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# Online Inspection and Output Control Communication Tools in Machine Vision based Application

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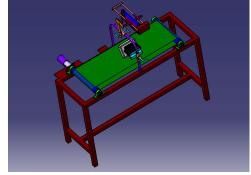
#### **Abstract**

**Objectives:** The purpose of the study is to develop online inspection of the quality of the machined components using Machine Vision (MV) and the tools required for its implementation in real time with low budget. **Methods/Statistical Analysis:** In this online inspection study, a belt conveyor model is fabricated for the movement of the machined component and their images are taken using a web camera connected to a PC through the USB port. These images are analyzed using MATLAB software and outputs a signal to the PIC microcontroller based control system in order to allow/eject the good or bad components with the help of pneumatic control systems. **Findings:** Applications of Machine vision were utilized in various automation processes. In this study, low cost automation tools are implemented for online inspection of machined components. A PIC16F870 microcontroller based control system was connected to a PC through the serial port. A separate serial port MAX 232 communication board was interfaced between PC and microcontroller. The image of the standard quality machined component geometry was taken and compared with machined components using Matlab software. Before implementing the whole set up, image processing output signals were simulated, verified using virtual port driver software and protest circuit design software. Only quality components are passed to the other end of the conveyor where as the faulty components are ejected by the pneumatic control system. **Application/Improvements:** The accuracy of the images can be improved by taking images using a CCD camera. The time required for analyzing the images of machined components should be reduced by using high processor speed computers.

Keywords: Machine Vision, MATLAB software, PIC microcontroller, Pneumatic Control System

#### 1. Introduction

Today, a lot of industrial Machine Vision software and hardware tools are available in the market. These readymade hardware's and software's are utilized for online inspection in the automation process<sup>1</sup>. The user gives limited inputs, operate and perform the requirements only by spending high budget cost for ready-made tools used for machine vision applications<sup>2</sup>. In order to implement the low budget machine vision tools for automatic inspection, the output analysed result from the matlab was communicated to microcontroller based control system.



**Figure 1.** Online inspection belt conveyor model for machine vision application.

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To explain the low cost output control tools of machine vision<sup>3</sup>, practically an experimental set up is fabricated as a prototype model for demonstration purpose. Before fabricating the structure, the model is designed using Catia software and shown in Figure 1. A fabricated prototype model of belt conveyor set up for online non-contact inspection of component for machine vision application shown in Figure 2.



**Figure 2.** Photo image of the on line inspection for machine vision process.

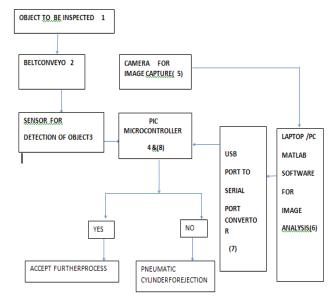
# 2. Components of Machine Vision System

- Software requirements.
- MATLAB R13 a software.
- Virtual serial port driver software.
- USB to RS 232 serial port convertor.
- USB to serial port convertor software.
- Proteous software for designing the circuit and program code simulation.
- · CCS compiler.
- Windows 7 ultimate.
- Hardware requirements.
- PIC 16F 877A PIC Microcontroller circuit board.
- Laser sensor.
- Omni vision 4576 CMOS sensor camera, 5MB mega pixel.
- LED illumination lighting set up.
- PC with windows ultimate operating system, 2GB memory. 300 GB HARDDISK.
- DB 9 serialport cable.
- Microcontroller programmer kit.
- Belt conveyor set up with M.S. Fabricated stand along with 24 VDC motor.

- Pneumatic cylinder 25MM DIA and 300 MM stroke length.
- 5/2 way solenoid operated directional control valve with 12VDC solenoid coil.
- Pneumatic component accessories.
- Compressor 10 bar, 300 liters capacity along with FRL unit'.
- 24VDC power supply.

# 3. Block Diagram for Machine Vision Experimental Set Up

The implementation process path is explained in block diagram shown in Figure 3.



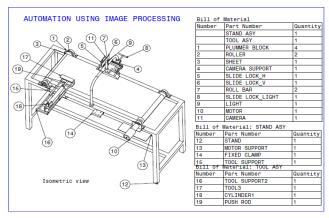
**Figure 3.** Block diagram for machine vision experimental set up.

## 4. Experimental Tools and Methods

## 4.1 Online Inspection Set Up

For the online inspection of the component to be tested is allowed to pass on the belt conveyor using a 24VDC motor with built in gearbox is coupled to a driving pulley. A conveyor belt of 250 mm width and 1800 mm circumference is moved over a driving and driven pulley of 50 mm diameter and 300 mm length. These conveyor pulleys are rotated in 20 mm diameter bore plummer block bear-

ings mounted on the 300 mm x 200 0mm x 1000 mm M. S. Fabricated stand made in 40 x40 mm mild steel square tube. The conveyor motor is controlled by the PIC microcontroller based control system. The fabricated set up drawn using CATIA software is shown in Figure 4.



**Figure 4.** Online inspection belt conveyor model sketch using Catia software.

#### 4.2 Image Acquisition Process

A web camera having 25MB pixel resolution using CMOS sensor with proper illumination set up is used for acquiring the image of the specimen to be tested is stopped by the microcontroller at image acquiring station through a signal from the laser beam sensor. At same time the microcontroller communicates signal for the detection of object at camera station to the PC through the USB to serial port convertor and the image of the object is taken out by the camera for image analysis using MATLAB software.

## 4.3 PIC 16F870 Microcontroller based Control System

(Peripheral Interface Controller) PIC microcontrollers are manufactured and marketed by UK based Microchip Company. They are supplying variety of 8, 18, 28, and 40 pin microcontrollers. Each one is manufactured for particular application functionality and their cost less than 500 rupees. PIC Microcontrollers are made in single chip and provided with Analog-to- digital convertors, serial communication port of Rx (Receiver) and Tx (Transmitter) for data communication with PC and other external devices<sup>4</sup>. The software program code is writing in assembly or C language and embedded into the microcontroller memory using programmer kit. The controller

circuit is drawn in Proteous software and the programmed hex code is simulated for testing the program code for our self developed application. After verifying the successful program code simulation, these coding are embedded into the controller memory using programmer kit. The controller circuit is shown Figure 5.

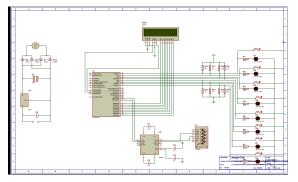


Figure 5. PIC microcontroller circuit diagram.

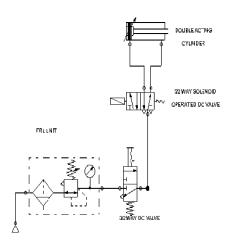
Now the programmed chip is inserted into the controller board and necessary power supply, input laser sensor and output motor and serial port cable communication to PC connections made as per the above circuit.

## 4.4 Output Control Communication Tools Set Up

Matlab, commercially available interactive mathematical programming software, also provides serial data communication functionality on the PC<sup>5</sup>. The image of the object to be tested is compared with the image of the masterpiece using MATLAB software and the output result is taken out via comport to the PIC microcontroller. Here the 6 number of specimen images is taken out and compared with the masterpiece. Any deviation beyond the permissible upper and lower limits are identified and send a signal to the controller for ejection purpose. Depending on the signal from the PC, the faulty components are ejected from the air cylinder controlled by the pic 16F877A microcontroller board.

### 4.5 Pneumatic Control System

For the ejection of faulty components, one pneumatic cylinder is used. Air is supplied to cylinder in A+ and A-position through the 12 VDC operated 5/2 way solenoid operated directional control valve is used. This solenoid is controlled by the microcontroller. The pneumatic circuit diagram is shown in Figure 6.



**Figure 6.** Pneumatic circuit diagrams for the ejection of faulty components.

The photo image of the whole model on line inspection for machine vision is given below.

#### 5. Conclusion

In this paper, thus a prototype model of belt conveyor set up for online non-contact inspection of component for the application of machine vision. Thus focusing output control of the machine vision process is implemented and executed successfully at low budget. This setup can be utilized for image processing laboratory for the engineering students for learning purpose. Moreover, it can be applied in miniature production line station.

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