Adaptively Adjusted GMM based Background Segmentation for Surveillance System

Research Contents

◆ Gaussian Mixture Model

Scheme: The L-recent window update equations give priority over recent data, therefore the tracker can adapt to changes in environment. When a new pixel value comes, check it against first N\_i Gaussian distributions in turn. If the \( a_i \) distribution \( G_i \) matches, update parameters as M-step in EM does. After that, we compare the value of \( w_i \) with value of \( G_i \), exchange the order of \( G_i \) and \( G_j \), and operate \( i=1 \) repeat it until \( i=1 \) or \( w_i \leq w_j \). Or else no match found, operate as follows:

\[
N_{ij} = \begin{cases} \frac{N_{ij} + 1}{K} & \text{if } N_{ij} < K \\ \frac{N_{ij}}{K} & \text{if } N_{ij} = K \end{cases}
\]

(1)

\[
w_i = \frac{w_i}{\sum_{j=1}^{K} w_j}, \quad k = 1, 2, ..., N_{ij}
\]

(2)

then replace the mean value of the \( N_{ij} \) distribution with current pixel. After that the Gaussians are eliminated from least updated ones according to two parameters: value of weight, which represent the time proportions that those colors stay in the scene and sum_match, which takes for the percentage of importance in K gaussians to dominant background component from training history. We subtract the weight of the last Gaussian from that of the one before the last, if the difference is less that threshold \( D = 0.001 \) and sum_match \( < 3 \), remove the last Gaussian and repeat this, as the pseudocode shown below. Then the weights of left Gaussian distributions are reassigned as below

For \( i=1, 2, ..., K \)

Begin

if \( \text{weight of } G_i \cdot \text{weight of } G_i < 0.001 \&\& \text{sum_match} < 3 \)

Remove Gaussian(G)

else break;

End.

◆ Foreground Mask

Experimental Results

Table 1. Percentage for saved Gaussian

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Value of K in E-step</th>
<th>K=5</th>
<th>K=4</th>
<th>K=3</th>
<th>K=2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PetsDIteC2 (Outdoor Sequence)</td>
<td>Original GMM</td>
<td>552980</td>
<td>442368</td>
<td>331776</td>
<td>221184</td>
</tr>
<tr>
<td>Proposed</td>
<td>371327</td>
<td>366409</td>
<td>323301</td>
<td>220534</td>
<td></td>
</tr>
<tr>
<td>Saved (%)</td>
<td>32.5%</td>
<td>18.5%</td>
<td>3.16%</td>
<td>0.29%</td>
<td></td>
</tr>
<tr>
<td>ThreePerson_Circles_Comp_0_Quad0 (Indoor Sequence)</td>
<td>Original GMM</td>
<td>384000</td>
<td>307200</td>
<td>230400</td>
<td>153600</td>
</tr>
<tr>
<td>Proposed</td>
<td>249931</td>
<td>339614</td>
<td>231520</td>
<td>152870</td>
<td></td>
</tr>
<tr>
<td>Saved (%)</td>
<td>34.9%</td>
<td>22.9%</td>
<td>8.19%</td>
<td>0.47%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Comparison of foreground detection: (a) original frames: 1867 and 2253 from PetsDIteC2, frame 1118 from Q4-01 and 265 from ThreePerson_Circles Comp_0_Quad0, frame 257 and 266 from ThreePerson_T snag_Split_Comp_0_Quad1 (from up to bottom respectively); (b) Foreground mask by applying improved GMM on RGB color space; (c) Foreground mask by applying improved GMM on Canny edge segmented image; (d) Foreground mask by proposed algorithm.