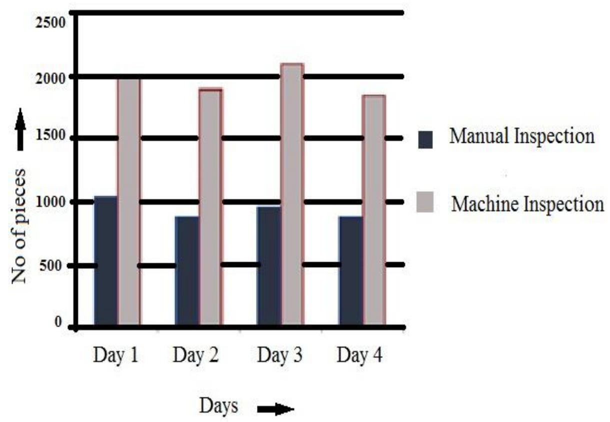

Fig.7: Days vs No. of pieces

As shown in the bar chart on day1 the number of pieces tested manually are 1000 but the number of pieces tested by PLC controlled machine are 2000 which is 2 times of the manual inspection, On day 2 the number of pieces tested manually are 932 and number of pieces tested by machine are 1906 which is 2.04 times the manual inspection, On day 3 the number of pieces tested manually are 967 and the number of pieces tested by machine are 2080 which is 2.15, even on day 4 the number of pieces tested manually are 894 and the number of pieces tested by machine are 1898 which is 2.12 times the manual inspection. This bar chart shows that the number of inspection of clevis has been improved when compared with the manual inspection.

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