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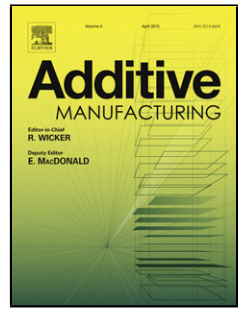


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# A Multi-scale Convolutional Neural Network for Autonomous Anomaly Detection and Classification in a Laser Powder Bed Fusion Additive Manufacturing Process

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## Abstract

In-situ detection of processing defects is a critical challenge for Laser Powder Bed Fusion Additive Manufacturing. Many of these defects are related to interactions between the recoater blade, which spreads the powder, and the powder bed. This work leverages Deep Learning, specifically a Convolutional Neural Network (CNN), for autonomous detection and classification of many of these spreading anomalies. Importantly, the input layer of the CNN is modified to enable the algorithm to learn both the appearance of the powder bed anomalies as well as key contextual information at multiple size scales. These modifications to the CNN architecture are shown to improve the flexibility and overall classification accuracy of the algorithm while mitigating many human biases. A case study is used to demonstrate the utility of the presented methodology and the overall performance is shown to be superior to that of methodologies previously reported by the authors.

## Keywords

Additive manufacturing; Convolutional Neural Network (CNN); Computer vision; Machine learning; In-situ process monitoring

## 1 Introduction

Many of the applications best suited for Additive Manufacturing (AM) (e.g. aerospace, biomedical, energy, automotive, and tooling [1–3]) require levels of part quality assurance and process reliability that are difficult to attain with currently available commercial systems [4]. In-situ process monitoring and closed-loop control schema can play a critical role in addressing these requirements [4]. In-situ process monitoring of builds has become a major research focus for the AM community over the last several years. Monitoring efforts for the Powder Bed Fusion (PBF) and Direct Energy Deposition (DED) AM processes have variously focused on