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Detection of Component Assembly Error using Computer Vision: A Review

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Abstract*: Object recognition (OR) is a main capability needed by most AI vision systems. The most recent R&D on this domain has been gaining incredible ground in numerous ways. OR has a variety of uses. In this paper we talk about applications of OR system in manufacturing industry. In recent era scenario increased level of process automation in production industry also demands process automation of quality examination with lesser human intervention.

Keywords: Detection System, Object Extraction, Object Recognition, Object counting, Deep Learning, Computer vision, AI, Machine Learning.

I. INTRODUCTION

OR using deep learning algorithm and computer vision to work with images and video clips files is provide input to recognize the various types of articles. OR is an important task in image processing and AI vision.

Visual Inspection with AI

Machine Vision and Deep Learning algorithm are changing the domain of Automatic Inspection in production lines. AI is ending up being a distinct advantage, with countless applications in nearly every areas. The domain of Manufacturing, permitting it to tackle the intensity of deep learning algorithm and in doing so, giving automation solution that is rapid, low-cost and effective. Automated visual assessment used deep learning perspective, which can spare noteworthy time and exertion.

What is Visual Inspection?

It involves the review of the assembly line goods and components with the end aim of quality management. Visual inspection can also be used to assess the internal and external efficiency of the different manufacturing equipment such as hood, cabinet door, hydraulic unit as well as other machinery. It's a cycle that happens at daily periods of time, like every day. Visual inspection has been shown repeatedly, resulting in the discovery of most hidden defects during production.

When and where is Visual Inspection needed?

Although visual inspection is used for quality or defect evaluation in manufacturing, it can also well be used in non-production environments to decide if the highlights of a "mark" are usable and to avoid possible negative effects

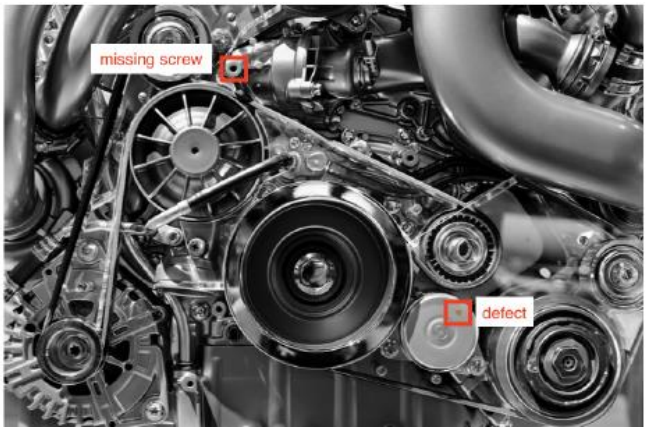

Fig. 1.Quality Fault analysis through object detection

Some areas where visual inspection is important.

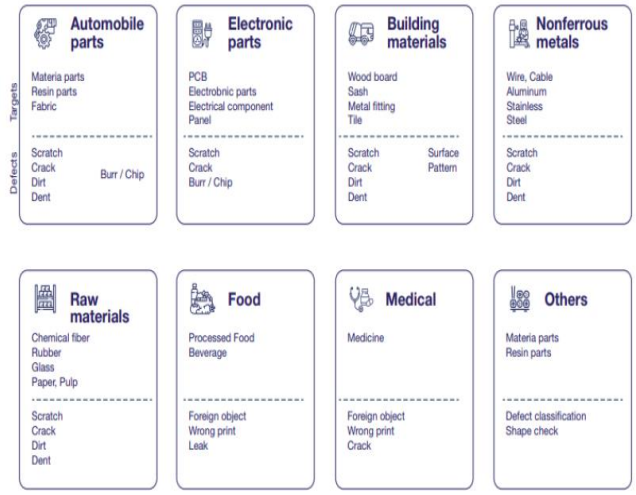

Fig. 2.Domains where visual inspection is important

Why not just stick to manual inspection?

Manual inspection involves a person to be present, an inspector who conducts an assessment of the object in question and passes judgement on it due to certain experience or prior expertise. Except for trained examiner's naked eye, no equipment is required. Visual inspection errors typically range from 20 to 30 percent according to research (Drury & Fox, 1975). Many imperfections may be related to human error, while others may be due to physical limits. Many errors can be reduced by preparation and practice, but cannot be eliminated entirely.

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A new age alternative

Automated visual inspection can address these problems by making the entire visual inspection procedure independent of any human involvement.

The use of automated systems generally exceeds manual inspection standards.

So what is Machine Vision then?

Computer vision is the technology and techniques used to include automated assessment and other applications based on images. Digital vision beats human vision in a standardized scene's quantitative and qualitative calculation due to speed, accuracy, and repeatability.

On a manufacturing line, computer vision machine scanning accurately and regularly inspects hundreds or thousands of objects per minute, far beyond human inspection capacities.

Machine Vision Application

Deep learning-based systems are better adapted for more complex visual inspections of nature: patterns that differ in a subtle yet tolerable manner. Deep learning is effective at fixing specific surface and aesthetic defects, such as scratches and dents on twisted, polished or shiny pieces.

Instructions to get started with Automated Visual Inspection

AVI generally doesn't require a lot of physical resources as far as preconditions are concerned. The resources needed to begin visual inspection can be split into hardware and software resources.

Hardware - Half of an AVI system's hardware consists of physical equipment such as a monitor, and optional equipment such as needed for grading or sorting, which will depend on process and automation process specifications.

Software- Half of an AVI system software requires advanced algorithms for image analysis, and huge programming. These algorithms process images in order to change their quality, find points of interest and areas, and eventually agree on the characteristics present in these image regions.

We are basically snapping a photo and analysing the image, a camera is all you need!

Fig. 3.Assembly area which need to inspect (M&M Assembly of part called 'X')

Contingent upon the business where it being use, the physical hardware can really be classified into three subsystems

Feeding system — Place pieces uniformly and shift them at a steady pace to grab frames of individual objects.

Optical system — Consists of a specially tailored source of light and a sensor (usually a digital camera). The optical machine takes images of examined objects so they can be analysed and analysed by the program.

Separation system — Removes defective items and/or grades

And separates products into several categories according to their quality condition and process requirement.

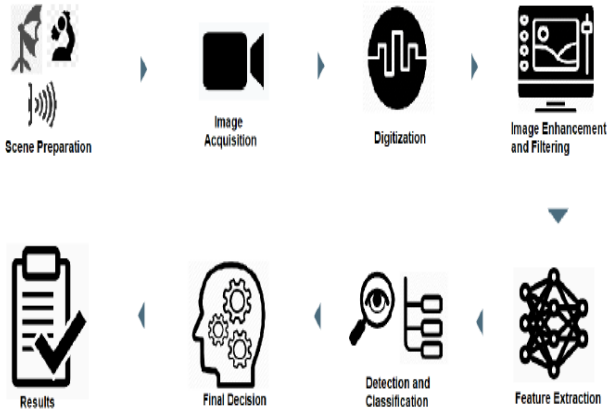

Fig. 4.Steps Involved in object detection

II. LITERATURE SURVEY

Development of a model that can perceive the dissent of showed concealing that make usage of open source equipment and that works on the reason of visual data got from a common webcam which has a sensible clarity.[1] This work help to make generalise model which detect common object and this can be used as basis knowledge block for Cobot development. Object detection system is key ability required for all most all computer vision system. Its play significant role in following day to day applications like optical character recognition, self-driving cars, tracking of objects, face detection and recognition, identity verification through iris code, object extraction from image or video, smile detection, activity recognition, pedestrian detection, digital watermarking, medical imaging, ball tracking in sports, object recognition as image search, robotics, automatic image annotation, ATR, object counting etc.[2] Process automation includes become a standard inside industry with cheap and easily available automation technology becoming turning into a standard choice accessible to manufacturing firms. Object recognition has challenges like shape matching, illumination, reflectivity, texture and orientation of a captured image to an existing image. [3] Mobility of person with upper limb disorder and constrained on power wheelchairs is empowered by robotic arms. Some users cannot explore all those potentialities of robotic arms due to their reduced manual skills. So we placed camera on robotic arm end effector, object get recognise with which user can interact by analysing video stream generated by camera. And such object shown to user with bounding box on HMI. User can select one of the object shown on HMI then desired action get performed by robotic arms with help of target position information with help of closed feedback algorithm. [4] The vast amount of the remote sensing data often poses a barrier to the identification of real time objects. To alleviate this issue, a high-performance computing approach was proposed to automate the study of SAR imagery using computational methods based on GPU.

[5] Effective software for automating CPU-based device production lines in an industry such that photographs of the production lines are collected and any discrepancies in their assembly are illuminated by the algorithm and knowledge regarding this is transmitted to the machine owner / operator through a network of cyber-physical cloud systems.[6]

III. PROPOSED WORK

Our objective was to detect the intricate parts (***X***) of the Mahindra & Mahindra tractor's ***(Y*** body assembly) if they are in the proper position or not, using Computer Vision (AI and Machine Learning). This detection helps safeguard and to ensure the hassle-free running of assembly line reducing time and human intervention.

This problem statement can be divided into two parts:

1. Detect the intricate part of the Mahindra tractor hydraulic body.
2. If it is present, then detect if it is in proper position or not

Scenario before solution

The parts to be detected lie in the very remote location of the tractor hydraulic body. And a person has to manually check whether the part is being placed properly in its position or not. If the part was not present in its position, the entire assembly line will be interrupted at final stages of assembly. Due to this, the entire hydraulic body was sent to re-work. Mahindra lost time and money because of this human intervention and many a time due to

Human errors the entire assembly line has to be stopped.

Proposed System

We proposed to use Computer vision to find the solution to this problem statement. A handheld device was made, which is named as Sentinal MV 001, to detect the parts and to check whether they are aligned in the proper position or not. This device consists of an industrial-grade camera, controller and LEDs. This device is connected to the computer via USB Amplifier cable to pass the real-time input and output.

Procedure

1. Data Collection and Analysis

We collected real-time images of the intricate parts (circlip) with various positions from the Mahindra and Mahindra hydraulic assembly line. A detailed data analysis has been performed on the data to extract the knowledge of important features from images.

2. Model Building and Training

After performing a detailed data analysis, more than ten thousand images were used to train the model. We use the YOLO algorithm for this specific task and customized it according to our problem statement. We performed a lot of permutation and combination in the fine-tuning of hyper parameters so as to get the maximum model accuracy or perfect prediction. After evaluating, the best performing model has been deployed in Mahindra and Mahindra as software on the computer. If the model detects the intricated parts in the proper position, the software will give output 1 or else 0, via computer's COM PORT.

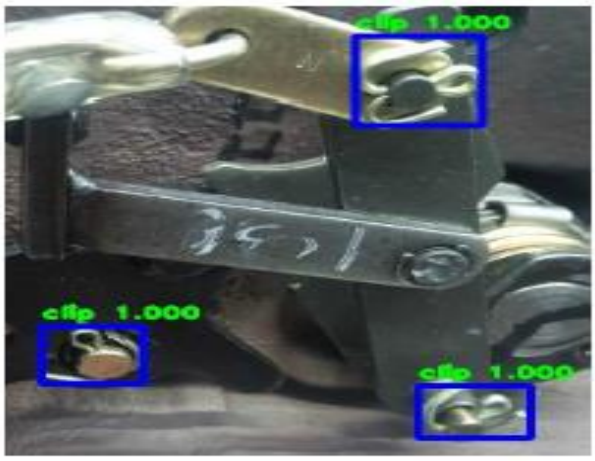

Fig. 5.Intrinsic part position and quantity detection with probability of presence.

3. Deployment

Here our objective was to show the status of OK or NOT OK. We use two different color LEDs as indicators. Red LED will show the intricate parts (pins/clips/object) are not detected/not OK. Green LED will show the intricate parts (pins/clips/object) are placed according to requirement. To show this indication we are getting inputs from computer/PC/Machine's COM PORT via serial communication at 9600 bits/sec Baud rate. When we get input as '0' we turn on red led and when we get '1' we turn on Green led. On getting signalling data '1', we turn on relay for a few seconds and then turn it off. One key is connected to send a signal to the computer to start the prediction process. It sends the character 's' to start the prediction process. 5 Volt coil-based relay is connected to sending a signal to the further connected

PLC/Machine/Relay/switching circuit. Relay load could be 240VAC up to 7Amp.

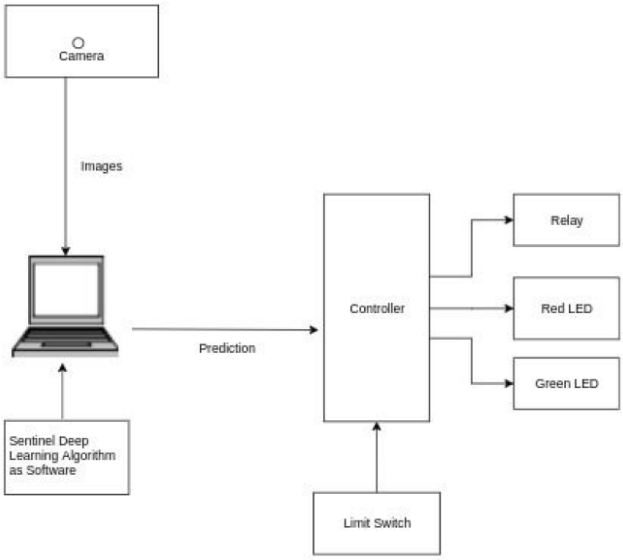

Fig. 6.Block Diagram of Proposed System.

IV. CONCLUSION

OR (Object recognition) techniques drastically improve the performance of quality assessment (detection of component assembly error) process by eliminating human lapses. Human lapses generated due to monotonousness of assessment procedure and huge product mix on conveyor line. Process health parameter like RPN no. define in PFMEA get improved(means get reduce) for process by using computer vision based error detection so no fault get forwarded from one station to next station. In this way quality of product get assured.

V. FUTURE SCOPE

Now this prototype is being develop for only 1 variant (of M&M Assembly of part called 'X') next phase we try to incorporate another 3-4 variant. This lead to total process automation for manual lapses found on assembly line. Which help to reduce activities RPN no in process FMEA. Challenges to do So- As various part has different geometrical specification so common gadget developing is difficult as viewing angle is different for different part, variant detection is not easy as no distinguishable different in assembly object so distance of gadget need to fix in case of use of dimension of part for type of variant detection.

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