A CONNECTED-TUBE MPP MODEL FOR OBJECT DETECTION
WITH APPLICATION TO MATERIALS AND REMOTELY-SENSED IMAGES

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Abstract

• A connected-tube model based on a Marked Point Process (MPP) for strip feature extraction in images is proposed.
• A mixed MPP model can be formed by combing the proposed model with other geometric models.
• The proposed model can be applied to complex detection tasks, such as short and long fiber detection in material images, road and roof detection in satellite images.

Introduction

• Traditional MPP model works well in figure 1, but may not work well with objects whose size varies over a wide range, as shown in figure 2.
• We propose a connected-tube model based on a MPP. Instead of modeling the long fiber by an ellipse object, we model it as a series of connected tubes.
• Advantages:
  - The size of the tubes can be controlled in a smaller range.
  - The tube model can be combined easily with the ellipse or rectangle model to form a mixed MPP model.

Model and Algorithm

• The density of the mixed marked point process of ellipses and tubes is given by
  \[ f(w;y) = \frac{1}{Z} \exp\left(-V_g(y|w) - V_p(w)\right) \]
where \(w\) is the object configuration, \(y\) is the observed image, \(Z\) is a normalizing constant, \(V_g(y|w)\) is the data energy, which describes how well the objects fit the observed image, \(V_p(w)\) is the prior energy introducing the prior knowledge on the object configuration.
\[ V_g(y|w) = \sum_i V_g(y|w_i) \]
where \(V_g(y|w_i)\) describes how well object \(w_i\) fits the observed image \(y\). In our model, it is characterized by the contrast between the inner (white) area and outer (green) area in figure 3.

MLR  MSR  OD

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<tr>
<td>ellipse MPP</td>
<td>81.53%</td>
<td>4.22%</td>
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<tr>
<td>mixed MPP</td>
<td>9.23%</td>
<td>1.40%</td>
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Table 1. Fiber Detection Evaluation. (missed long fiber rate: MLR, missed short fiber rate: MSR, and over-detection rate: OD)

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References:


Results

• We test the mixed-MPP model on 10 images of dimension 308×308.
• The missed long fiber rate(MLR), missed short fiber rate(MSR), and over-detection rate(OD) are listed in Table 1.

Conclusions

• A connected-tube model based on marked point processes has been proposed.
• By combining it with an ellipse model, a mixed MPP model is built, which solves the problem of wide mark range in MPP model for detecting the fibers in material microscopy images.
• The tests of our model on remotely sensed images shows its potential for detecting roads and roofs.