Background modeling by combining joint intensity histogram with time-sequential data

Yasuyo Kita（*National Institute of Advanced Industrial Science and Technology (AIST)*）

National Institute of Advanced Industrial Science and Technology
AIST

Abstract

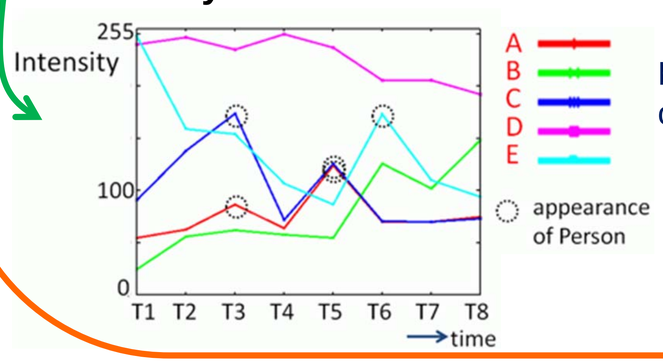
Subject: **Calculation of background model of each pixel at time t_0 from time-sequential images of outside scenes taken with long time intervals.**

Problem: **Not enough number of frames to refer**

Our solution: **Statistics of all the pixels similar to the pixel of interest is used as a prior probability, assuming that pixels of the same value in an image tend to show similar distribution.**

Example of Time-series images (T1-T8: taken every five minutes)

Intensity transition at the marked pixels（A–E）



Examples of background model obtained by the proposed method

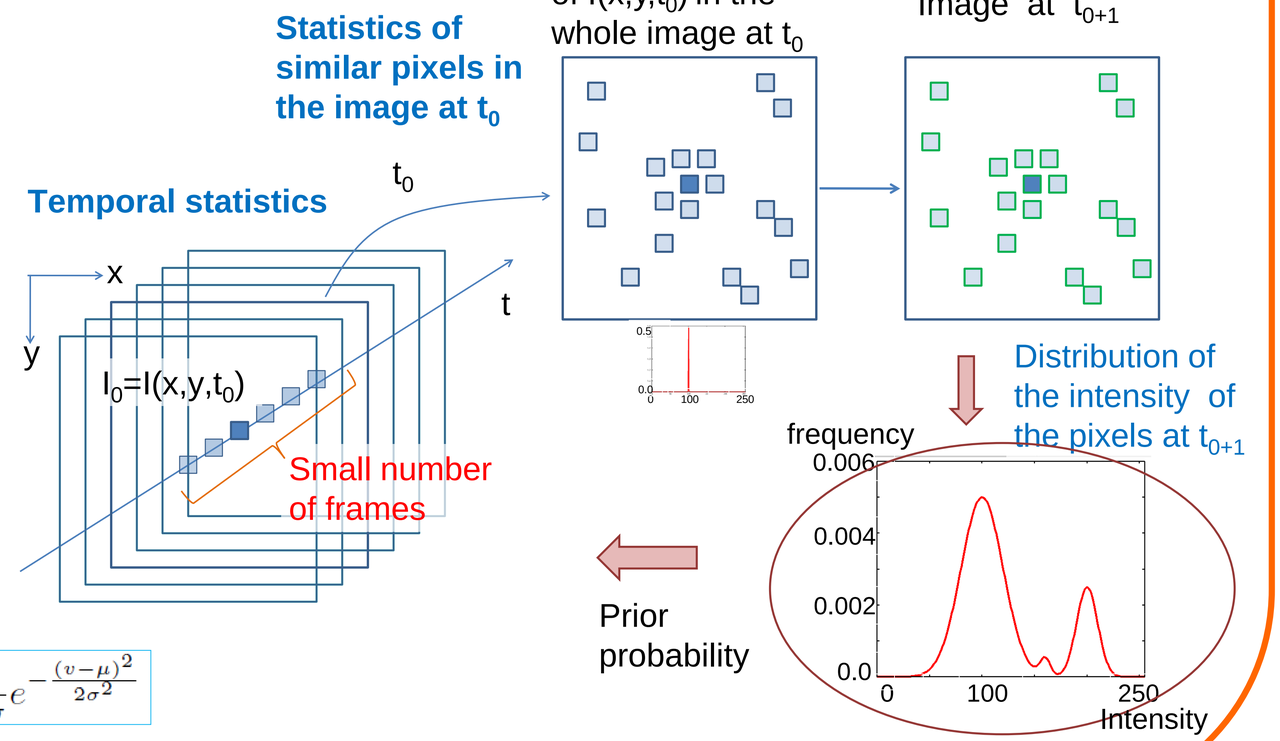
Model for C at T5

η(v, 71.1, 2.7)

Model for B at T5

η(v, 58.4, 2.4) + η(v, 112.8, 11.9)

$$\eta(v,\mu,\sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(v-\mu)^2}{2\sigma^2}}$$



Methods

Algorithm

1. Background probability function per intensity, *is obtained from the cross-section of* $H(I_{t0}, I_{t0+1})$ *at* $I_{t0} = X(t_0)$ *. If the function* has clear plural peaks, it is partitioned as different background clusters, $B_1, B_2, ., B_K$,

$$\bar{h}_{X(t_0)}(v) = h_{X(t_0)}(v) / \sum_{v=0}^{255} h_{X(t_0)}(v)$$

2. GMM is calculated with the following equations using fore and aft frames of *t0 + 1:*

$$P(v) = \sum_1^K \eta(v, \mu_k, \sigma_k)$$

$$\mu_k = \frac{B}{A} \qquad \sigma_k = \frac{C}{A} \qquad \begin{cases} W_k(v) = \bar{h}_{X(t_0)}(v) & if \quad v \subset B_k \\ W_k(v) = 0 & else \end{cases}$$

$$A = \left(\sum_{t=t_0-N_F}^{t_0+1+N_F} W_k(X(t)) \right) - W_k(X(t_0+1))$$

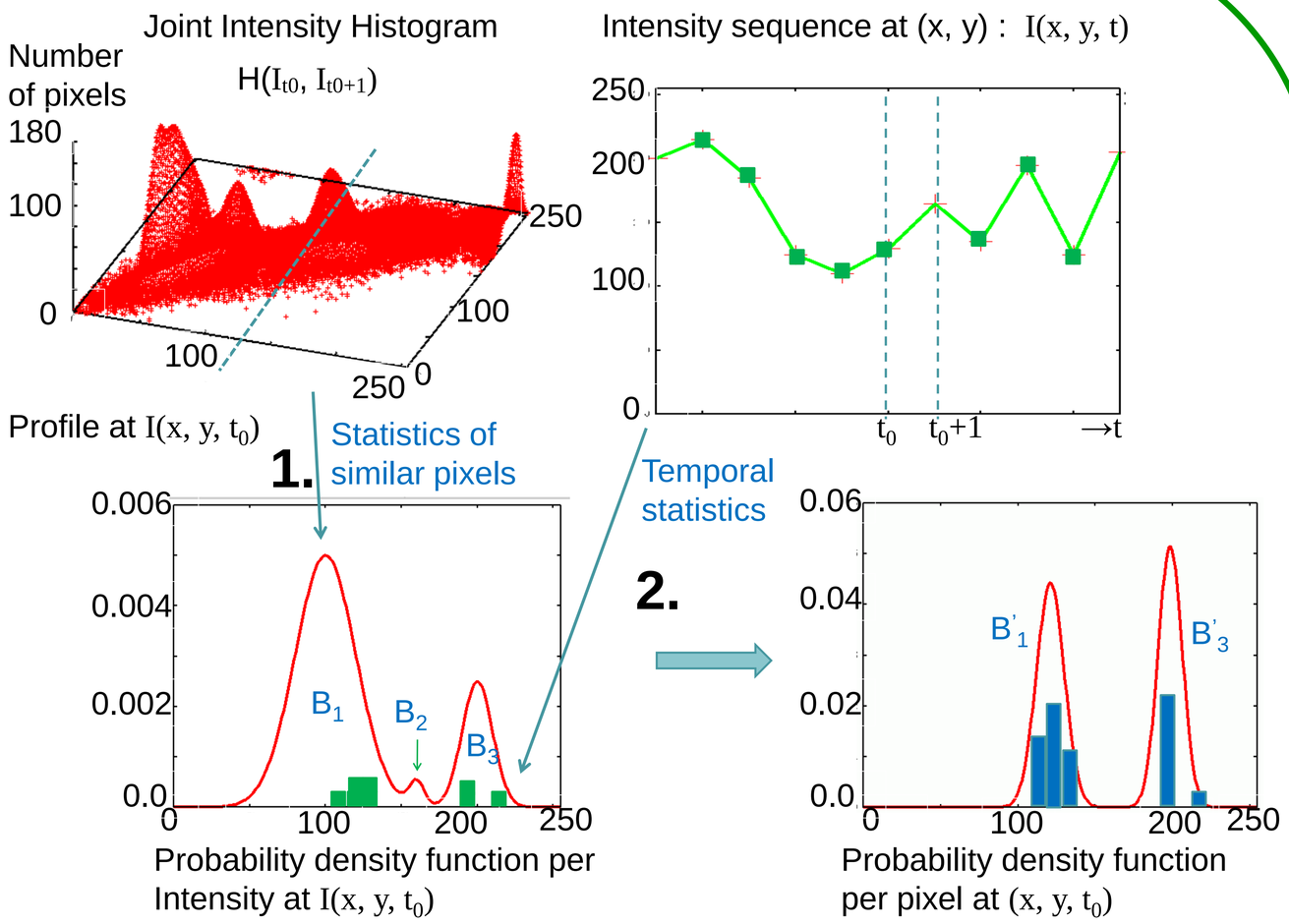
$$B = \left(\sum_{t=t_0-N_F}^{t_0+1+N_F} W_k(X(t)) * X(t) \right) - W_k(X(t_0+1)) * X(t_0+1)$$

$$C = \left(\sum_{t=t_0-N_F}^{t_0+1+N_F} W_k(X(t)) * (X(t) - \mu_k)^2 \right) - W_k(X(t_0+1)) * (X(t_0+1) - \mu_k)^2$$

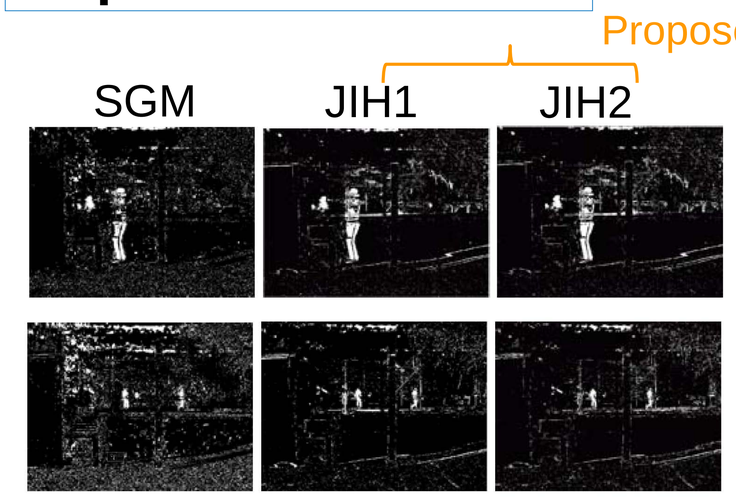
N_F: number of referred frames

Summary

- ＋Influence of outliers in time-series data is reduced
- ＋Good performance in detecting changes from field monitoring images



Experimental results



Results comparing to Ground Truth

		SGM	JIH1	JIH2
T5	TP	0.532	0.643	0.641
	FP	0.069	0.050	0.051
T6	TP	0.712	0.723	0.741
	FP	0.127	0.052	0.054

TP: True Positive
FP: False Positive