Morphology-Based Approach to Detection of Free Form Line Objects in Grayscale Images

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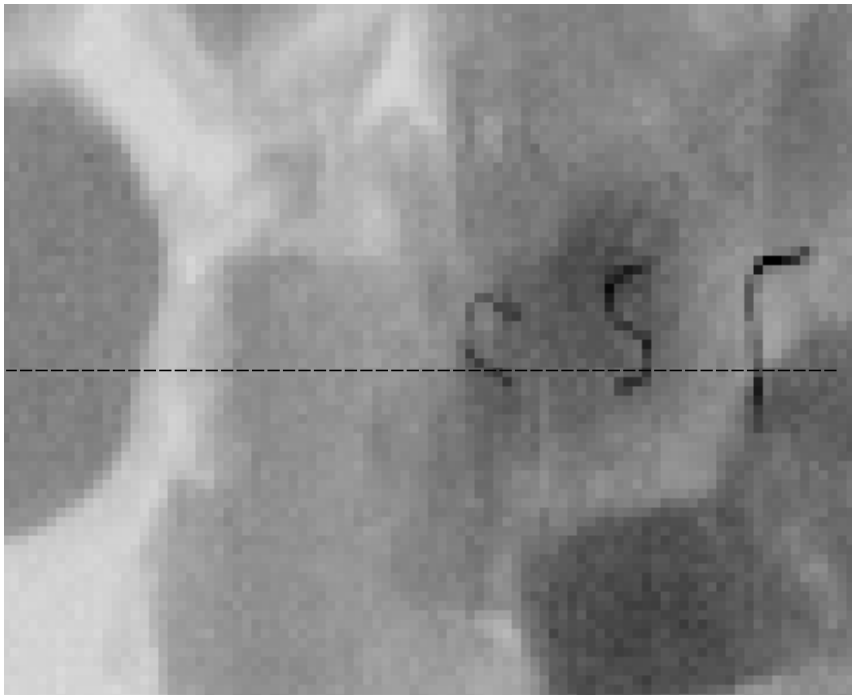
Outline

- Task definition
- Processing approach - steps
- Conclusions

Task = Detection of free form line objects



X-ray image of food sample

- Production line with high scanning **speed** (up to 50 cm/s)
- Line objects on the **varying** image **background**
- Strong **noise** impact

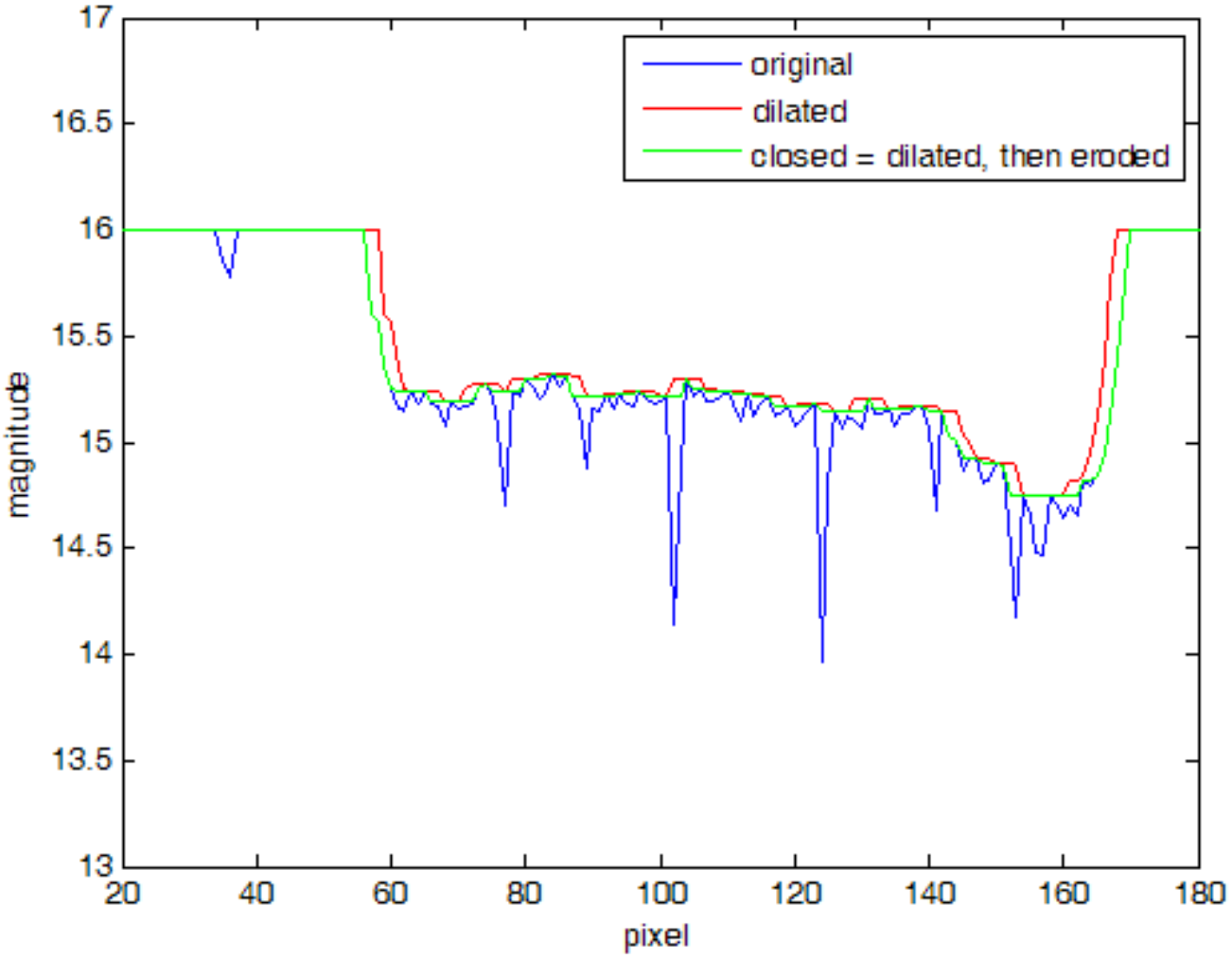
Proposed approach

- Elimination of the **background** trend
- **Thresholding** for obtaining binary image where pixels possibly related to foreign bodies show up
- "**Glueing**" parts of the foreign bodies possibly disrupted due to noise
- **Skeletonization** of free form line objects
- Calculation of the **object length** for making **decision** about the presence of the foreign body

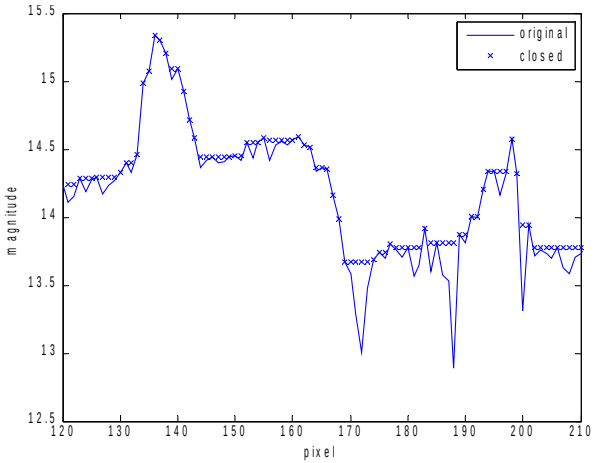
Morphologic bottom hat (BH) filtering

- Fundamental operations of mathematical morphology (MM) defined for binary and grayscale images, can be used in 1D, 2D
- Applied to the image by rows, then by columns
- MM operates with *structuring element* (SE) = binary image defining neighborhood of processed pixel.
  We will use 1D SE *ones(1,N+1)*, where *N*=object size
- **D**ilation = max(<pixel values within SE>)
- **E**rosion = min(<pixel values within SE>)
- Closing = Dilation, then Erosion
- Bottom hat filtering = Closed – Original
- Multitude of other operations defined in MM using **D,E**

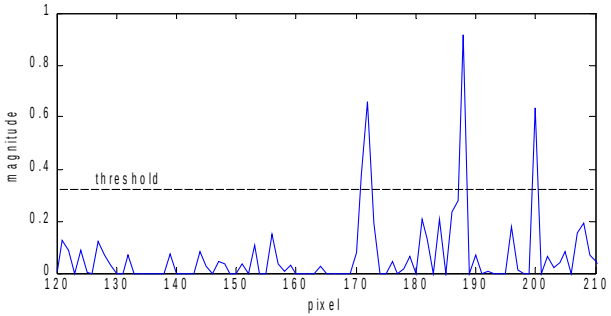
Dilation & closing



Background compensation by BH filtering

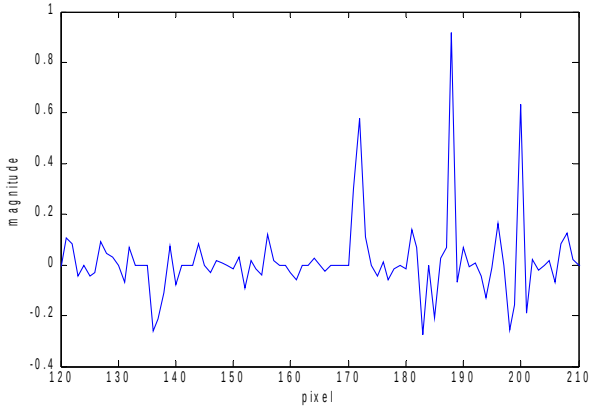


a) original and closed



b) original – closed
(SE length N+1)

c) image after bg compensation



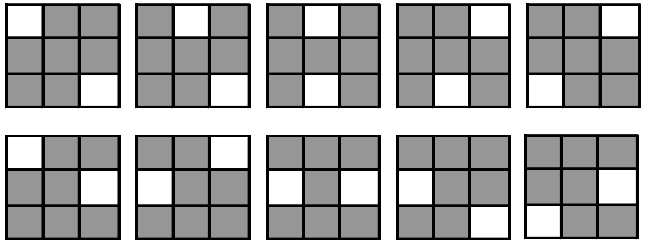
d) using median filtering (size 2N+1)

Thresholding

a) image after bg compensation

b) after thresholding

Glueing



c) lookup table properties

d) glued

Skeletonization

a) after glueing

b) after skeletonization

Conclusions

1. Mathematical morphology provides a set of efficient procedures that can be exploited for detection of foreign bodies in grayscale images. Most of these operations can be used in real time mode

3. Using the bottom hat filtering, small foreground objects can be effectively extracted from the background clutter. Comparing to widely used median filtering approach, this type of filter provides similar results but performs faster

5. Proposed approach can be successfully applied for detection of foreign bodies appearing as free form line shapes. The approach can be successfully applied for solving industrial application tasks- processing X-ray images in real time mode

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