Machine Vision for Bearing Orientation Detection

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Abstract- **Software for object detection is a low-cost, highly accurate measurement method that is frequently used in assembly lines. Production facilities are prepared to access big production numbers without faults thanks to these systems' provision of control and balance without touch. The camera may be used to do computer vision tasks like size measuring, error control, and product computation. This paper suggests a computer vision application that could find a distinct object. The suggested approach allows for automatic calculation regardless of product type or color and is based on Binary thresholding and Hough transformation. In essence, the system uses a single camera to capture photos of the objects moving through the conveyor. These images are then processed using a variety of image processing methods, such as image thresholding to apply filters and Hough circle transform to identify circles. In this manner, a real-time computer vision program was developed to determine the shape and orientation of the Industrial Bearing. The main aim of this proposed system is to minimize the use of sensors in the CNC manufacturing industry.**

Index Terms: Computer Vision, Industrial Automation, YOLO, Image Processing, Bearing.

I.INTRODUCTION

One of the fundamental issues with computer vision is object detection. Computer vision tasks form the idea of many other downstream, tasks. Specific object detection applications include object counting, Industrial Object detection. Object discovery could be a computer-aided detection method that identifies and detects objects within a picture or video. Specifically, the invention of an object draws the binding boxes next to those finds, which allows us to work out where the said objects are located (or how they move) in an exceedingly particular area. Object discovery is commonly confused with image recognition, so before we continue further, it's important to clarify the differences between Object discovery and image recognition. Image recognition provides a label on the image. The model predicts where each item is and which label should be applied. Thus, the invention of an object provides more information about the image than the visual. Object count is that the count of the quantity of events during a single image or video sequence. Especially in high-speed production systems, it's very difficult to create measurements without employing a computer vision. Therefore, it is essential to use machine vision systems. In this investigation, a camera was used to capture images of products moving via a conveyor. The background was created for this investigation, and moving things were located. Then, a test performed whether the object is passed or not in a certain place, and a calculation process is performed. For this project, we mainly use python modules PyTorch, a machine learning framework for data flow planning across a large range of tasks. OpenCV, an open-source computer vision library, machine learning, and image processing. Primarily, one camera is employed within the arrangement. With this camera, video streaming of products is captured which passes through the conveyor and various image processing methods are used on these images and fed to the ML model. Based on the predictions from the ML model decision is made.

A. EXISTING VS. PROPOSED SYSTEM

- Currently in the CNC Machines, sensor are used to determine the position and orientation of an object but traditional sensor systems have the problem of increasing the complexity of the system, the proposed system will replace these sensors with a single camera hence reducing the complexity of the system.
- Sensors cannot determine the position and orientation when the object structure is similar this problem can be solved using computer vision with the help of machine learning.

- Traditional sensor system requires monitoring sensors periodically to ensure proper operation of the system, through our project this can be eliminated and maintenance cost can be reduced.
- Centralized control and monitoring can be achieved through our project, but in traditional sensor systems centralized monitoring is difficult.
- Using single camera, we can perform multiple tasks which requires multiple sensors in the traditional sensor systems.
- Human intervention is not required, hence accuracy of the overall system can be improved when compared to traditional sensor systems.

B.DISADVANTAGES OF EXISTING SYSTEM

- High Maintenance Cost
- Manual Control
- Increased System Complexity

II.METHODOLOGY

A. BLOCK DIAGRAM

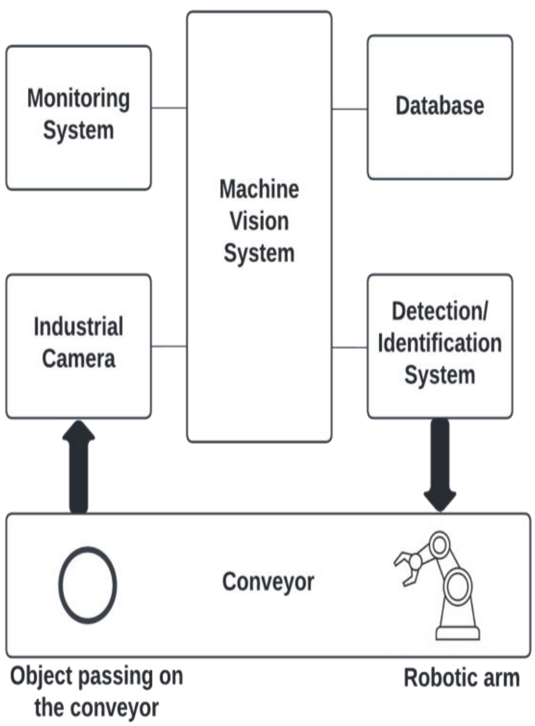


Fig 1. Block diagram

- The creation of a computer vision system that can do tasks automatically without requiring human input in industrial production units. A robotic device with an RGB camera installed on it is able to safely move on its own basis based on its perception of the environment. If the object is in the proper position and the orientation of the object is correct, the robot will pick up the object (a bearing) and send it to the next production level; if not, the robot will reject it. The camera captures the image of the object (a bearing), then processes it at the computer using computer vision and checks for the object's position.
- Monitoring System: It is used to monitor the system resources and various aspects of the system and processes the raw information generated by machines. Basically, it is an industrial computer in which the Desktop application is installed and through this application, the user can control and monitor the system.
- Database: It stores the information generated by the system for future reference. The database used in this project is SQLite which is a serverless database and suitable for applications running locally on the system. Report can be generated using the data in this database file from the application.
- Algorithm: With the help of neural networks, the YOLO - You Only Look Once - algorithm provides real-time object recognition and image classification.

These 3 methods are essential to the YOLO algorithm.

1. Residual Blocks.
2. Bounding Box Regression.
3. Intersection over Union

These techniques combined will produce final object detection results. We are implementing the YOLOv5 algorithm to train the model on our own custom dataset. There are 5 pre-trained models which are trained on COCO dataset, those are YOLOv5n, YOLOv5s, YOLOv5m, YOLOv5l, and YOLOv5x. We are using YOLOv5s model to continue training on our custom dataset which is suitable for devices having low computing capabilities, since it requires less computational resources.

III.RESULTS AND DISSCUSSIONS

A. FLOW CHART

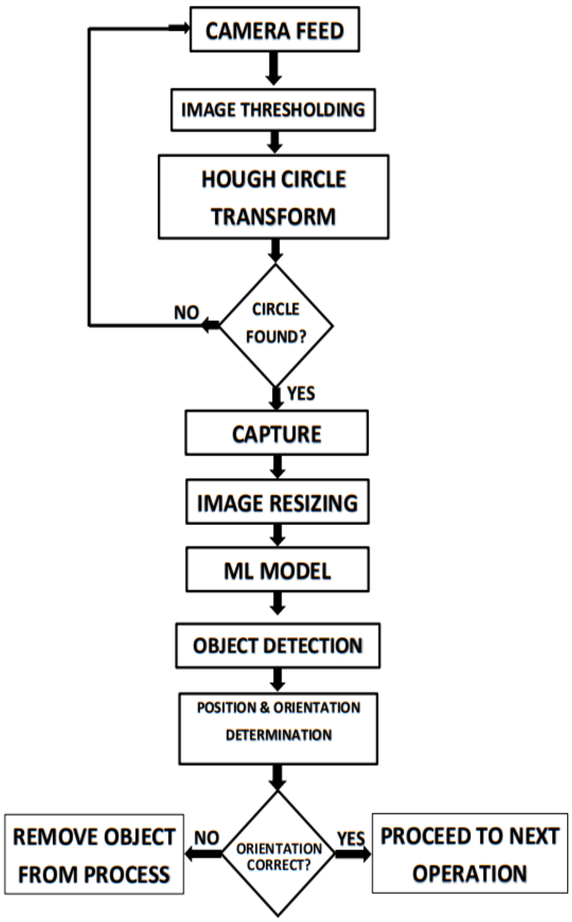


Fig 2. Flow Chart

The above flow chart shows the steps involved in the Process.

Step 1- Camera Feed: The device's live camera can be used to locate objects in the area using a camera. The live camera feed can be used to identify objects in the physical area. The live camera acquisition feature uses both existing Material Design components and new features related to camera interaction. Then captures the images of the bearing and feeds to the next process which is image processing.

Step 2- Image Processing: An image is converted into a digital format during image processing, which also carries out certain tasks to gather specific important data. When using preset signal processing techniques, the image processing system typically interprets all images as 2D signals. The primary categories of image processing are five, those are: 1. Visualization: Recognize intangible elements in a picture. 2. Object separation or location in the image 3. Sharpening and Restoring - From the original image, produce an upgraded version. 4. Pattern Visibility - Evaluate the different patterns surrounding the image's objects. 5. Retrieval - Look through and do searches on photos on a sizable digital photography site, like the original photo. The image processing gets images from the camera feed and then converts the images into the required form. Then feeds the image to ML model.

Step 3- Feeding image to ML Model A subset of artificial intelligence known as "machine learning" (ML) is the process through which computers learn to recognise patterns, or the capacity to constantly learn, make predictions based on data, and make changes without being explicitly programmed. Machine learning is significant because it helps with the development of new goods and gives organisations an understanding of patterns in business performance and customer behaviour. In many businesses, machine learning has emerged as a crucial competitive edge. The following step, object detection, is fed by the ML model.

Step 4- Object detection Object detection is a computer-aided detection method for detecting events in images or videos. To deliver relevant findings, acquisition algorithms frequently advise machine learning or in-depth reading. People may instantly view and learn about their favourite items when they watch images or movies. The purpose of object acquisition is to automate the replication of this intelligence. Object detection is a computer diagnostic problem. Although closely related to image editing, object acquisition enables image classification. Object discovery both finds and separates objects within images. Acquisition models typically trained using in-depth learning and emotional networks.

Step 5- Position and Shape Determination Position and shape determination is used to identify the position of the object which is present under the camera feed. The position and shape of the object will be compared with the images that were annotated before. After the comparison of the images then they determine the position and shape of the object. This is the actual main process in our project. If the orientation is correct then it is sent to the next process. If the orientation is wrong then it is not sent to the next process, it is removed from the process.

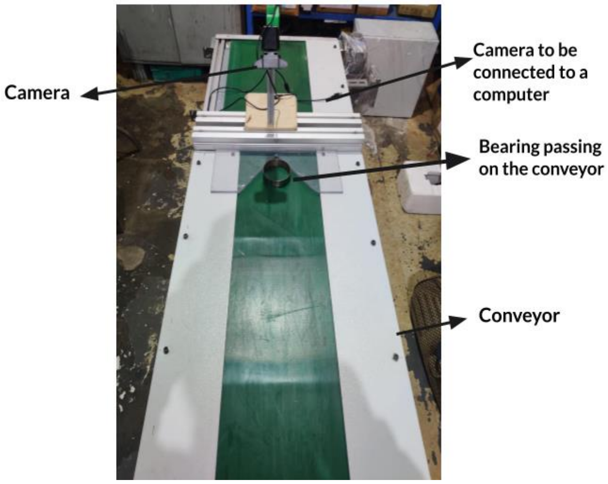
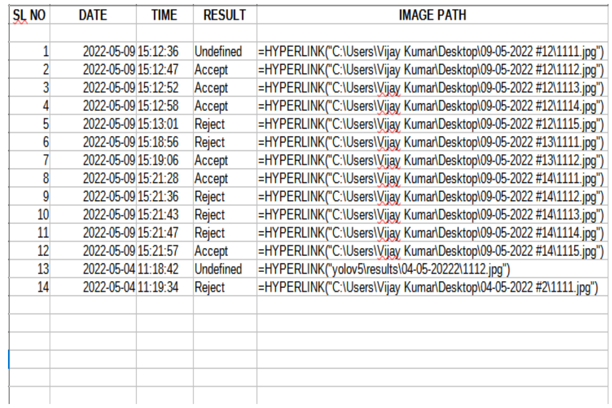


Fig 3. Overview of the proposed system

B. USER INTERFACE

Fig 4. User Interface

The above figure shows the UI of our Desktop Application built using PyQT5. In this UI we are able to see the camera feed in real time. The indicator shows us the indication of the bearing's orientation. If the orientation of the bearing is right then the indication is going to be in green color, if the orientation of the bearing is wrong then the indication is going to be in red color. Just in case the other thing apart from the bearing is present it shows the black color indication. The check button is for operating the system manually. Aside from the indicator we've got the count of the accepted and rejected items also which show the total no of items in real-time. On clicking the view results button the system open the folder where the result images are stored. We can decide the path where result images should be stored using choose output folder butto.



SL NO	DATE	TIME	RESULT	IMAGE PATH
1	2022-05-09	15:12:36	Undefined	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #12\1111.jpg")
2	2022-05-09	15:12:47	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #12\1112.jpg")
3	2022-05-09	15:12:52	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #12\1113.jpg")
4	2022-05-09	15:12:58	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #12\1114.jpg")
5	2022-05-09	15:13:01	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #12\1115.jpg")
6	2022-05-09	15:18:56	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #13\1111.jpg")
7	2022-05-09	15:19:06	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #13\1112.jpg")
8	2022-05-09	15:21:28	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #14\1111.jpg")
9	2022-05-09	15:21:36	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #14\1112.jpg")
10	2022-05-09	15:21:43	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #14\1113.jpg")
11	2022-05-09	15:21:47	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #14\1114.jpg")
12	2022-05-09	15:21:57	Accept	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\09-05-2022 #14\1115.jpg")
13	2022-05-04	11:18:42	Undefined	=HYPERLINK("yolov5\results\04-05-20222\1112.jpg")
14	2022-05-04	11:19:34	Reject	=HYPERLINK("C:\Users\Vijay Kumar\Desktop\04-05-2022 #2\1111.jpg")

Fig 5. Report Sheet

This is how the get report looks: the get report button takes us to the report sheet in which we can find all details with time, date, time, images link and the result of those images. The view results button takes us to the images captured by the camera in real-time. Select the output folder is used to select folder in which we want save the data

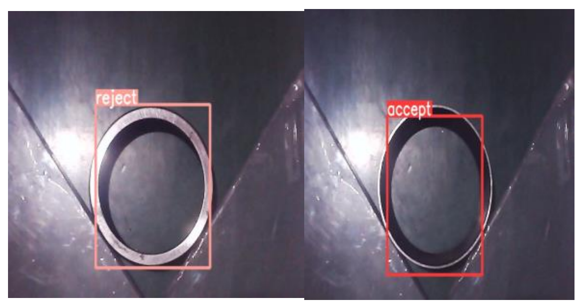


Fig 6. Result Images

Model Parameters after Training:

- Yolov5s model has been trained on our custom dataset having 600 images which is divided into
  - 69% (753 images) into training set.
  - 20% (218 images) into validation set.
  - 11% (119 images) into testing set.

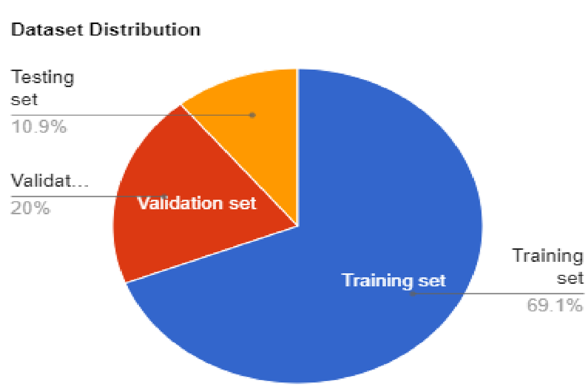


Fig 7. Dataset Distribution

- The images in Dataset have two labels accept and reject.
- The size of the ML model is ~14mb.
- Accuracy of model after training when compared with validation set having 218 images was 99.2%.
- The below table shows the accuracy for each labels.

Class	Images	Labels	Accuracy
all	218	218	99.2
accept	111	111	99.3
reject	107	107	99.2

Table 1: Validation Accuracy

REFERENCE

[1] "Learning to Count Objects with Few Exemplar Annotations," - Jianfeng Wang, Rong Xiao Yandong Guo and Lei Zhang, 14th European Conference, Amsterdam, The Netherlands, October 11-14, 2016, Proceedings, Part III. (2016) 785–8001

[2] "An Image Processing based Object Counting Approach for Machine Vision Application," - Mehmet BAYGIN, Mehmet KARAKOSE, Alisan SARIMADEN, and Erhan AKIN, International Conference on Advances and Innovations in Engineering

[3] "An Image Processing based Object Counting Approach for Machine Vision Application," - Mehmet BAYGIN, Mehmet KARAKOSE, Alisan SARIMADEN, and Erhan AKIN, International Conference on Advances and Innovations in Engineering.

[4] "Review of hough transform for line detection In Real-Time Detection of Lines and Grids," – A. Herout, M. Dubská, and J. Havel, Springer London, pp. 3-16.

[5] "Counting objects in an image by marker controlled watershed segmentation and thresholding," - S. Rahman, and R. Islam, IEEE 3rd International Advance Computing Conference (IACC), Ghaziabad, India, 2013, pp. 1251-1256.

[6] "Automatic detection and counting of circular shaped overlapped objects using circular hough transform and contour detection," - J. Ni, Z. Khan, S. Wang, K. Wang, and S. K. Haider, 12th World Congress on Intelligent Control and Automation (WCICA), Guilin, China, 2016, pp. 2902-2906.

[7] "YOLO9000: better, faster, stronger. In: 2017 IEEE Conference on Computer Vision and Pattern Recognition" - Redmon, J, Farhadi, CVPR 2017, Honolulu, HI, USA, July 21-26, 2017. (2017) 6517–6525.

[8] "A large contextual dataset for classification, detection and counting of cars with deep learning. In: Computer Vision" - Mundhenk, T.N., Konjevod, G., Sakla, W.A., and Boakye, K., 14th European Conference, Amsterdam, The Netherlands, October 11-14, 2016, Proceedings, Part III. (2016) 785–800.