

# 模糊方法实验

学生姓名: 李盛; 学号: 229221

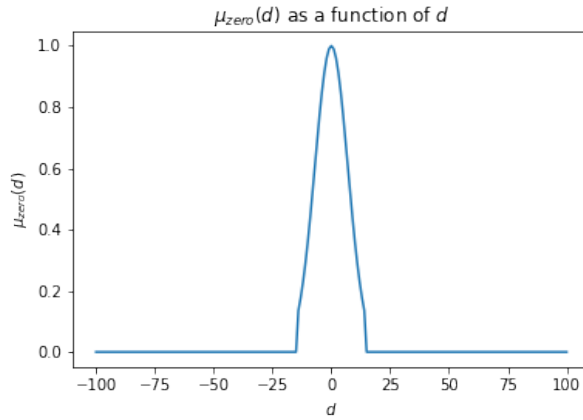
Course: 图象分析与理解 – Professor: 季续  
Due date: 5月8日, 2022年

## 1. 模糊边界提取

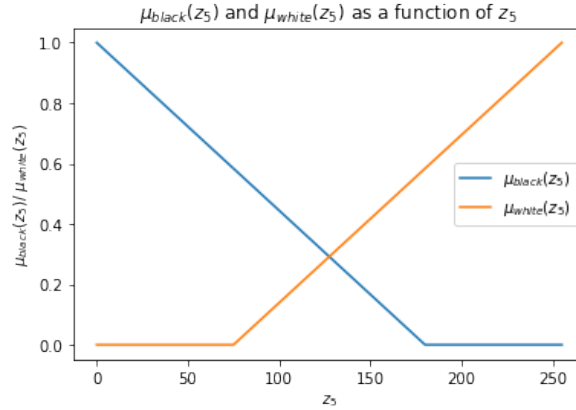
**Solution.**

### 1. Definitions of membership functions

- (a) The change of  $\mu_{zero}(d)$  with respect to  $d$  is shown in Figure 1a.
- (b) The change of  $\mu_{black}(z_5)$  and  $\mu_{white}(z_5)$  as a function of  $z_5$  is shown in Figure 1b.



(a) Membership function of the fuzzy set *zero*

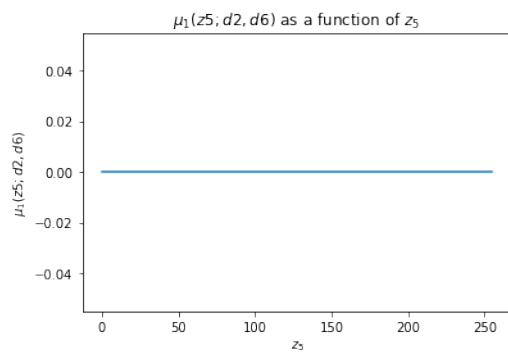


(b) Membership functions of the fuzzy sets *black* and *white*

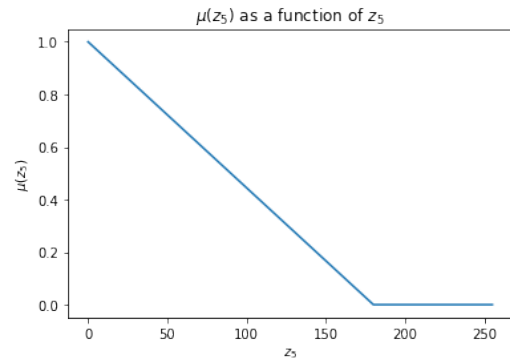
Figure 1: Membership functions

(c) The change of  $\mu_1(z_5; d_2, d_6)$  with respect to  $z_5$  is shown in Figure 2a.

(d) The change of  $\mu(z_5)$  with respect to  $z_5$  is shown in Figure 2b.



(a) Rule 1 membership function



(b) Overall membership function

Figure 2: Membership functions

## 2. Rule-based Inference

(a) Results of fuzzy spatial filtering are shown in Figure 3.

(b) When  $\sigma$  of the input membership function is changed to 10, the corresponding boundaries are less obvious. The bandwidth of the truncated Gaussian is wider, which recognizes neighbours with larger intensity differences as a uniform area.



(a) Boundary extraction ( $\sigma = 7$ )



(b) Boundary extraction ( $\sigma = 10$ )

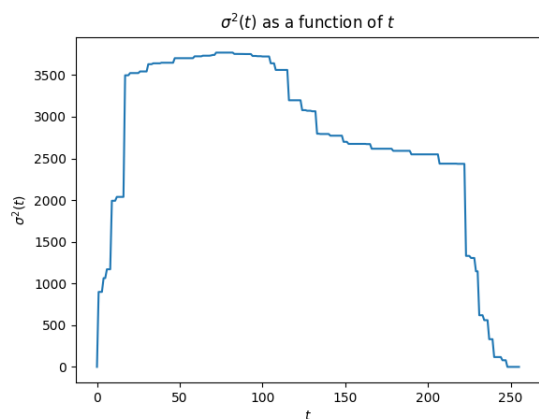
Figure 3: Results of fuzzy spatial filtering

## 2. 阈值分割

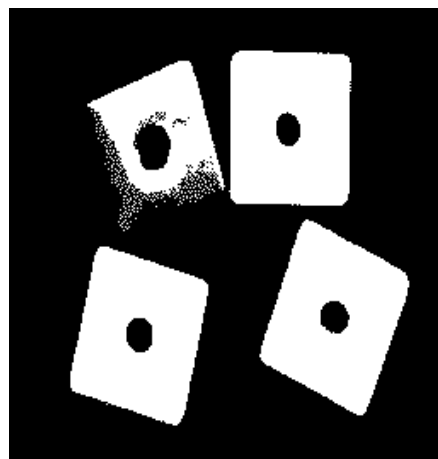
### Solution.

#### 1. Otsu's Binarization

- (a) The change of  $\sigma^2(t)$  with respect to  $t$  is shown in Figure 4a.
- (b) As is shown in Figure 4b, the result after Otsu thresholding is barely satisfactory where the top-left square is not well determined.



(a) between-class variance  $\sigma^2(t)$  with respect to  $t$

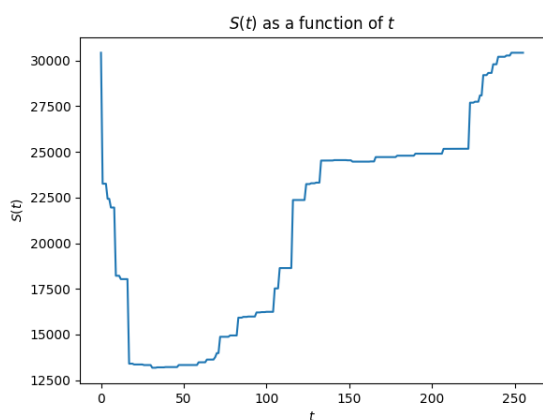


(b) thresholded by Otsu algorithm

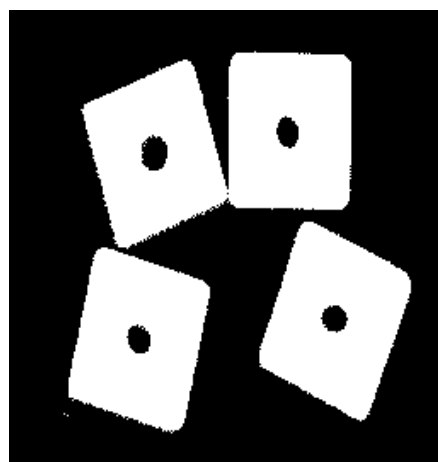
Figure 4: Illustration of Otsu's Binarization

#### 2. Fuzzy thresholding method

- (a) The change of sum of all pixels' entropy  $S(t)$  with respect to threshold  $t$  is shown in Figure 5a.
- (b) As is shown in Figure 5b, the result after fuzzy thresholding is satisfactory where all the four squares are well segmented from the background.



(a) Entropy  $S(t)$  with respect to  $t$



(b) thresholded by fuzzy method

Figure 5: Illustration of fuzzy thresholding