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Adaptive Object Fault Detection using Computer Vision

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Abstract - *The aim of the project was to detect faults in objects such as nuts and bolts so that faulty objects are screened after the manufacturing process is complete. More specifically, whether the outgoing bolts and nuts from an assembly line were threaded was to be determined. Two major approaches were attempted. The first was to use traditional methods of image processing and object detection to segment the object. Thread counting was then performed. The frameworks used were MATLAB 2018b as well as Python 3.0. As another approach, the solution was sought using machine learning techniques. The results of the first method are currently available. Nut and bolt thread counting has been performed on static images. Later, video input was successfully taken and the results of thread counting were found to be accurate.*

***Key Words*: Object Detection, Machine Learning, Fault Detection, Thread Counting, Artificial Intelligence.**

1.INTRODUCTION

Due to increasing demands manufacturers are complied to increase their manufacturing quantity as well as quality. Quality control systems help to achieve these goals. Due to some unavoidable reasons expectations are not met to the requirements. Screw threads are work pieces where accuracy of the parameters has an important effect on their performance.

Some bolts and nuts pass through the process with faulty parameters. The faulty parameters may include errors like partially threaded screws and nuts or completely unthreaded screws and nuts. This paper focuses on identifying the faulty pieces using computer vision algorithm. So, the threads on the nuts and bolts are counted and if the value is less than a particular threshold, the piece is termed as faulty. The nuts and bolts come in a particular fashion as desired by the mechanism, gets scanned by the camera, then gets analyzed and finally the result is passed out.

Machine learning is being used since last couple of decades in almost every minute possibilities. Be it automobile industry, healthcare, robotics, consulting, gameplay, etc. It has also expanded its roots in the computer vision domain. Using machine learning one can train the model to detect a particular object of the choice. Object detection involves detecting region of interest of object from the desired class. The different methods are frame differencing, optical flow, background subtraction[1].

2. RELATEDWORK

2.1 Machine Learning Approaches

Machine learning is one of the approach practiced in this project. Machine learning starts from object detection of nuts and bolts of which threads are to be characterized. The location of the bolts and nuts would be determined by the trained algorithm and then the rest algorithm can work only on the specified location so as to speed up the process.

1. YOLO object detection: YOLO stands for "you look only once". Method like R-CNN and its variations are slower as they use a pipeline to perform the task. So in YOLO each input image is broken down into SxS grid and it predicts where does the object fall in the grid. Each grid cell predicts the B bounding boxes and its C probabilities of object being in the grid. There are a total of 5 components of box predictions, so total number of predictions become SxSxBx5. So it requires a powerful processing capabilities of the machine as well.
2. Acquiring the dataset: The huge dataset required for the training can be simply be obtained by using a software called as "Bulk Image Downloader" which can save thousands of concerned images from Google.
3. Annotating the dataset: Once the dataset is acquired one needs to annotate them, that is describe where the object of concern is present in the image. To do this tedious task, a software known as "BBoxLabelTool" can be used. It opens up multiple images in stack and then the annotation can be done easily. The BBox Label Tool creates the annotation which yolo is unable to process. The YOLO format is as follows: [category number] [object center in X] [object center in Y] [object width in X] [object width inY][2].

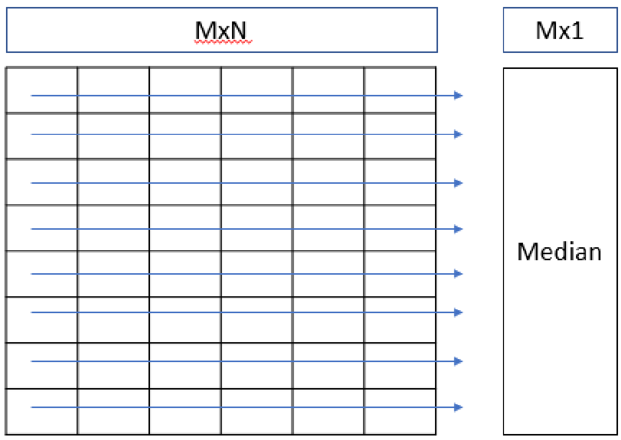

Fig -1: conversion of matrices from Mxn to Mx1

2.2 Traditional Computer Vision Approaches

In this approach, adaptive thresholding is used, so as to diminish the probability of error occurrence. Adaptive thresholding is basically used to avoid the error caused by different lighting conditions. Next the image is converted into a matrix form. This image is called as the reference image. The matrix form of this image is then manipulated with other test images, so as to align the images as per the reference image.
Now let us assume that the image is an MxN matrix with each entity being the intensity level of the image varying from 0-255. Now a row-wise median operation is carried out on all the M rows that is, the median value of each row is calculated and placed in a new matrix say M_new. So, the MxN matrix is converted into Mx1 matrix with each entity as the median of each row of the previous matrix.

In the final step, a transition is checked between each row of the M_new matrix. If the transition is above the threshold value we consider that there is a thread located and hence the counter is incremented.

3. RESULTS

The algorithm was implemented in Matlab. A simple graphical user interface is developed in which it is linked with the phone to use its camera. The mobile application used for camera here is IP webcam[3][4]. Firstly a sample image or the reference image needs to be given and then continuous clicks of the bolts or nuts can be taken. There is an option in the software to type in the IP address of the phone so as to link the camera with the software. There's also an option for the threshold adjustment according to the light conditions of the surrounding. The final thread count is displayed in the box as in the figure 2.

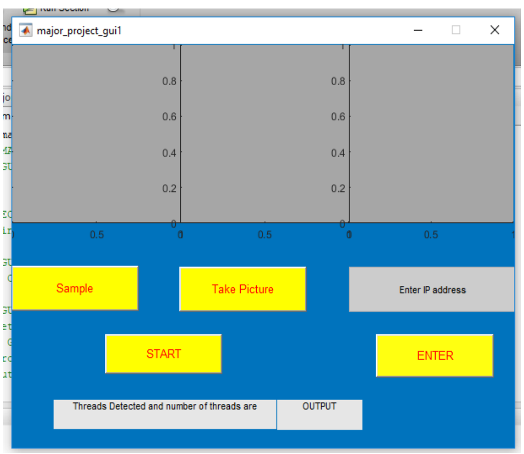

Fig -3: opening window of the software

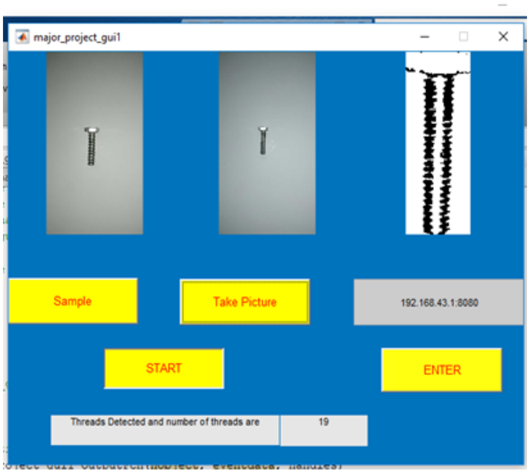

Fig -2: GUI of the software

4. CONCLUSIONS

In this project, a combination of image processing, graphical user interface, and machine learning is used. For appropriate and accurate results, the adjustment of adaptive threshold value is very much important. It decides if the automatic cropping of image would be accurate. The error of the software varies between $\pm$7-8%. But the error rate is acceptable as the only aim of the project is to check if the bolt or nut has threads at all or not.

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