Application of Image Processing For Development of Automated Inspection System

[1,]Ms. Shubhada.K. Nagrale, [2,]Mr. S.T.Bagde
[1]P.G.Student(M-Tech, CAD/CAM), Dept. Of Mechanical Engg.,
Yeshwantrao College Of Engg, Wanadongri, Nagpur,India.
[2]Assistant Professor, Dept. Of Mechanical Engg.,Yeshwantrao College Of Engg, Wanadongri, Nagpur,India

Abstract

In manufacturing industry, machine vision is very important nowadays. Computer vision has been developed widely in manufacturing for accurate automated inspection. A model of automated inspection system is presented in this conceptual paper. Image processing is used for inspection of part. It is assumed that the part after going through many previous operations comes to inspection system where the weight of the part as well as geometry made on that part is detected and later decided whether it is to be accepted or rejected with the help of image processing technique. Using MATLAB software a program is developed and pattern or geometry is detected.

Keywords: Automated Inspection System, Digital Camera, Image Processing, Machine Vision, MATLAB, Pattern Recognition, PRO-E Software .

1. Introduction

Automated inspection systems are continuously conveyed in the manufacturing process. The systems are capable of measuring predetermined parameters of various parts, comparing the measured parameters with predetermined values, evaluating from the measured parameters the integrity of the parts and determining whether such parts are acceptable or, alternatively, whether they should be rejected.Humans are able to find such defects with prior knowledge. Human judgment is influenced by expectations and prior knowledge. However, it is tedious, laborious, costly and inherently unreliable due to its subjective nature. Therefore, traditional visual quality inspection performed by human inspectors has the potential to be replaced by computer vision systems. The increased demands for objectivity, consistency and efficiency have necessitated the introduction of accurate automated inspection systems. These systems employ image processing techniques and can quantitatively characterize complex sizes, shapes, and the color and textural properties of products. Accurate automated inspection and classification can reduce human workloads and labor costs while increasing the throughput. Machine vision has been used to detect the part and take the image of the part which compares it with the standard dimensions given to it through programming language.

Machine vision (MV) is the process of applying a range of technologies and methods to provide imaging-based automatic inspection, process control and robot guidance in industrial applications. the first step in the MV sequence of operation is acquisition of an image, typically using cameras, lenses, and lighting that has been designed to provide the differentiation required by subsequent processing. MV software packages then employ various digital image processing techniques to extract the required information, and often make decisions (such as pass/fail) based on the extracted information. Though the vast majority of machine vision applications are still solved using 2 dimensional imaging, machine vision applications utilizing 3D imaging are growing niche within the industry.

Machine vision image processing methods include:

- Pixel counting: Counts the number of light or dark pixels
- Thresholding: Converts an image with gray tones to simply black and white or using separation based on a grayscale value.
- Segmentation: Partitioning a digital image into multiple segments to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.
- Blob discovery & manipulation: Inspecting an image for discrete blobs of connected pixels (e.g. a black hole in a grey object) as image landmarks. These blobs frequently represent optical targets for machining, robotic capture, or manufacturing failure.
- Pattern recognition including template matching: Finding, matching, and/or counting specific patterns. This may include location of an object that may be rotated, partially hidden by another object, or varying in size.
- Barcode, data matrix and 2D code reading.

- Optical character recognition: Automated reading of text such as serial number.
- Gauging: Measurement of object dimensions (e.g. in pixels, inches or millimeters).
- Edge detection: Finding object edge.
- Neural net processing: Weighted and self-training multi-variable decision making.
- Filtering (e.g. morphological filtering).

We assume that the part after going through many previous operation comes to the automated inspection system where it is decided whether to accept or reject the part. Based on the weight of the part as well as through image processing, pattern of the part is matched through the standard program and image fed beforehand. Aluminum block is the part which is to be weighed and geometric pattern is recognized and matched using image processing.

2. Review Of Papers

The manual activity of inspection could be subjective and highly dependent on the experience of human inspectors. So image analysis techniques are being increasingly used to automate industrial inspection.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 [1]. Computer vision has been for detection of defective packaging of tins of cigarettes[2].A large amount of research has been carried out on automated inspection of tile surfaces[3],[4], biscuit bake color[5], the color of potato chips, textile fabrics, food products and wood[6]. However, relatively little work has been done in automated defect classification, mainly because of the difficult nature of the problem. Computer vision has been used to objectively measure the color of different food since it provides some additional and obvious advantages over conventional techniques such as using a colorimeter, namely, the possibility of analyzing each pixel of the entire surface of the food, and quantifying the surface characteristics and defects. Defective images are detected in textile fabrics by individually applying simple classification to discriminate knots from slubs according to the ratio of length to width [7], and pyramid linking scheme is employed to locate defects in wood and a hierarchical defect classification scheme to classify different types of wood defect [6]. An Automated Visual Inspection (AVI) system for weaving defect detection is developed based on image processing and recognition algorithms. The techniques from neural network for classifying the weaving defect are also used. The irregularities of the weaving fabrics are detected as defects [8].

3. Conceptual Designs

3.1. Rotary Disc Type Mechanism

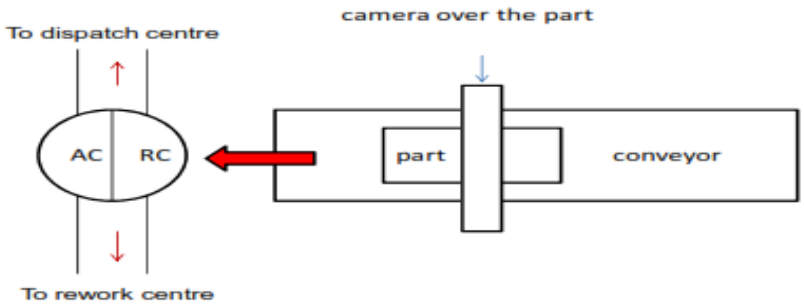

Figure 1. Rotary disc type mechanism

In this mechanism, the part is kept over conveyor with an overhead gantry. Camera is fitted on the gantry exactly over the part. Conveyor is used to transfer the part from one end to another end. As soon as the part is kept over the conveyor, the camera takes image of the part and matches with parameters of the program fed beforehand. After this the part goes to rotary disc where weighing machine is kept. If the weight and other parameters match exactly then the part goes to the acceptance centre. The disc is rotated 90° clockwise if part is to be accepted otherwise it directly drops the part in rejection centre (RC). After the part is accepted, it is sent to the dispatch centre for final packaging otherwise the part is sent to the rework centre where the rejected part is again operated for obtaining exact dimensions.

3.2. Pusher type mechanism

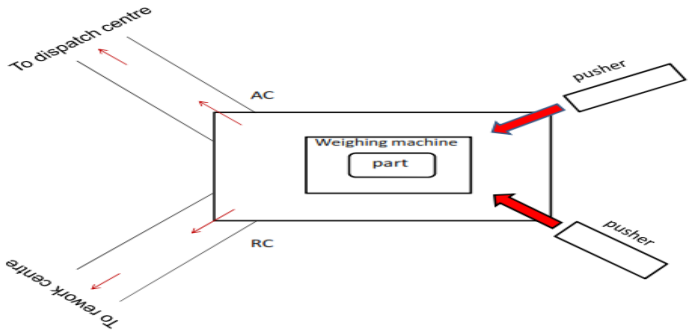

Figure 2. Pusher type mechanism

In pusher type mechanism, pusher is used to send the part to the acceptance centre or rejection centre. There is a rectangular block on which weighing machine is kept at the centre. The part is kept on the weighing machine. Camera is fitted on the weighing machine in such a way that camera comes exactly over the part. Weight is measured and other dimensions along with the weight are matched with the fed program. If the dimensions of the part are exactly matched, the lower pusher pushes the part towards acceptance centre from where the part is sent to dispatch centre for further processing otherwise the upper pusher pushes the part towards rejection centre from where the part goes to rework centre for further machining so that exact dimensions of the part are obtained.

3.3. Gantry type Mechanism

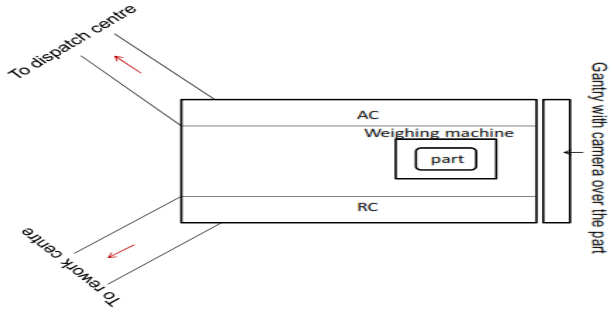

Figure 3. Gantry type mechanism

In this layout, the acceptance centre and rejection centre is kept besides weighing machine. Overhead Gantry is fitted at the extreme right of the layout so that camera fitted on the gantry comes exactly above the part. Other process is same as explained above. Now after the part is matched exactly, the part is transferred to acceptance centre through the arm (attached to the overhead gantry) otherwise it is transferred to rejection centre which in turn is sent to either dispatch centre or rework centre respectively.

3.4. Flip Drop mechanism

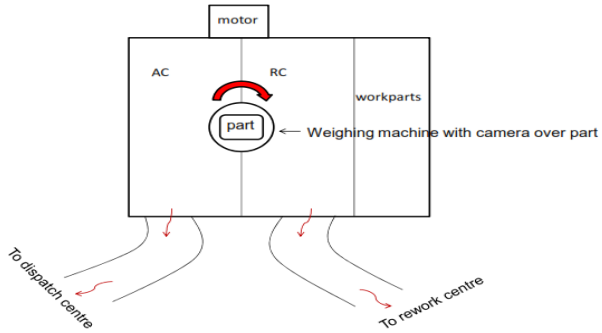

Figure 4. Flip drop mechanism

In this mechanism, the part is flipped with the help of motor. The part is either dropped in the acceptance centre or rejection centre by rotating the block through 90° (either clockwise or anticlockwise respectively). The part is kept over weighing machine where camera is fitted such that the camera is exactly over the part. Other procedure is same as mentioned above.

3.5 Oscillatory mechanism

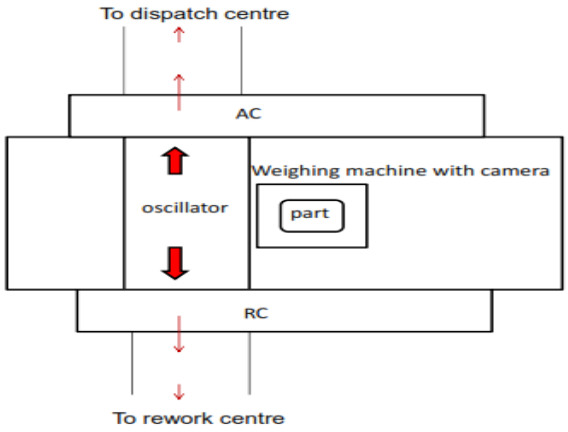

Figure 5. Oscillatory mechanism

In this, the oscillator is used to transfer the part either to acceptance centre or rejection centre by to and fro motion. If the part is exactly matched, the oscillator drops the part to the acceptance centre which in turn is sent to dispatch centre. The oscillator moves forward if the part is to be sent towards acceptance centre otherwise it moves backward to drop the part to rejection centre. Other processing is done as mentioned before.

4. Proposed Design

Flip drop Mechanism is the best suited design for the project as it requires

- less space
- less moving parts
- no gantry arm for placing the part in the respective centre.

The disadvantages of other models are: All other conceptual designs used gantry arm to place the part in the respective centre, conveyors were used which complicated the design. More floor space. Use of gantry arm will increase the computational time during processing. For weighing the Aluminium block, load cell is used.

3-D model of the system is represented below:

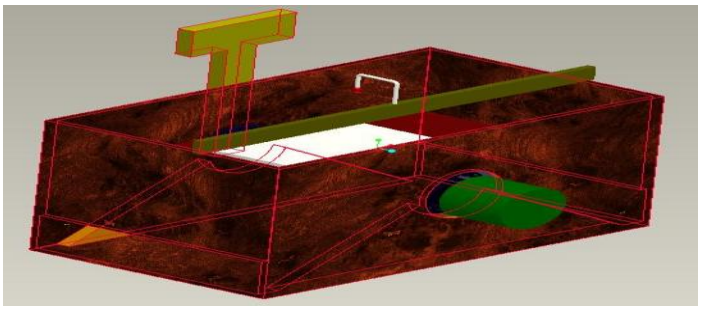

Figure 6. 3-D model of the system

This is the proposed concept of the system. Specification of the main components of system is given below:

Aluminium block

- DimensionsofAluminium block=100mm×100mm×10mm;
- Density of Aluminium=2700kg/m^3;
- Density=mass/volume;
- Volume=$100\times100\times10\times10^{-9}$ m^3
- Mass=$2700\times100\times100\times10\times10^{-9}$
  =0.27 kg

Servo Motor

- Dimension: 23mm x 12mm x 25mm
- Torque: 1.5kg/cm at 4.8V
- Motor weight: 30gms
- Operating speed: 0.15sec/60 degree

- Operating voltage: 4.8V/6V
  Camera
- Camera:3MP
- Model: HD Webcam C270

Load cell

- Type: VLC131 Single point load cell
- Capacity:5lb
-

5. Image Processing

Fundamental steps in image processing:

1. Image acquisition: This is the first step of image processing. In this a digital image is acquired
2. Image preprocessing: In the second step image is improved in a way that increase the chances for success of the other processes.
3. Image segmentation: It partitions an input image into its constituent parts or objects.
4. Image representation: It converts the input data to a form suitable for computer processing.
5. Image description: In this step features are extracted that result in some quantitative information of interest or features that are basic for differentiating one class of objects from another.
6. Image recognition: It assigns a label to an object based on the information provided by its descriptors.
7. Image interpretation: A meaning is assigned to an ensemble of recognized objects in this step.

General code for comparing two images in MATLAB is given below:

```
a = imread('image1.jpg');
b = imread('image2.jpg');
c = corr2(a,b);
   if c==1
    disp('The images are same')
    else
    disp('the images are not same')
    end;
```

6. Conclusion

In this paper, the proposed design is being developed. This design is advantageous than other papers as this is a portable type of machine which has acceptance and rejection centre placed in a single machine. Different types of geometries can be used for image processing. This design is more advantageous for small scale industries. Different types of models or objects can be used as a workpiece for testing.

7. References

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