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Visual Inspection for Industries

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Abstract: *The system is an AI-ML image recognition-based application that gives Quality Control and Quality Assurance functionality at the same time to the small-scale industries. The system continuously scans the product for any defects, anomalies, imperfections, damages, foreign substances, or any other non-standard qualities on the product. The system basically is a governing/supervising authority that keeps that fact in check that the standard procedures and standard quality has been maintained throughout the production. This system works automatically and there is little to no human input required. It is fully automatic and requires no human input. There are no chances of error that are very plausible in a human-assisted or human-moderated system. The system only requires regular maintenance from a well-trained technician and no further human input. The system is smart and gives warnings, can halt production when needed for the QA.*

Keywords: Machine learning, Image recognition, Industries, Assembly line, Image Recognition

I. Introduction

Over the past 20 years, automation in manufacturing has been transforming factory floors, the character of producing employment, and therefore the economics of the many manufacturing sectors. Today, we are on the cusp of a replacement automation era: rapid advances in robotics, AI, and machine learning are enabling machines to match or outperform humans in a range of labor activities, including ones requiring cognitive capabilities.

Industry executives those whose companies have already embraced automation, those that are just getting started, and people who haven't yet begun fully reckoning with the implications of this new automation age got to consider the subsequent three fundamental perspectives: what automation is making possible with current technology and is probably going to form possible because the technology continues to evolve; what factors besides technical feasibility to think about when making decisions about automation; and the way to start brooding about where and how much to automate so as to best capture value from automation over the long term.

The Visual Inspection systems that are available in India are expensive and are ranged from 60K-700K INR. A small scale company is unable to acquire such devices without spending huge chunk of their funds in the systems. Also after scaling up their production. There's a need for a system that will be able to handle the conveyer speed. Here are few of the companies that manufacture such systems in India. (Source: IndiaMart)

Infinity Automation Systems PVT LTD	5 lakhs
Rabro Systems	2 lakhs
Analte Control	3 lakhs
Nexgen Robotic Automation Private Limited	4 lakhs
Radheykrishna Technology	3 lakhs
Mayura Automation & Robotic Systems Pvt. Ltd	60k

(Source: IndiaMart)

II. Research Approach

2.1 Study of Algorithms for Object Detection

Various methods for image detection were being studied for the project. All of this was done in the pursuit of creating the most efficient model that'd work on lower end devices. Here are some of the algorithms that can be used for object detection:

1. Fast R-CNN
2. Faster R-CNN

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3. Histogram of Oriented Gradients (HOG)

4. Region-based Convolutional Neural Networks (R-CNN)
5. Region-based Fully Convolutional Network (R-FCN)
6. Single Shot Detector (SSD)
7. Spatial Pyramid Pooling (SPP-net)
8. YOLO (You Only Look Once)

We found that the best suited algorithm for our purpose is the CNN algorithm. To make it usable for mobile devices, we also used mobileNetV2.

2.2 Learning about CNN in Detail

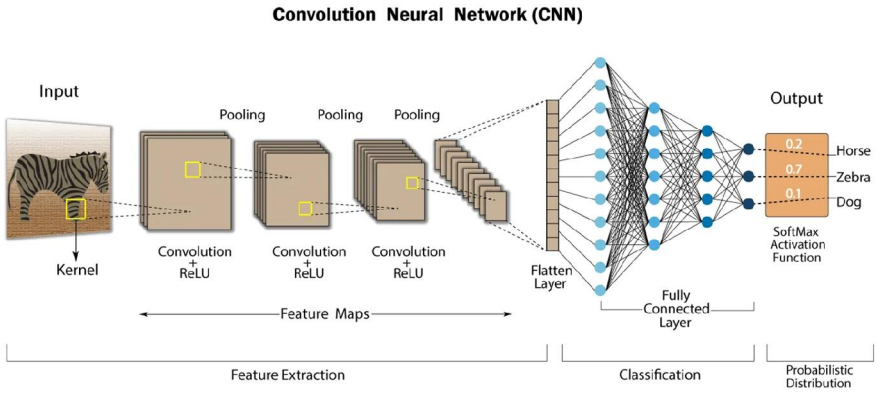

Figure: Convolutional Neural Networks (CNN)

CNN is different from other Neural Networks because of its hidden layers known as 'Convolutions'. The communications done by these convolutions are called as Convolution Operation. The convolutions try to imitate human neurons are responsible for recognising patterns, shapes and colors in an image recognition system.

III. METHODS

For the working visual inspection system, one has to choose a product. Any standard product can be chosen for the purpose. These are the steps taken further are as follows:

A. Collection of Data and taking Inference from the Trained Model

The data was collected using a camera. The photos were cleaned and made consistent for the algorithm to make a model out of it. The photos were classified into two distinct classes for the model to interpret on its own. A standard product was chosen as the subject. The subject was captured in its perfect form and the damaged form in order to make the data ready for model making.

B. Trial and Error Approach for the Accurate Model

The cleaned data is ran through the selected algorithms and the accuracy levels are noted down. The procedure is repeated till a suitable accuracy is obtained. This trial and error helped us get to the completion of the visual inspection system. This also concluded that the CNN works best for such projects

C. The Model is Tested with Real-Time Objects

A suitable object detection model is used for detection. One can use general purpose models available in Kaggle or make a specific model. The object detection model is ran to detect the object. The classification algorithm is then ran on the detected object. That is how the detected object can be classified into perfect or damaged.

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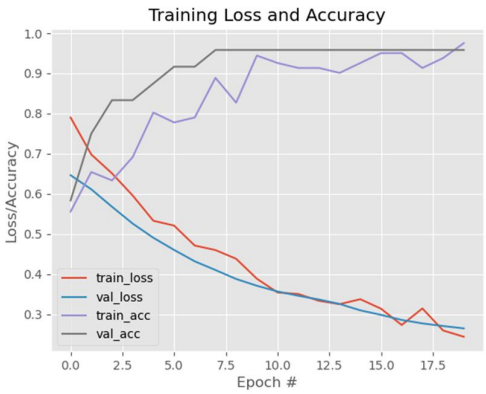

Figure: Training loss and Accuracy

IV. FINDINGS

The model was trained and the model wasn't accurate at first. Despite having 89% accuracy, the model was inaccurately producing results. We had to repeat the process until we made a model with 96% accuracy that was able to identify the objects accurately. Once the model was tested and found to be accurate, we could successfully identify the faulty objects on the assembly line.

V. CONCLUSION

The Project enables an assembly line to automate the inspection of manufactured products. It is scalable as well as can be programmed for multiple products. Automated technologies aren't only executing iterative tasks but also augmenting workforce capabilities significantly. In fact, automated machines are expected to exchange almost half the worldwide workforce. Multiple industries from banking to manufacturing, are adopting automation to drive productivity, safety, profitability, and quality. Automation will support connectivity and reliability in a hyper-competitive ecosystem. The future of automation looks hopeful where everything will be made easily available and accessible.

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