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A REVIEW ON COMPUTER VISION BASED CRACK AND DENT DETECTION

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Abstract: Cracks and dents in infrastructure pose significant risks to safety and structural integrity, necessitating accurate and efficient detection methods. Traditional manual inspection processes are often labor-intensive and prone to human error, leading to delayed defect identification and maintenance interventions. We explore the application of computer vision technology for crack and dent detection in infrastructure assets. By leveraging advanced methodologies such as holistic edge detection and feature extraction, our proposed system aims to achieve high precision in identifying and delineating surface defects. Additionally, we discuss strategies to improve image processing efficiency, optimize system performance, and enable comprehensive analysis of surface defects. The integration of computer vision technology in infrastructure maintenance not only enhances safety practices but also offers potential cost savings by facilitating proactive maintenance interventions. Through this paper, we highlight the
transformative impact of computer vision-based crack and dent detection in revolutionizing infrastructure inspection practices for enhanced safety and longevity.

Keywords - Computer Vision, Crack, Dent, Image Processing

I. INTRODUCTION

In modern industrial settings, ensuring the integrity of surfaces is paramount for safety, reliability, and efficiency. Traditional methods of crack and dent detection often rely heavily on manual inspection, which can be time- consuming, subjective, and prone to human error. However, with the rapid advancements in computer vision technology, there has been a paradigm shift towards automated inspection systems that offer higher accuracy and efficiency. Computer Vision Based Crack And Dent Detection represents a cutting-edge approach in this domain, leveraging sophisticated algorithms and image processing techniques to detect imperfections in various materials. The first paragraph introduces the importance of surface integrity in industrial contexts and highlights the shortcomings of traditional inspection methods. It sets the stage for discussing the need for more efficient and reliable crack and dent detection technologies. Computer Vision-Based Crack and Dent Detection employs advanced algorithms and image processing to automatically identify defects, overcoming manual inspection limitations. This technology enhances efficiency and accuracy in quality control across various industries, ensuring timely detection of defects for improved safety and product quality.

By employing advanced algorithms, Crack and Dent Detection via Computer Vision will analyze digital images or live video feeds to swiftly and accurately identify defects such as cracks and dents, surpassing the limitations of manual inspection methods. This automated process enhances efficiency and ensures comprehensive defect detection across diverse industries.

It explores the possible uses of Computer Vision-Based Crack and Dent Detection in industries like automotive, aerospace, and civil engineering, emphasizing the crucial role of surface quality in guaranteeing product and structure safety and reliability.

It examines how machine learning algorithms enhance the adaptability and effectiveness of Computer Vision-Based Crack and Dent Detection systems by enabling them to learn and improve performance over time, regardless of environmental conditions or material types.

II. LITERATURE SURVEY

Changqing Cao et al. (IEEE, 2019), propose a novel Region Proposal Network (RPN) that enhances object detection efficiency by sharing convolutional features with object detection networks. This approach effectively reduces the computational bottleneck typically associated with proposal generation. Notably, the algorithm demonstrates proficiency in spotting small objects, even in challenging scenarios where traditional methods may struggle. However, it's essential to note that the algorithm's performance might be impacted by its speed, as it could potentially be slower compared to other methods. Additionally, achieving optimal results with this approach requires careful tuning of the settings, which may pose challenges for users. Despite these limitations, the introduction of the RPN represents a significant advancement in small object detection within the field of computer vision.[1]

P. Durgadevi et al. (IEEE, 2022), recognize the renowned Canny edge detection algorithm for its remarkable precision, albeit at the cost of computational complexity. They propose augmenting this method with a median filter to preserve image details, leading to sharper edge detection and improved noise handling. While these enhancements facilitate easier parameter tuning and yield more accurate results, the increased complexity may pose challenges for users seeking simplicity in their segmentation tasks. Despite this drawback, the paper presents a valuable advancement in edge detection techniques, offering improved segmentation capabilities.[2]

Arunish Kumar et al. (IEEE, 2020) focuses on identifying concrete surface cracks, essential for structural integrity maintenance. It highlights the inadequacy of manual inspection methods, such as sketches, due to subjective interpretation. Leveraging deep learning techniques, the proposed framework effectively detects cracks in diverse road and bridge materials. While demonstrating proficiency across various materials, the success of the approach is contingent upon access to high-quality datasets for training. Despite this reliance, the paper underscores a significant advancement in structural maintenance practices, offering a more objective and efficient solution for crack detection.[3]

T. Lilienbum et al. (IEEE, 2020) focuses on integrated approach utilizing Convolutional Neural Networks (CNN) and region growing techniques to map both visible and concealed dents, including those obscured by vegetation or flooding. Notably, the integration of neural networks facilitates accurate detection of hidden dents, ensuring comprehensive inspection of car bodies. However, the success of this method heavily depends on the quality and representation of training data, potentially limiting its effectiveness in scenarios with inadequate or inconsistent data. Despite this constraint, the paper signifies a significant advancement in dent detection technology, offering a promising solution for improving automotive maintenance and safety standards.[4]

Ao Yan-Li et al. (IEEE, 2019) highlights the significance of data pre-processing in machine learning and image processing domains. It emphasizes critical tasks such as outlier detection and handling missing values, essential for enhancing data quality. Additionally, the paper delves into Pixel Brightness Transformations (PBT), a technique for adjusting brightness, contrast, and color correction, thereby improving image quality. One of the main advantages discussed is the utility of image segmentation, which facilitates breaking down pictures into smaller, more manageable parts for analysis and processing. However, a notable drawback mentioned is the potential difficulty some individuals may face in understanding and effectively utilizing image segmentation techniques. Despite this challenge, the paper provides valuable insights into the importance of pre-processing and segmentation in digital image analysis, offering a foundation for further research and application development in the field. [5]

Sadiq Thomas, et al. (IEEE, 2021) presents an innovative approach to crack detection. This method identifies various types of cracks, tracing them pixel by pixel and connecting them to form a complete picture. This comprehensive approach proves effective in detecting and analyzing pavement cracks, showcasing its versatility in handling different crack types. One advantage of this technique is its ability to effectively handle various crack types, demonstrating its versatility in crack detection applications. However, the accuracy of this approach is heavily reliant on clear and high-quality images. Blurry or low- quality images may impact the accuracy of crack detection, potentially limiting its effectiveness in real-world scenarios. Despite this limitation, the paper represents a significant advancement in crack detection technology, offering a promising solution for infrastructure maintenance and safety enhancement.[6]

Weihe Zhong et al (IEEE, 2019) addresses common issues such as blurriness or excessive light in digital images. The authors propose various techniques to enhance image quality by adjusting pixels directly or employing specific histogram processing methods to enhance patterns. This process effectively improves image visibility and comprehension, making images easier to interpret and analyze. While image enhancement techniques offer significant benefits in improving picture quality, some methods may require technical expertise to implement effectively. The complexity of certain enhancement techniques may pose challenges for users without advanced technical skills. Nonetheless, the paper provides valuable insights into image enhancement methodologies, paving the way for improved image processing techniques in various applications. [7] handle the computational workload could limit the accessibility of this approach in certain settings. Despite this drawback, the paper represents a significant advancement in object detection technology, offering enhanced accuracy and reliability in computer vision applications.[8]

Yang Cheng et al. (IEEE, 2021) delves into the concept of image segmentation, a pivotal aspect of digital image processing. It explores various segmentation methods and their applications, such as license plate recognition, medical image analysis, and fire prevention. One advantage highlighted is how image segmentation aids in breaking down pictures into smaller, more manageable parts, facilitating analysis and processing. However, depending on the segmentation method employed, there are potential disadvantages. If not executed accurately, there is a risk of missing important details in images or making mistakes in the segmentation process. Despite this drawback, the paper underscores the significance of image segmentation in diverse applications, demonstrating its potential for enhancing image processing tasks and advancing technology across various domains.[9]

III. PROBLEM STATEMENT

To focuses on creating a computer-vision based solution which will identify cracks and dents on any large objects such as vehicles and big manufacturing subsystems using image processing and machine learning algorithms. The detected cracks and dents of the scanned images will then be highlighted using visualization and saved to a database.

IV. OBJECTIVES

The main objective of the Project is as follow,

- Firstly, enhancing crack and dent detection accuracy is essential to ensure the structural integrity and safety of infrastructure assets, thus necessitating the development of a robust computer vision-based system.
- Secondly, improving image processing efficiency is crucial to streamline inspection processes, reducing time and resource expenditure while enhancing overall system performance.
- Thirdly, enabling comprehensive surface defect analysis is vital for informed decision- making in maintenance tasks, facilitating timely interventions to prevent potential hazards.
- Additionally, facilitating real-world application integration ensures practical deployment of the developed system, meeting the demands of diverse operating environments, these objectives align with the overarching goal of enhancing maintenance and safety practices across industries, underscoring the critical importance of this project in safeguarding lives and preserving infrastructure integrity.
- Ultimately, the overarching objective is to contribute to enhanced maintenance and safety practices across various industries, including infrastructure management, automotive maintenance, and structural engineering

V. MOTIVATION

The project addresses safety risks posed by cracks and dents in infrastructure, emphasizing the need for automated detection to ensure timely intervention and prevent hazards. By replacing labor-intensive manual inspection methods, computer vision technology offers a more efficient and cost-effective solution, optimizing resources and reducing both time and financial burdens. Before this project, delayed defect detection impeded proactive maintenance efforts, impacting infrastructure longevity and safety; implementing automated detection systems facilitates timely interventions and prolongs the lifespan of critical assets.

VI. CONCLUSION

In conclusion, the development of this project has been marked by overcoming various challenges to achieve our objectives successfully. Through meticulous research and innovation, we addressed the need for enhanced crack and dent detection accuracy by employing advanced computer vision methodologies. We overcame hurdles in image processing efficiency by optimizing techniques such as edge detection and texture calculation, thereby streamlining the inspection process and improving system performance. By prioritizing comprehensive surface defect analysis, we ensured that our system provides detailed insights for informed decision- making in maintenance tasks. Moreover, our commitment to real-world application integration enabled seamless deployment of the developed system in diverse environments, overcoming compatibility issues and ensuring robust performance. Overall, our perseverance and dedication have allowed us to surmount obstacles and deliver a solution that contributes significantly to enhancing maintenance and safety practices across industries.

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