Real-time Splatter Tracking in Laser Powder Bed Fusion Additive Manufacturing

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INTRODUCTION

In the LPBF printing process, splatter originates from the laser interaction with the metal powder, which not only reveals the melting and printing quality but also reflects the laser scanning path. Before the real-time splatter tracking for defect detection in LPBF, some basic investigations, such as time consumption, feature extraction, and defect correlation, must be done. Therefore, in this paper, a basic splatter tracking approach is investigated to provide a solid foundation for future real-time application that can correlate the defects with splatter information.

METHODS

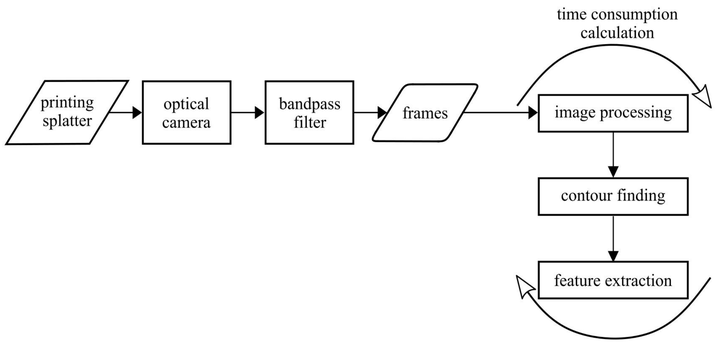

Fig. 1. The methodology of splatter tracking.

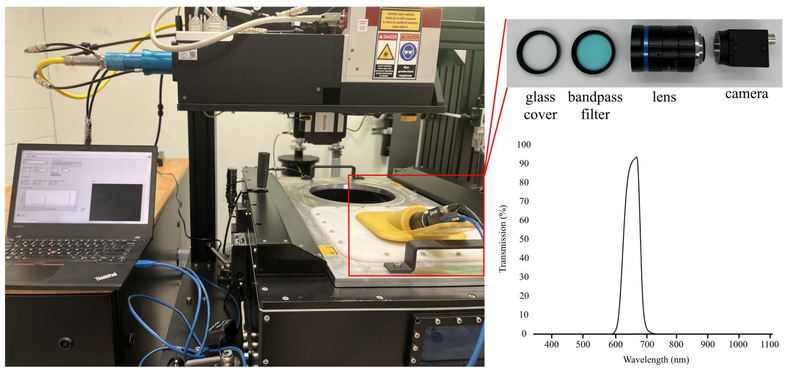

Fig. 2. Splatter tracking setup on the metal 3D printer with the bandpass filter range.

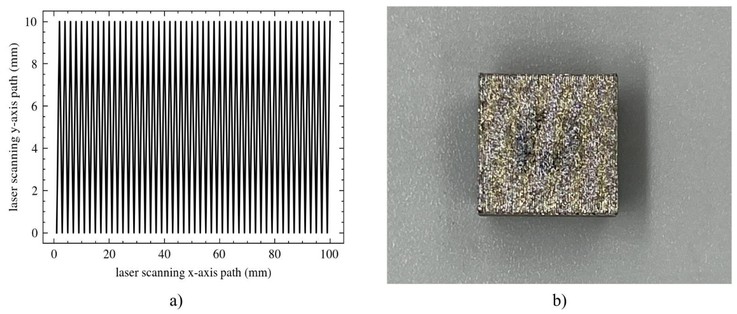

Fig. 3. The cubic sample in the research: a) laser scanning path from G-code and b) the printed cubic sample.

METHODS

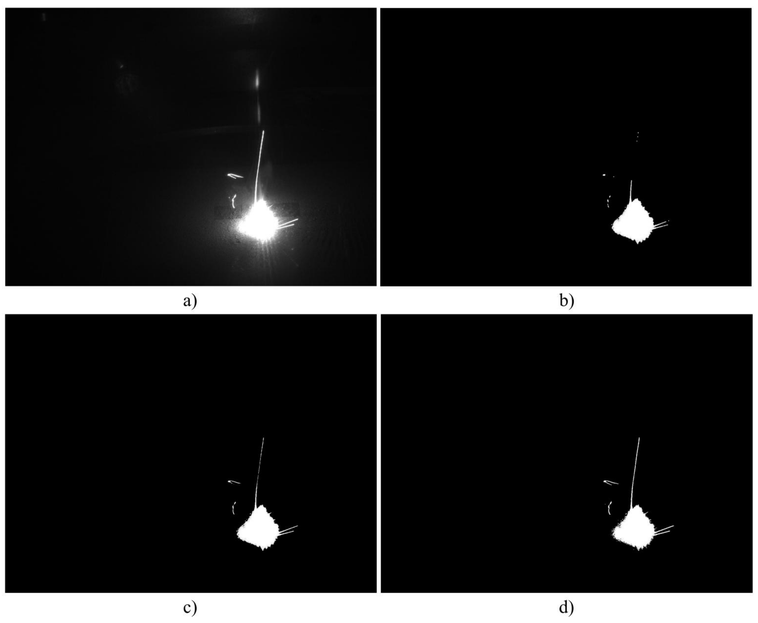

Fig. 4. Splatter image processing showing: a) the raw splatter image; b) splatter with Gaussian blur, erode, dilate, and threshold filter; c) splatter with Gaussian blur and threshold filter; and d) splatter with threshold filter.

RESULTS

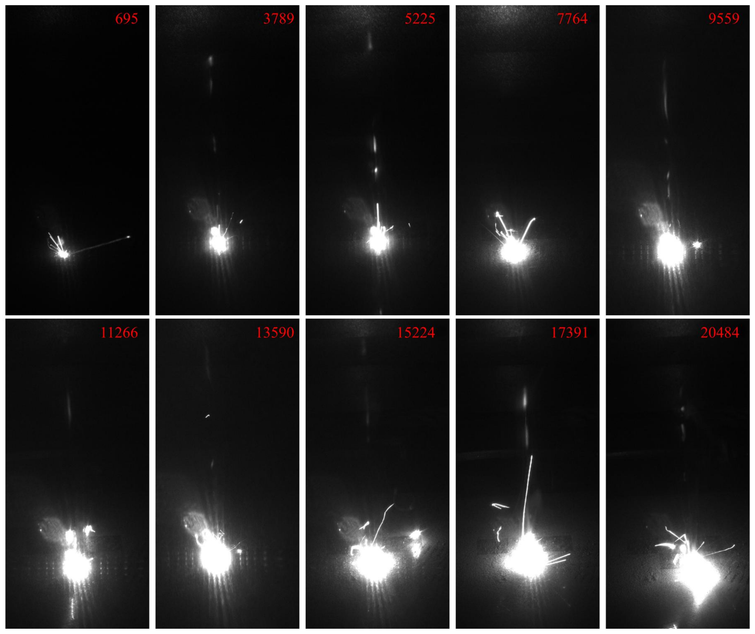

Fig. 5. Splatter images with various areas (pixels).

Table 1. Time consumption (ms) for different filters processing splatter with various areas.

splatter area (pixel) / filters	695	3789	5225	7764	9559	11266	13590	15224	17391	20484
Gaussian blur, erode, dialte, and threshold	24.15	25.21	25.00	25.45	26.03	26.02	25.92	25.72	25.61	25.45
Gaussian blur and threshold	22.48	23.49	24.02	24.29	24.62	24.37	24.69	24.50	24.38	24.41
threshold	21.81	23.29	23.23	23.59	23.85	24.08	24.04	24.39	24.42	23.55

RESULTS

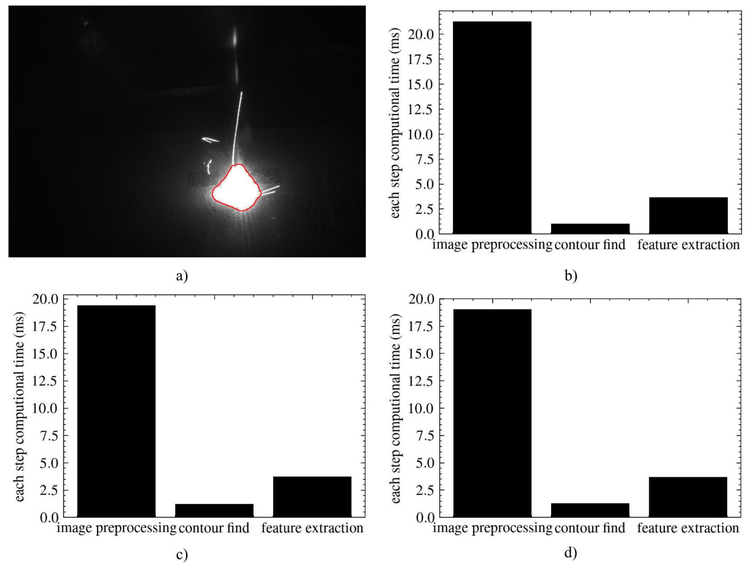

Fig. 6. Splatter image processing showing: a) the image of splatter with contour; b) each step time consumption with Gaussian blur, erode, dilate, and threshold filter; c) each step time consumption with Gaussian blur and threshold filter; and d) each step time consumption with threshold filter.

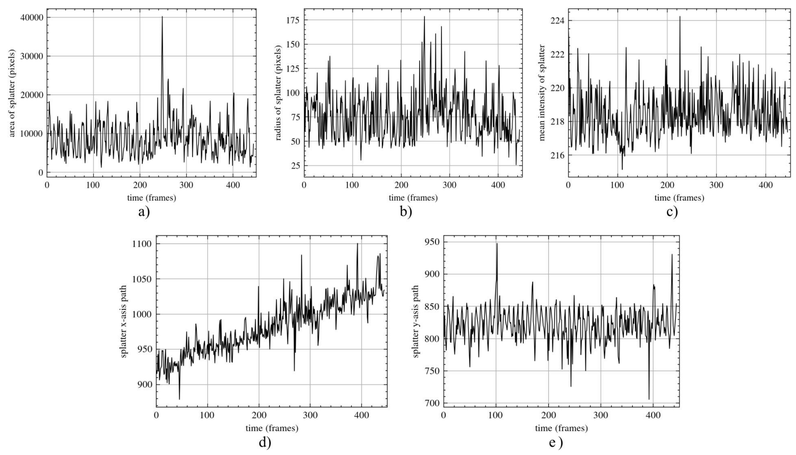

Fig. 7. Splatter image processing: a) extracted area of splatter; b) extracted radius of splatter; c) extracted mean intensity of splatter; d) extracted x-axis moving path of splatter; and e) extracted y-axis moving path of splatter.

CONCLUSIONS

1. **Various filters are applied for splatter image processing and time consumptions are calculated.**
2. **The relationship between image processing time and splatter area is established.**
3. **A series of features are extracted from the splatter images.**