Detection of Lint by Using Machine Vision

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Introduction

This thesis, commissioned by Häme University of Applied Sciences, researches the possibility of detecting lint formed during high-speed offset printing and paper manufacturing by using machine vision.

Due to the small particle size and high speed of the lint various problems occur:

- A high framerate is required to fully represent all of the lint passing by.
- A high resolution is required to detect the small particles.
- A short exposure time is required to prevent inaccuracy due to motion blur [1].

Figure 1. Lint

Objectives

- Research the most optimal machine vision components.
- Research if the available hardware can fullfill the goals.
- Research a solution for motion blur.
- Create a practical test setup and program to verify the theoretical conclusions and detect the lint.

Vision Setup

A CMOS area scan camera will be used. The settings can be seen in table 1.

Table 1. Vision Setup Settings

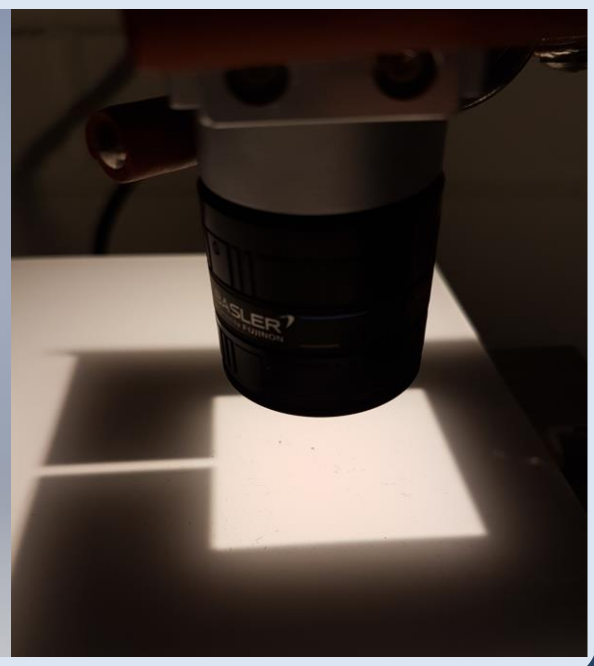
Field of View	22,5mm
Working Distance	36,59mm
Maximum Depth of Field	4,3mm
Magnification	0,219
Images per Second	180
Flash Exposure Time	1,06µs
Smallest Detectable Feature	43,95µm

Vision Setup

A visual overview of the settings from table 1 is given in figure 2. Also, a practical test setup, seen in figure 3, was created to verify the theoretical conclusions.

Figure 2. Visual Overview

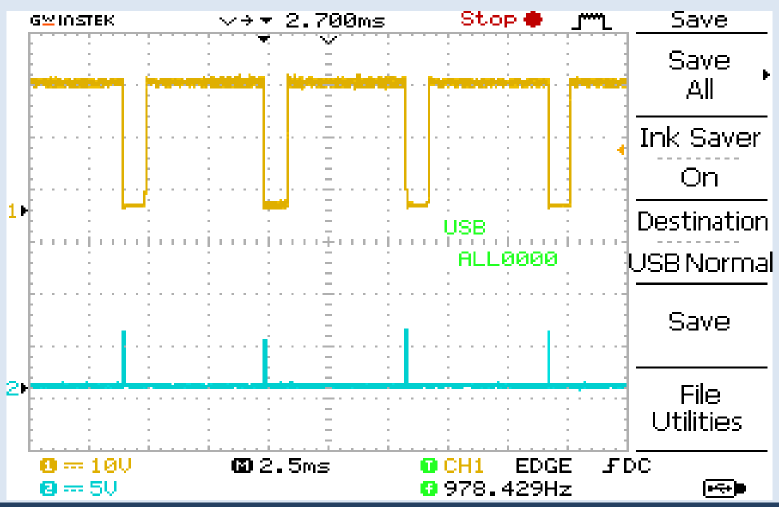
Figure 3. Test Setup



Strobe Light

A high speed strobe light was created with four overdriven LEDs [2] which will decrease the exposure time and thus prevent motion blur. The strobe light (channel two: blue) is synchronized with the exposure active camera output (channel one: yellow).

Figure 4. Strobe Light Synchronization



Program

Two MATLAB programs were created. Firstly, an extensive image analysis program (figure 5) and secondly a program to test the performance of various segmentation techniques.

Figure 5. Image Analysis

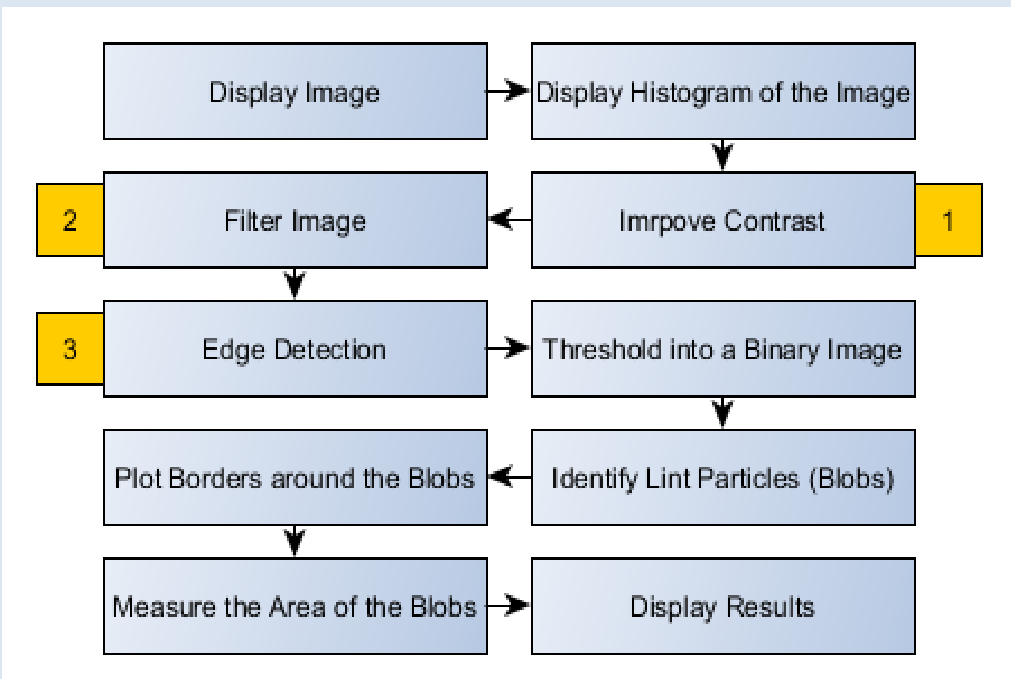
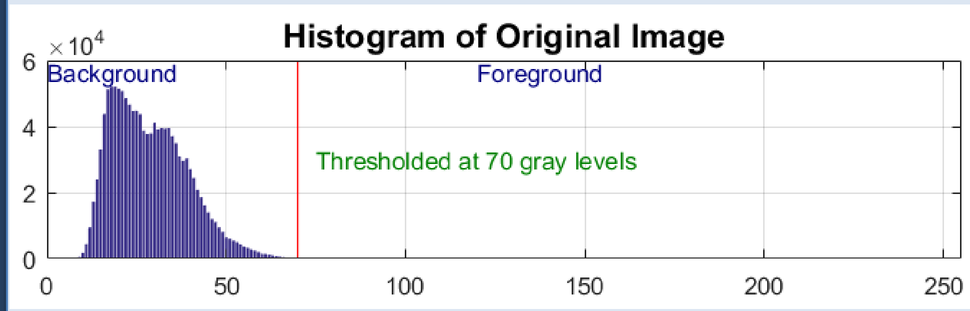


Image Analysis Results

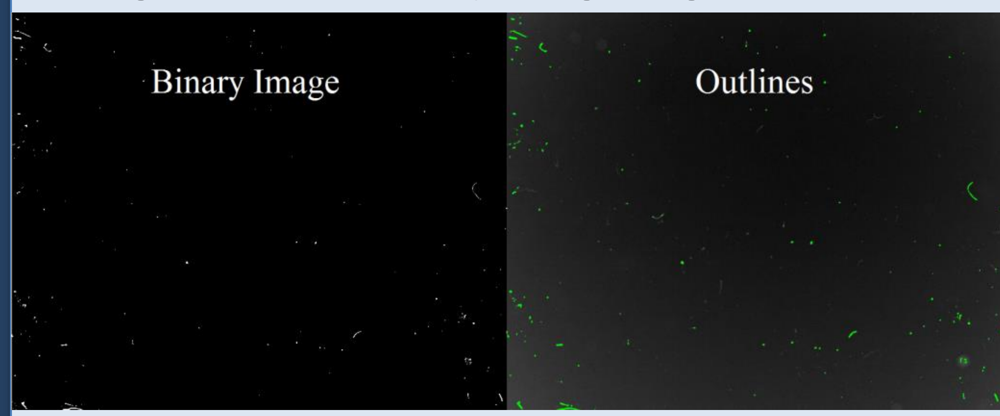
The program will segment the original image from figure 1 into a binary image by using a threshold selected based on the histogram.

Figure 6. Histogram Thresholding



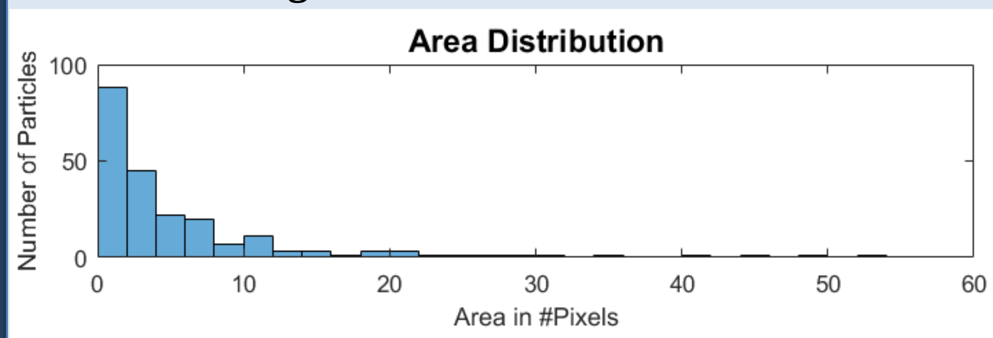
The particles are labelled and outlines are drawn around the particles.

Figure 7. Left: Binary Image, Right: Outlines



The smallest detected particle can be as small as one pixel, which is 20 microns. The area distribution of the particles is displayed in figure 8.

Figure 8. Area Distribution



Conclusion

- The available hardware is capable of detecting particles as small as 20 microns at sufficient framerate.
- Synchronization between the camera and strobe light was successful.
- Real time processing is not possible at 180 fps in MATLAB. Further optimization and implementation in C++ is required.
- Frame differencing is the segmentation technique with the least processing time and highest accuracy.

References

[1] M. Wloka and R. C. Zeleznik, “Interactive Real-Time Motion Blur,” *Sci. Technol.*, 1996.

[2] C. Willert, B. Stasicki, J. Klinner, and S. Moessner, “Pulsed operation of high-power light emitting diodes for imaging flow velocimetry,” *Meas. Sci. Technol.*, vol. 21, no. 7, p. 75402, 2010.

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