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Deep Learning for Automatic Vision-Based Recognition of Industrial Surface

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ABSTRACT: Some uncontrollable defects will occur on the surface of metal work pieces during processing. The existence of surface defects not only affects the appearance of the finished product, but also affects the quality to a certain extent. Surface defect detection of metal work pieces can effectively improve product quality and production efficiency, and is an important link in the process of product quality control. Although there are many different types of surface defect detection methods, in the actual production process, due to the characteristics of multiple types and irregular distribution of the surface defects of metal work pieces, in most cases, manual inspection or simple machine inspection is still used to detect the surface of metal work pieces. Defect inspections often lead to missed inspections and false inspections. The defect detection efficiency, accuracy and precision of metal work pieces still need to be further improved. This paper studies the method of detecting the surface defects of metal work pieces based on deep learning, provides the surface defect recognition accuracy and defect detection rate of metal work pieces, and provides references for the staff and scientific researchers engaged in metal work piece defect detection.

KEYWORDS: Artificial vision, auto-encoder, automatic recognition, feature attention mechanism, convolutional neural network, deep learning, explainable artificial intelligence, generative-adversarial network, industrial surface defects, transfer learning.

I. INTRODUCTION

With the continuous improvement of science and technology, the intelligent, automated, and unmanned manufacturing industry will be an inevitable trend in the future. China has also put forward the "Made in China 2025" strategy to become a powerful country in science and technology to realize the transformation from a manufacturing country to a manufacturing country [1]. As an important form of metal materials, metal workpieces are widely used in daily life and industrial production by virtue of their excellent mechanical and physical properties. In the production process of the product, due to the influence of equipment and technology, different kinds of defects often appear on the surface of the product, such as scratches, holes, and cracks in the metal workpiece [2]. The surface quality of metal workpieces not only affects the appearance and image of the product, but may also affect the functional characteristics of the product and cause significant losses to the enterprise [3]. Therefore, it is very necessary to detect the surface defects of the product, and it is particularly important to design a real-time and effective surface defect detection method for metal workpieces. Conventional non-destructive inspection methods for surface defects of metal workpieces include magnetic particle inspection, penetrant inspection, infrared thermal imaging inspection, ultrasonic inspection, visual inspection, etc. Machine vision inspection technology is constantly being used in inspections in various fields. Machine vision inspection mainly uses high-resolution industrial cameras to obtain images of specimens to be inspected, and uses digital image processing inspection algorithms to complete the inspection of defects [4]. The visual inspection is a non-contact inspection, and it will not cause any damage to the workpiece to be inspected during inspection. At the same

time, the visual inspection has a high degree of automation, which can be realized for a long time and work continuously and smoothly.

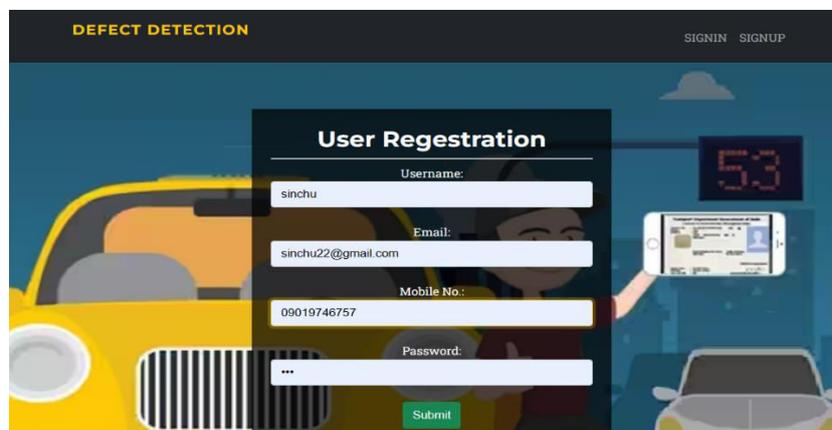
II. RELATED WORK

With the development of machine vision technology, researchers use image processing to detect screen defects of 3C products. Liu et al proposed an algorithm combining the line intercept as the threshold and particle swarm optimization, which solved the problem of low detection accuracy of mobile phone screen defects. Gao et al improved the median filter algorithm and utilized the image processing algorithm to preprocess the defective image. In addition, they proposed an image difference algorithm based on fast image matching for detection. Zhang et al posed an improved differential image detection method for mobile phone screen defects to improve detection efficiency and accuracy. However, the performance of pure image processing technology cannot achieve satisfactory detection results.

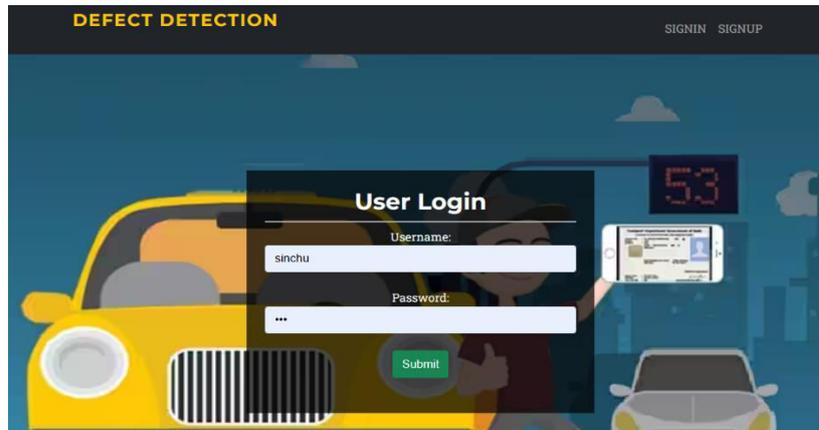
III. METHODOLOGY

A pre-processing procedure is performed to enable more accurate classification as well as ensuring the image resolution corresponds to the expected size of input images in the network. Image Processing for a more detailed description of the implemented image processing algorithm. Once processed, the image is transferred to a classification network which attempts to determine if the product is defective or not. The framework allows for easy exchange of the classification network to test how different approaches perform in the same conditions. Monolithic approaches, of which there are many architectures available for use, do not need any further design to function and can be implemented as soon as they have been trained. However, the implementation of a modular network requires additional steps, especially given how the very structure of modular networks can be tailored to specific use cases and specific sets of data.

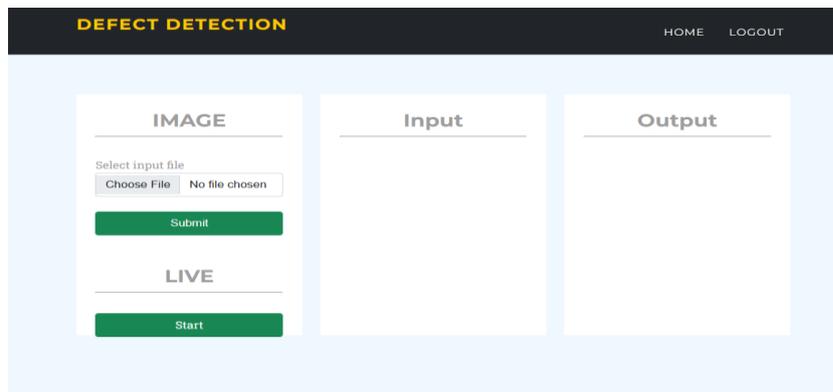
IV. EXPERIMENTAL RESULTS



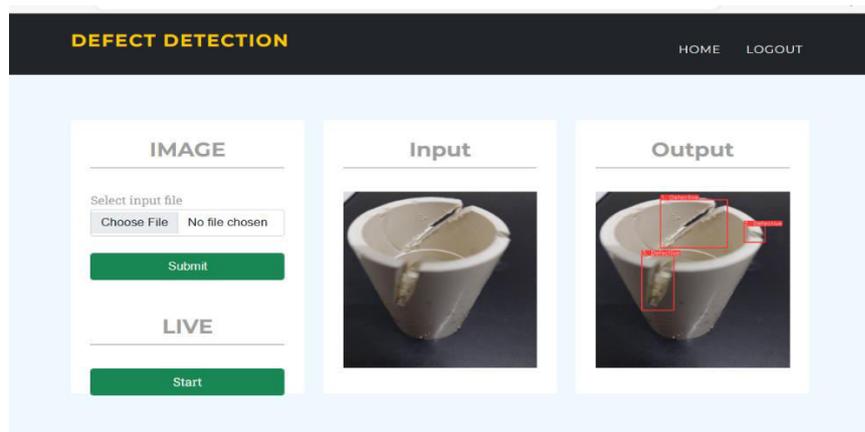
Fig(a): User Registration Page



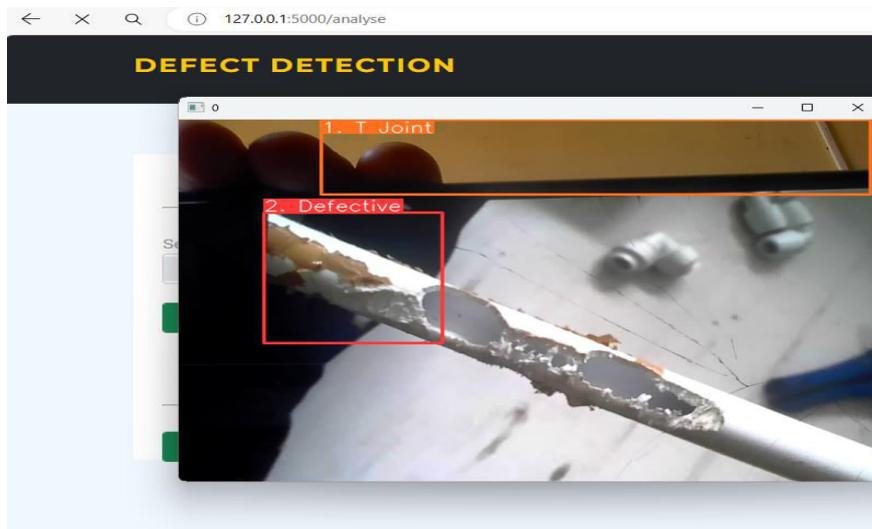
Fig(b): User Login Page



Fig(c): Home Page



Fig(d): Result Showing the Defective Part in the Image



Fig(e): Result Showing the Defective Part using Live Image

V. CONCLUSION

In this modern world, almost every sector is being enlightened by different technological innovations and findings. India is also moving forward with these blessings although the most significant economic resource of our country. We believe this model can play a very essential part in today's world. Industrialization is a fundamental aspect of modern civilization. With increasing modernization and Industrialization, industrial growth and demand emerge as a massive factor in this. But this is lacking in using new technologies of machine learning. As a result, our industry should be familiar with all of the latest machine learning and other techniques. These techniques help in getting the maximum output. Many algorithms of machine learning are applied to Industry to improve product quality and various factors. All the accuracy of the models was carefully obtained through various methods and compared with each other.

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