INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078

(Volume 8, Issue 3 - V8I3-1406)
Available online at: https://www.ijariit.com

Image Processing in Industry 4.0

Jhanavi Trilok
jhanavi.20bis@cmr.edu.in
CMR University, Chagalahatti, Karnataka

Shivkumar A.
shivkumar.infion@gmail.com
Infion Advanced Laser Systems Pvt. Ltd., Hoskote, Karnataka

Dr. Babu Rao
baburao.k@cmr.edu.in
CMR University, Chagalahatti, Karnataka

Dr. S. Saravana Kumar
sarvana.k@cmr.edu.in
CMR University, Chagalahatti, Karnataka

ABSTRACT

The world is moving rapidly towards establishing industry 4.0 in every field. The concept of industry 4.0 is to replace humans with Robots or Software bots to perform repetitive tasks and tasks that require high amount of accuracy and speed. Industry 4.0 is achieved by connecting various machines that can communicate with each other to collect and analyze tremendous amounts of data. These machines are connected to large number of high precision sensors and actuators that can help to monitor, operate and manage various industrial processes in real time. The use of machine learning and artificial intelligence has enabled machines automate various processes that required manual labor and also to make accurate decisions without the need of any human intervention. Image Processing is a major component of Industry 4.0. The main objective of this paper is to understand the concept of image processing, its application in the industry and to build simple Machine Vision (MV) solution that uses image processing algorithms to detect an object irrespective of its orientation.

Keywords: *Industry 4.0, Industrial Image Processing, Open CV, Machine Vision, Feature matching*

1. INTRODUCTION

Image Processing is a method of converting an image into its digital form. It runs various algorithms on the image so as to extract relevant/useful information. To understand image processing we need to first understand what constitutes an image. An image is made up of a set of pixels. A pixel is a point on the image that has a specific color, shade or opacity. The number of pixels defines the dimension of the image. A pixel are represented majorly in 3 forms : Grayscale, RGB , RGBA.

Image processing algorithms executes a sequence of instructions on each of the pixel in the image. The output of the algorithm maybe an image or certain features/characteristics of the image. There are two methods in image processing – analogue image processing and digital image processing. Analogue image processing algorithms are applied on analogue signals and works only for two dimensional signals. It is a slower and a much costlier process. Since analogue signals are real world signals the quality of the images are very poor. Analogue signal are continuous and cannot not be broken into smaller bits/pieces. Examples of analogue image processing are television images, medical images in scanning reports, photographs, etc. Whereas digital image processing algorithms are applied to digital signals that help analyze, extract data and manipulate input images .It is a cheaper, better and faster method to process images. It uses various image compression techniques which improve the quality of images produced. Example of digital image processing are color processing, image recognition, video processing etc.

The main purpose of image processing is divided into groups :

- **Image Recognition:** Image processing algorithms are used to differentiate objects in a given image. Algorithms are trained with a reference image and then executed on a test image. The output will be the location of the object trained if present in the test image
- **Object/Pattern Measurement:** Image processing algorithms are used to measure the dimensions of a given object. Algorithms are pre trained with standard

measurements for parameters such as length, height, width, diameter, etc. When executed on test images, the algorithm will produce the accurate measurement of the object in the test image as the output

- **Image Restoration:** If the input image contains of noise or is damaged or detect at places. Image processing algorithms use various noise removal techniques and help to reconstruct the defected parts of the input image. Hence the output image will be a noiseless and defect less image.
- **Image Retrieval:** Image processing algorithms are used to seek a image of interest from the input/test image. The output of the algorithm will be the location of the desired image in the test image.
- **Object Visualization:** Image processing algorithms are used for visualizing and dinging objects that are difficult to detect by human naked eye.

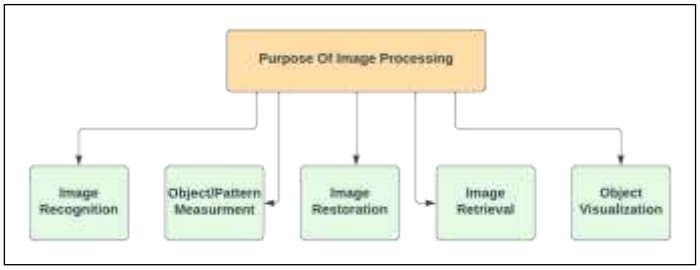

Fig 1.1 Purpose Of Image Processing

This paper focuses mainly on digital image processing techniques and its uses in the industry. It throws light on how digital image processing has revolutionized various automation processes around the globe. It also describes the role played by image processing in Industry 4.0. The paper also contains methodology and results of a project developed to detect the presence of an object irrespective of its orientation.

2. DIGITAL IMAGE PROCESSING SYSTEM

Digital Image Processing is the process of manipulating digital images to obtain a desired output image or information from the given digital image. A digital image processing system basically consists of the following components:

- Image Sensors
- Suitable Hardware for Image Acquisition
- Computer
- Software for Image Processing
- Image Display
- Mass Storage

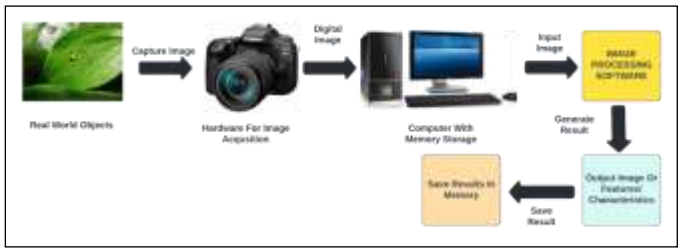

Fig 2.1 Components of Digital Image Processing System

The source of digital images is the real world objects around us. Image sensors are hardware used to capture images of these real world objects. The hardware required for image acquisition mostly consists of lenses and cameras. They provide mechanisms such as zoom in, zoom out, focus etc. This helps the user to easily locate and capture image within their region of interest. The output of the hardware is a digital image. This digital image is then transferred to a computer via either Ethernet, Bluetooth or is manually transferred using a pen drive. This digital image acts as an input image to the Image processing software that runs on the computer. Image processing software performs various algorithms such as image recognition, object recognition, pattern matching, feature matching, measurement etc. It then produces a suitable output depending on the function selected by the user. The output maybe an image or specific features/characters of the input image.

3. ROLE OF IMAGE PROCESSING IN INDUSTRY 4.0

Industrial Image processing is mostly based on the use of different types of vision cameras along the production line for inspection of components during various stages of manufacturing. For example, for inspection of raw materials during the start of the manufacturing process to final inspection of quality of the end products. The main two main components of imaging systems used in production line are high precision vision cameras and a computer with high processing capacity. Each camera is configured and trained for a specific application with the help of computer based software. The other accessories for industrial image processing are sensors which trigger the camera, stand for camera mounting and railing for moving the cameras.

Industrial image processing helps in real time monitoring of various manufacturing processes. The high speed processing of these imaging systems can capture images of moving parts with high accuracy. They guarantee high precision results. These industrial machine vision cameras can be mounted at areas that are not accessible for people or environments with extreme temperatures or which are toxic.

Industry 4.0 is referred to as the fourth industrial revolution. The main objective of Industry 4.0 is to increase the use of automation, smart machines and data acquisition units to convert factories into smart factories. Collecting and analyzing real time data helps to get insights of manufacturing processes at different stages. By collecting data from the factory shop floor and combining it with other operational data of the enterprise makes decision making an easier task. This helps to manufacture goods/products with high efficiency, reduces the time and cost of production. The introduction of automation in manufacturing processes has increased the flexibility which helps manufacturers meet demands of their customers.

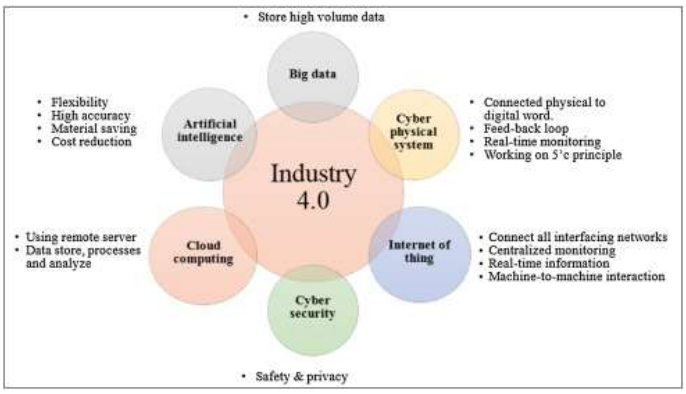

Fig 3.1 Basic Block Diagram Of Industry 4.0

Industrial Image Processing systems play a major role in enhancing the performance of smart factories. Industries that use imaging systems are Manufacturing, Medical, Automobile, Defense and security, Robotics, Agriculture etc. With the advancement of technology, imaging systems are much easier to develop since machine vision cameras are not costly. Below is a

block diagram of machine vision cameras being used to detect and inspect parts on a conveyor.

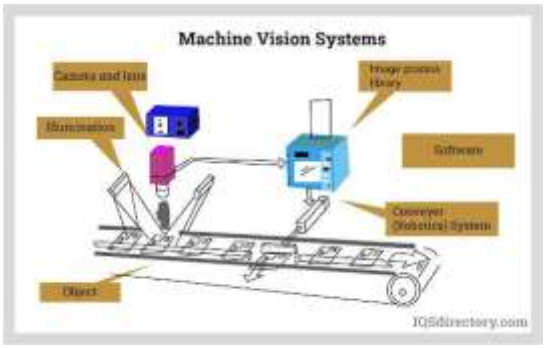

Fig 3.2 Industrial Machine Vision System

A simple example of use of image processing systems in industries is automated spraying systems that are used to coat newly produced metal parts. A normal robotic system without machine vision can be programmed for painting movements. But a robotic system does not have the intelligence to check whether the part is coated correctly after executing the pre-defined sequence of steps. This might lead to production of metal parts with improper paint coating. Whereas when an industrial camera is introduced to this system, the algorithms are developed to make high precision measurements of the component to be sprayed. They can be used to monitor and inspect the spraying process as the robotic arm is moving around the component. This helps to give a real time feedback which can be used to change the sequence of painting or the quality of spray to get the best painting results. This system can eventually become a self-learning system. This shows that introducing a simple imaging system will reduce defects in parts, enhances productivity and to obtain high quality end products. Industrial cameras thus play a significant role as they provide tireless method for auditing the color, structure, shape, length, width, diameter and other geometric properties of work pieces irrespective of its size. They are used for auditing components for correctness as they pass through various stages of manufacturing. They are used to overcome or reduce human errors and therefore increase the efficiency, accuracy and speed of the process.

Some of the most common applications of industrial image processing are: predictive maintenance, packing inspection, quality inspection, defect detection, component assembly, tracking and tracing of components, optical character recognition, barcode reading, 3D vision inspection, quality inspection etc. This shows that Industrial Image Processing plays a major role in contributing to the growth and development of Industry 4.0.

4. PROPOSED SYSTEM

The main objective of the project is to develop image processing software using Open CV and Visual Studio to detect a trained object in a test image irrespective of its orientation.

The system is implemented by using the feature matching algorithm. Feature detection is the process of extracting important features of an image that is used to identify the image. Image features include edges, corners, ridges and blobs. Feature Detection can be implemented using different methods such as:

- Harris Corner Detection
- Shi Tomasi Corner Detection
- SIFT (Scale – Invariant Feature Transform)
- Fast Algorithm for corner detection
- ORB (Oriented Fast and Rotated Brief)

In this project we will be implementing feature detection using ORB algorithm. ORB is built on two major components: FAST key point detector and BRIEF descriptor. The FAST key point detector helps to extract important and unique key points from the image. This output is then given as an input to BRIEF descriptor. The BRIEF descriptor converts key points found by FAST in relevant information.

The developed image processing software has the following sequence of operation. It is a desktop based application and hence needs a computer to run the software. When the Software is opened, the user needs to select the source of training image. This can be done by uploading the desired image by using the UPLOAD IMAGE button. Once the training image is uploaded, the user can choose the region of interest and press SAVE . This will save the ROI as the reference image. Now The User can proceed to upload a test image. The test image may or may not contain the object trained in the reference image. To run the algorithm the user has to press the button START TEST. This will call the image processing algorithm as a subroutine and the output will be the test image along with a box shape that will indicate the location of the reference object if it is present in the test image.

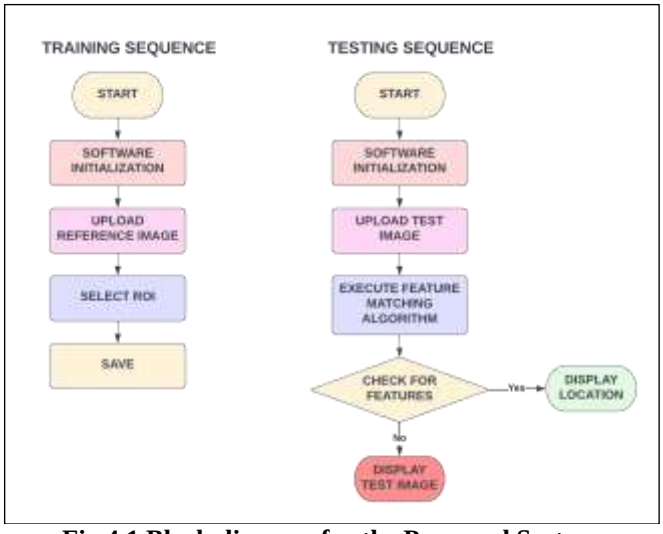

Fig 4.1 Block diagram for the Proposed System

5. IMPLEMENTATION AND RESULTS

5.1 Training Sequence

In this test case, we train the algorithm to detect the Big End Bore of a Connecting rod, irrespective of its orientation.

Step 1: Open Landing Page

Fig 5.1.1 Landing Page of Image Processing Software

Step 2: Upload a Reference Image

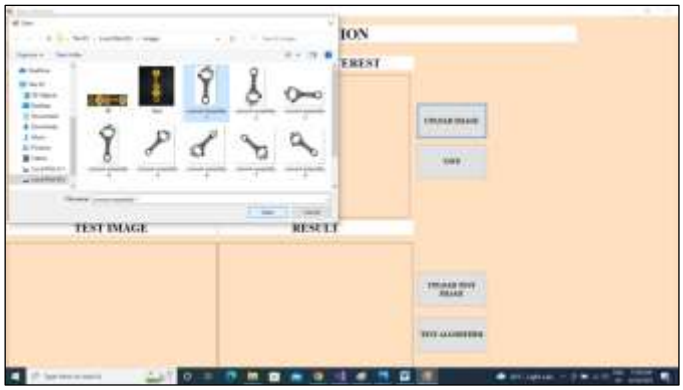

Fig 5.1.2 Uploading a Reference Image

Fig 5.1.3 The Reference Image on the screen after selection

Step 3: Choose Region of Interest

Fig 5.1.4 Choosing Region of Interest

Step 4 : Save ROI as Reference Image

Fig 5.1.5 Saving Reference Image

5.2 Testing Sequence

During the testing sequence we check the correctness of the algorithm by rotating the connecting rod in different angles .The algorithm successfully detected the ROI irrespective of its orientation. The Results are as below

5.2.1 Test Case 1 – With 0 degree Rotation

Fig 5.2.1 Test Case 1 Result

5.2.2 Test Case 2 – With 90 degree Rotation

Fig 5.2.2 Test Case 2 Result

5.2.3 Test Case 3 – With 180 degree Rotation

Fig 5.2.3 Test Case 3 Result

5.2.4 Test Case 4 – With 270 degree Rotation

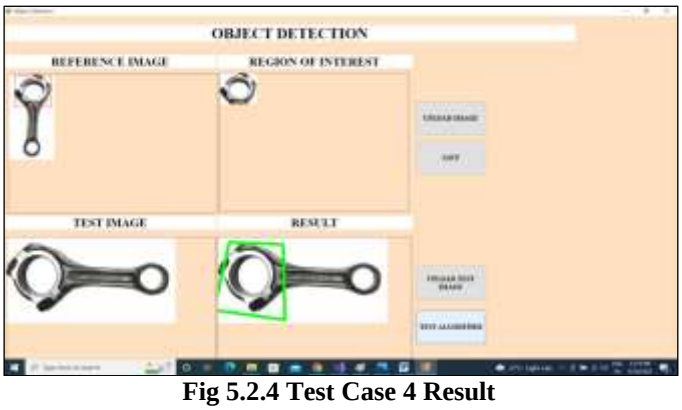

Fig 5.2.4 Test Case 4 Result

6. CONCLUSION

Industrial image processing systems helps to greatly enhance various manufacturing processes. It helps to build new and more cost effective business models. As the world is moving towards Industry 4.0, Industrial image processing systems have a great scope in future. Integration of these imaging systems along with various machines will soon replace humans to give high speed and accurate outputs. Human errors can be completely eliminated. Enterprises and organization can use their human workforce for more complex operations. This will help to increase the productivity and efficiency of the organization. It will also reduce labor costs. We will very soon see fully automated production lines working without the need of any human intervention.

The project developed is simple image processing software that is used to detect the presence of an object or a particular feature of it irrespective of its orientation. The software has been implemented and tested. It is verified that the software gives accurate results for all test cases. The future scope of work is to develop low cost image processing solutions that will help automate processes in small and medium scale industries.

7. REFERENCES

[1] Fault Detection of Mechanical Components Using Image Processing by Aiswarya Kannan and S V Sathish Kumar – JAN 2021 |IRE JOURNALS|Volume 4 Issue 7|ISSN : 2456-8880

[2] Image Processing Based Fault Detection and Isolation for Mechanical Components by C Bharathi Priya and V.Sudha – IJEAT | ISSN : 2249 – 8958 | Volume 8 Issue 6S |August 2019

[3] Using Deep Learning to Detect Defects in Manufacturing : A Comprehensive Survey and Current Challenges

[4] The Detection of Spoiled Fruits on a Conveyor Belt Using Image Processing Techniques and OPC Server Software – IJCESEN | ISSN : 2149 – 9144 | Volume 4 No 1

[5] Amol Dhenge, Pallavi Keskar, “Computer Vision Based Object Sorting & Fault Detection Using Ann”, IFERP, volume 1, Issue 5, April 2015

