4.2 学生发表论文

4.2.1 CFM-YOLOv5:CFPNet moudle and muti-target prediction head incorporating YOLOv5 for metal surface defect detection

PLOS ONE

RESEARCH ARTICLE

CFM-YOLOv5:CFPNet moudle and muti-target prediction head incorporating YOLOv5 for metal surface defect detection

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Abstract

Aiming at the problem of low efficiency of manual detection in the field of metal surface defect detection, a deep learning defect detection method based on improved YOLOv5 algorithm is proposed. Firstly, in the feature enhancement part, we replace the multi-head self-attention module of the standard transformer encoder with the EVC module to improve the feature extraction ability. Second, in the prediction part, adding a small target detection head can reduce the negative impact of drastic object scale changes and improve the accuracy and stability of detection. Finally, the performance of the algorithm is verified by ablation experiments and analogy experiments. The experimental results show that the improved algorithm has greatly improved mAP and FPS on the data set, and can quickly and accurately identify the types of metal surface defects, which has reference significance for practical industrial applications.

Introduction

With the development of artificial intelligence, more and more industries integrate enterprise technology with artificial intelligence, such as Tesla. These phenomena reflect that artificial intelligence has gradually become an indispensable part of the industrial field and has gradually become one of the world's hot industries. In the industrial manufacturing industry, metal workpieces are an important part of some products. The quality of metal workpieces not only affects the life of products and the development of enterprises, but also involves the safety of users. Therefore, adopting accurate and fast target detection algorithms plays an important role in industrial manufacturing.

In recent years, with the development of deep learning, more and more studies have used convolutional neural networks and other deep learning methods for metal defect detection. These methods can automatically learn feature representation and perform well on large-scale data sets. However, metal defect detection faces some major problems. First of all, since metal defects are usually related to materials and construction techniques, there is a problem of class imbalance, that is, the number of normal samples far exceeds the number of defective samples. This may lead to the model biased towards normal samples and insufficient detection performance for defect samples. Secondly, metal defects are often small, even small subtle changes,

4.2.2 Research on oil boom performance based on Smoothed Particle Hydrodynamics method

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RESEARCH ARTICLE

Research on oil boom performance based on Smoothed Particle Hydrodynamics method

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Abstract

To address the issues of fluid-solid coupling, instability in the liquid two-phase flow, poor computational efficiency, treating the free surface as a slip wall, and neglecting the movement of oil booms in simulating oil spill containment, this study adopts the Smoothed Particle Hydrodynamics (SPH) method to establish a numerical model for solid-liquid coupling and liquid two-phase flow, specifically designed for oil boom containment and control. The Dual-SPHysics solver is employed for numerical simulations, incorporating optimized SPH techniques and eight different skirt configurations of the oil boom into the numerical model of two-phase liquid interaction. By setting relevant parameters in the SPH code to enhance computational efficiency, the variations in centroid, undulation, and stability of undulation velocity for different oil boom shapes are observed. The experimental results demonstrate that the improved oil boom exhibits superior oil containment performance. These findings provide a theoretical basis for the design of oil boom skirt structures.

Introduction

Oil booms are widely acknowledged as a critical measure in emergency response to oil spills, with high practical value. They are effective in containing the spread of oil spills, thereby preventing further pollution of the marine environment [1, 2].

In order to enhance the effectiveness of oil booms as a critical measure for emergency response to oil spills and to address different scenarios, the Smoothed Particle Hydrodynamics (SPH) [3–5] numerical simulation method can be utilized to accurately simulate the undulation process and lift force of oil booms with various shapes. The undulation behavior of oil booms, particularly significant undulations, can lead to reduced oil containment effectiveness and potential failure. The findings of this research provide a scientific basis for the design of oil booms. The SPH method discretizes a continuous medium into a set of particles, and the discrete Navier-Stokes equations are locally integrated at each particle's position based on the physical properties of the surrounding particles [6, 7]. The set of neighboring particles is determined by a distance-based function, which can be two-dimensional or three-dimensional, with the characteristic length or smoothing length denoted as h [8, 9]. In each time step, new physical quantities are calculated for each particle, and they are then updated to determine the movement of the particles [10]. Based on previous experimental and numerical research, it has been consistently shown that an optimized skirt structure of

4.2.3 Road surface crack detection based on improved YOLOv5s

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Research article

Road surface crack detection based on improved YOLOv5s

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Abstract: In response to the issues of low efficiency and high cost in traditional manual methods for road surface crack detection, an improved YOLOv5s (you only look once version 5 small) algorithm was proposed. Based on this improvement, a road surface crack object recognition model was established using YOLOv5s. First, based on the Res2Net (a new multi-scale backbone architecture) network, an improved multi-scale Res2-C3 (a new multi-scale backbone architecture of C3) module was suggested to enhance feature extraction performance. Second, the feature fusion network and backbone of YOLOv5 were merged with the GAM (global attention mechanism) attention mechanism, reducing information dispersion and enhancing the interaction of global dimensions features. We incorporated dynamic snake convolution into the feature fusion network section to enhance the model's ability to handle irregular shapes and deformation problems. Experimental results showed that the final revision of the model dramatically increased both the detection speed and the accuracy of road surface identification. The mean average precision (mAP) reached 93.9%, with an average precision improvement of 12.6% compared to the YOLOv5s model. The frames per second (FPS) value was 49.97. The difficulties of low accuracy and slow speed in road surface fracture identification were effectively addressed by the modified model, demonstrating that the enhanced model achieved relatively high accuracy while maintaining inference speed.

Keywords: road surface crack detection; deep learning; YOLOv5s; Res2-C3 module; attention mechanism

1. Introduction

In recent years, China has maintained a relatively stable development trend in its highway

4.2.4 Research on injection molded parts defect detection algorithm based on multiplicative feature fusion and improved attention mechanism

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Research on injection molded parts defect detection algorithm based on multiplicative feature fusion and improved attention mechanism

Rongnan Zhang, Yang Li & Zhiguang Guan✉

Injection molded parts are increasingly utilized across various industries due to their cost-effectiveness, lightweight nature, and durability. However, traditional defect detection methods for these parts often rely on manual visual inspection, which is inefficient, expensive, and prone to errors. To enhance the accuracy of defect detection in injection molded parts, a new method called MRB-YOLO, based on the YOLOv8 model, has been proposed. This method introduces several key improvements: (1) the MAFHead, a four-detection head based on multiplicative feature fusion, which replaces the original detection head to enhance feature representation; (2) the RepGFPN-SE module, a re-parameterized generalized feature pyramid network that improves detection of small objects by replacing the original C2f. module; (3) and the BiNorma module, employing a bi-level routing attention mechanism to optimize the training process by reducing input distribution changes across layers. The effectiveness of the MRB-YOLO model was validated through ablation and contrast experiments using a specially constructed dataset of injection molded parts defects. The results demonstrated an accuracy of 88.8%, a recall rate of 86.8%, and a mean average precision (mAP) of 91.5%. Compared to the YOLOv8n model, the MRB-YOLO model shows an increase in accuracy by 8.2%, in recall rate by 17.2%, and in mAP by 11.8%. These findings confirm that the MRB-YOLO model meets the requirements for accurate detection of defects in injection molded parts.

Keywords Injection molded parts, Improved attention mechanism, Multiplicative feature fusion, YOLOv8, Defect detection

Injection molded parts are widely used across various industries due to their advantages of low material cost, lightweight nature, and durability[1]. However, various defects such as bubbles, deformation, burns, short shots, and weld lines can occur during the injection molding process, resulting from factors like mold design, material properties, process parameters, and environmental conditions. These defects not only affect the surface quality but also degrade the performance and usability of the parts[2]. Therefore, it is crucial to conduct stringent inspections of injection molded parts[3].Traditional defect detection methods primarily rely on manual visual inspection[4]. This approach is not only inefficient and costly but also introduces significant uncertainty due to the subjective nature of human assessment[5]. With the advancement of industrial automation and intelligent manufacturing technologies, machine vision-based defect detection has become a prominent research area[6]. Machine vision technology captures images of injection molded parts using cameras and processes these images to automatically detect and classify defects[7]. This method offers several advantages, including rapid detection speed, high accuracy, and improved stability, making it a valuable tool in quality control for injection molded parts.

In recent years, deep learning has made significant strides in the field of object detection[8]. Leveraging advancements in convolutional neural networks (CNNs), deep learning-based approaches for defect detection in injection molded parts have garnered extensive attention from both academia and industry[9]. These methods offer significant advantages by overcoming the limitations of traditional techniques, enhancing the generalization ability of image recognition systems, and being particularly well-suited for identifying complex surface defects[10].

In this field, several studies have made notable contributions: Shen et al.[11]. modified the YOLOv5s network by replacing the C3 backbone with the lightweight ShuffleNetV2, reducing model parameters and size, which

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4.2.5 Numerical Simulation of Casting Filling Process Based on SPH-FEM Coupling Method

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Numerical Simulation of Casting Filling Process Based on SPH-FEM Coupling Method

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Abstract: The coordinated optimization of free-surface dynamics tracking and solid deformation computation remains a persistent challenge in casting filling simulations. While the traditional smoothed particle hydrodynamics (SPH) method suffers from prohibitive computational costs limiting practical applications, the delayed interface updates of the finite element method (FEM) compromise simulation fidelity. This study proposes a symmetric SPH-FEM coupling algorithm that integrates real-time particle-grid data exchange, and validation through ring filling simulations demonstrated close agreement with Schmid's benchmark experiments, confirming flow field reconstruction reliability. Furthermore, bottom-injection plate experiments verified the method's thermal modeling stability, achieving fully coupled flow–thermal–stress simulations with enhanced computational efficiency. The proposed symmetric coupling framework achieves engineering-ready simulation speeds without compromising accuracy, and this advancement establishes a novel computational tool for predicting casting defects including porosity and hot tears, significantly advancing the implementation of high-fidelity numerical simulation in foundry engineering applications.

Keywords: casting; numerical simulation; SPH-FEM coupling method; symmetry; temperature field

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1. Introduction

As a historically significant metal forming technique, casting remains crucial in modern manufacturing industries [1]. Casting components find extensive applications in strategic sectors, including aerospace, automotive, and machinery manufacturing. However, persistent challenges in conventional casting processes—including melt flow regulation, defect formation prediction, and process parameter optimization—have emerged as critical constraints impeding technological advancement. To address these limitations, numerical simulation methodologies have been progressively implemented in casting research, establishing themselves as indispensable analytical tools [2,3].

Recent advances in casting simulation reveal complementary advantages between the SPH method and the FEM. The SPH approach inherently circumvents mesh distortion via particle-based discretization, demonstrating superior capabilities in free-surface flow tracking [4] and fluid–structure interaction modeling [5]. This methodology proves particularly effective for liquid metal filling processes involving abrupt geometric transitions, such as cavity expansions from narrow runners. While SPH's meshless nature