0704 讀碩士論文

1~9 database 本人字跡 50→25 25

testcase 仿照字跡 50→25 25

training test

0708 projection feature:

A SVM method for Projection features

database 50 → 25 | 25   true 1

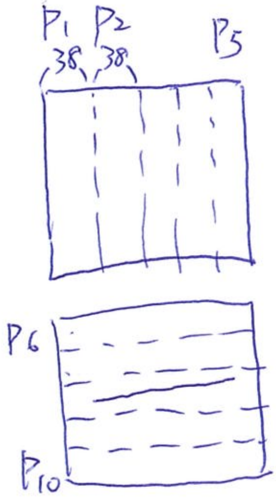
testcase 50 → 25 | 25   forged 2

↑ training   ↖ test

$Y = 0.299R + 0.587G + 0.114B$ (intensity)

$Y < 220 \Rightarrow$ stroke

$\geq 220 \Rightarrow$ background   0~255



$P_1, P_2 \cdots P_{10}$ (how many pixels in each slot are stroke pixels)

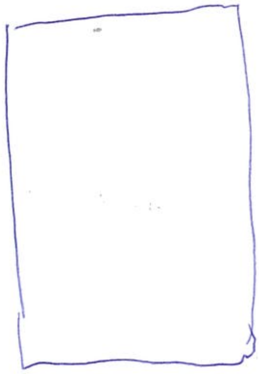
features: $f_e = \frac{P_e - \text{mean}(P_e)}{\sigma_{P_e}}$ (Eq.(4))

exclude the features that almost equal to 0 >95%

training data

50 data, 10_features

label



feature vectors

$\xrightarrow{\text{SVM}}$ prediction model

test data

$f_e = \frac{Q_e - \text{mean}(P_e)}{\sigma_{P_e}}$

features

↓

prediction model

↓

label

0715 moment feature

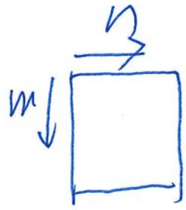
projection ≤ 10 features

$> 95\%$

exclude the features that are zero

moment features

$$B(m,n) = \begin{cases} 1 & \text{for stroke} \\ 0 & \text{non-stroke} \end{cases}$$



$$m_0 = \frac{\sum_m \sum_n m B(m,n)}{\sum_m \sum_n B(m,n)} \qquad n_0 = \frac{\sum \sum n B(m,n)}{\sum \sum B(m,n)}$$

$$m_{a,b} = \frac{\sum_m \sum_n (m-m_0)^a (n-n_0)^b B(m,n)}{\sum_m \sum_n B(m,n)}$$

$m_0, n_0, \underbrace{m_{2,0}, m_{0,2}, m_{1,1}}_{\text{variance}}, \overbrace{m_{3,0}, m_{2,1}, m_{1,2}, m_{0,}}^{\text{skewness}}$

$a+b=3$ skewness

$a+b=4$ kurtosis

0722 erode feature

$\bar{Y}$

- mean of the intensity of stroke pixels
- standard deviation

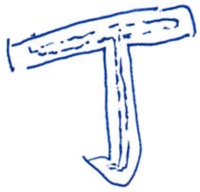
  σ_Y
- $\dfrac{\text{number of stroke pixels after } k \text{ erosions}}{\text{number of stroke pixels}} = r_k$

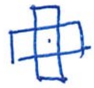
initial: $Y_0[m,n] = x[m,n]$

1: stroke

0: background

$$Y_k[m,n] = \cancel{0}\, Y_{k-1}[m,n] \,\&\&\, Y_{k-1}[m,n+1] \,\&\&\, Y_{k-1}[m,n-1] \,\&\&\, Y_{k-1}[m+1,n] \,\&\&\, Y_{k-1}[m-1,n]$$





r_1, r_2, r_3

$Y = 0.299R + 0.587G + 0.114B$

m_{20}

m_{11}

m_{02}

m_{30}

$\vdots$

m_{03}

$$\hat{f}_n = \frac{f_n - \bar{f}_n}{\sigma_{f_n}}$$

$$\bar{f}_n = \frac{\sum_{m=1}^{50} f_{n,m}}{50}$$

$$\sigma_{f_n} = \sqrt{\frac{\sum_{m=1}^{50} (f_{n,m} - \bar{f}_n)^2}{50}}$$

$f_{n,m}$: the nth feature for the mth training data

0.124

stroke pixels (x_n, y_n) $n = 1, 2, \cdots P$

$$\underset{P\times 2}{Z} = \begin{bmatrix} x_1 - x_0 & y_1 - y_0 \\ x_2 - x_0 & y_2 - y_0 \\ \vdots & \vdots \\ x_p - x_0 & y_p - y_0 \end{bmatrix} \qquad \underset{2\times 2}{Z_2} = Z^T Z$$

$x_0 = \text{mean}(x_n)$

$y_0 = \text{mean}(y_n)$

PCA (principle component analysis)

if $\lambda_1 > \lambda_2$ $\quad Z_2 = E\,D\,E^T$

$(e_{11}\ e_{21})^T$

$(e_{12}\ e_{22})^T$

$$\begin{bmatrix} e_{11} & e_{12} \\ e_{21} & e_{22} \end{bmatrix} \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix} \begin{bmatrix} e_{11} & e_{21} \\ e_{12} & e_{22} \end{bmatrix}$$

eigenvalues

$(0,1)$

$(1,0)$

3 features

① θ: 較水平的 eigenvector 和橫軸夾角

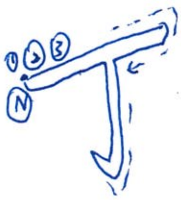
$-\frac{\pi}{4} < \theta < \frac{\pi}{4}$ $\quad -45$ degree $< \theta < 45$ degree

$$\theta = \arccos \frac{\vec{V_1} \cdot \vec{V_2}}{\|\vec{V_1}\|\,\|\vec{V_2}\|} \ (+\pi) \text{ or}$$

② λ horizontal

③ λ vertical

0805 將字給邊緣統一圖

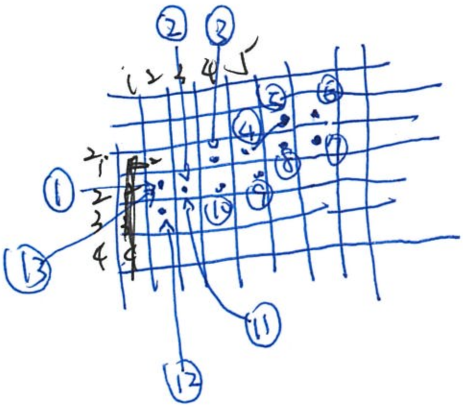


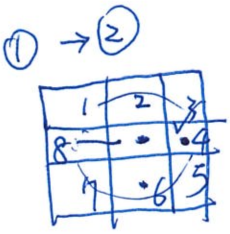
Initial: leftest upper pixel

reference direction:

previos pixel

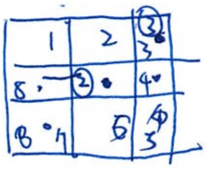
(If it is the first pixel, the reference direction is left



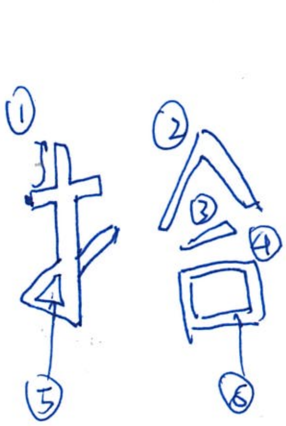


sort the sorrounding 8 pixels

Select the stroke pixel with the smallest rank



When returning to the first pixel the contour is completed



Boundary pixels

$A(m,n)=1$

but one of $A(m\pm1,n)$

$A(m,m\pm1)$ is 0

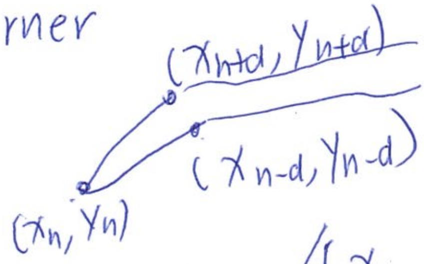
All the boundary pixels should be numbered.

0812 判斷 corner

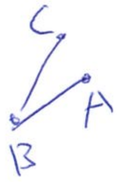
(x_n, y_n): the n^{th} pixel on the contour

$d \equiv 10 \sim 15$

corner



$$\cos \theta_n = \frac{\langle (x_{n-d}-x_n,\ y_{n-d}-y_n),\ (x_{n+d}-x_n,\ y_{n+d}-y_n) \rangle}{\sqrt{(x_{n-d}-x_n)^2+(y_{n-d}-y_n)^2}\sqrt{(x_{n+d}-x_n)^2+(y_{n+d}-y_n)^2}}$$

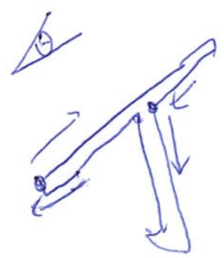


$$\theta = \arccos \frac{\langle \overrightarrow{BA}, \overrightarrow{BC} \rangle}{\|\overrightarrow{BA}\| \|\overrightarrow{BC}\|}$$

If ① $\theta_n < \theta_{n+m}$ $\quad m \in [-10, 10]$

② $\theta_n \leq \frac{3}{4}\pi \quad \frac{5}{6}\pi$

then θ_n is a corner



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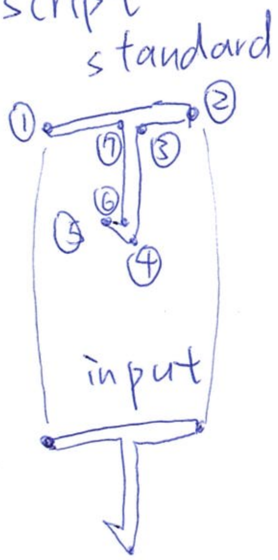
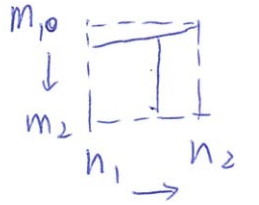
select a standard script



① normalized coordinate



$m_1 = \min(m)$

$m_2 = \max(m)$

$$m_c = \frac{m_2 - m_1}{2} + m_1 , \quad n_c = \frac{n_2 - n_1}{2} + n_1$$

$$\hat{m} = \frac{m - m_c}{L} 100 \qquad L = \max(m_2 - m_1,\ n_2 - n_1)$$

$$\hat{n} = \frac{n - n_c}{L} 100$$

$-50 \le \hat{m}, \hat{n} \le 50$

(m,n) : original coordinate

② $$r_m = \frac{\text{the number of pixels whose } m \text{ coordinate is smaller than } m}{\text{tatal number of pixels}}$$

r_n

standard corners $\hat{m}_s$, $\hat{n}_s$ $r_{m,s}$ $r_{n,s}$

input corners $\hat{m}_i$, $\hat{n}_i$, $r_{m,i}$ $r_{n,i}$

$$\text{dist} : \sqrt{(\hat{m}_s - \hat{m}_i)^2 + (\hat{n}_s - \hat{n}_i)^2 + \lambda\left((r_{m,s} - r_{m,i})^2 + (r_{n,s} - r_{n,i})^2\right)}$$

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(3) direction

$\phi(m,n)$

$= \text{angle}\left(B(m,n) * \Phi(m,n) \right)$

$B(m,n)$: 189x189 — binarized stroke image

$\Phi(m,n)$: 15x15

$n = x$

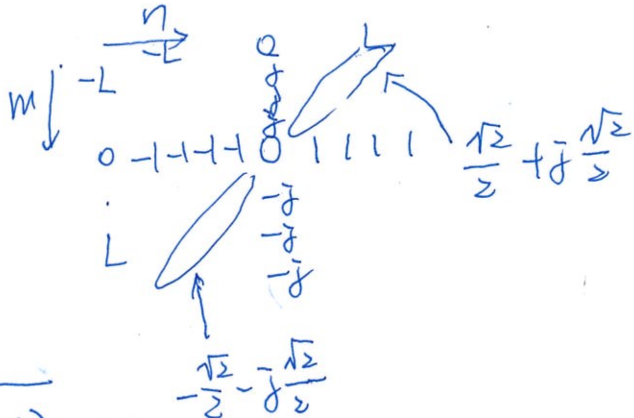
$m = y$

$$\Phi(m,n) = \frac{m + jn - jm}{\sqrt{m^2+n^2}} \quad -L \le m, n \le L$$

?

ex: $L = 7, 9$

$\Phi(0,0) = 0$



$\arctan\left(\frac{Im(\ )}{Re(\ )}\right) +$

$\cos\theta + j\sin\theta$

$\sqrt{\cdots + \lambda_2 \left(dist(\phi_{in}(m,n) - \phi_{ref}(m,n)) \right)}$

$$dist(\phi_{in}(m,n) - \phi_{ref}(m,n)) = \min\left(|\phi_{in}(m,n) - \phi_{ref}(m,n)|,\ 2\pi - |\phi_{in}(m,n) - \phi_{ref}(m,n)| \right)$$

179°

180

-179°

$0 \sim \pi$

(4) end   turning

end point only matches end point

turning point only matches turning point

C B

B A

observe the training data, select only the corners that can well match

$\theta \le \frac{\pi}{6}$ end points

$\frac{\pi}{6} \le \theta < \frac{5}{6}\pi$ turning points

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(i) If P corners are chosen

(X_m, y_m) $m = 1, 2, \cdots, P$ ($2P$ features)

(ii) relative distance of (X_n, y_n) and (X_m, y_m)

$(X_m - X_n, y_m - y_n)$ $2\binom{P}{2} = \frac{P!}{2!(P-2)!} \cdot 2 = P(P-1)$ features