heatmap construction using background subtraction

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***Abstract*—**

***Keywords*-Heatmap; Background subtraction;**

I. Introduction

As anlises de comportamento de clientes em lojas possuem grande valor para varejistas, empresas e organizaes, j que podem ser utilizadas para aperfeioar suas estratgias de marketing, e ajudar os clientes nas tomadas de decises. Algumas das anlises realizadas por tcnicas computacionais atualmente so feitas por meio de tecnologias que impe algumas limitaes, exigindo dispositivos acoplados ao cliente ou at mesmo identificaes previamente definidas nos produtos de uma loja. Do mesmo modo, as ferramentas tecnolgicas existentes ainda so pouco acessveis, sendo compostas de solues comerciais que exigem um investimento alto e consequentemente pouco exploradas. Este trabalho implementa um sistema baseado em viso computacional capaz de detectar clientes em lojas a fim de criar um mapa de calor para apoiar as anlises de comportamento de clientes. Utilizando datasets disponvieis publicamente, fizemos uma prova de conceito para o sistema, e validamos os resutados.

A. Related work

O trabalho de Padua [1] desenvolve um sistema baseado em viso computacional para apoiar as anlises ttica e fsica no futsal. Em seu sistema foram utizadas as tcnicas de subtrao de fundo baseado em misturas gaussianas descritas em [2] e operaes morfolgicas sobre imagens como descrito em [3].

B. Technique overview

II. Technical background

A. Important concept

Definition 1 (Image binarization)**.** *Binarization is the conversion of a gray scale image to a two values image. There are many binarization formulas, we used the following:*

$$output(x,y) = \begin{cases} G_{max} & \textit{if } input(x,y) > threshold \\ 0 & \textit{otherwise} \end{cases}.$$

Definition 2 (Gaussian filter)**.** *The Gaussian Filter is a 2D convolution with a kernel defined by samples of the 2D Gauss function. This function is defined as follows:*

$$G_{\sigma,\mu_x,\mu_y}(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{(x-\mu_x)^2}{2\sigma^2}} e^{\frac{(y-\mu_y)^2}{2\sigma^2}}.$$

Definition 3 (Dilation)**.** *Dilation is the morphological transformation which combines two sets using vector addition of set elements. Let A and B be subsets of image carrier Ω. The dilation is defined as:*

$$A \oplus B = \{c \in \Omega | c = a + b \textit{ for some } a \in A \textit{ and } b \in B\}.$$

Definition 4 (Erosion)**.** *Erosion is the morphological dual to dilation.Let A and B be subsets of image carrier Ω. The erosion is defined as:*

$$A \ominus B = \{x \in \Omega | x + b \in A \textit{ for every } b \in B.$$

Definition 5 (Opening)**.** *The opening of image B by structuring element K is denoted by $B \circ K$ and is defined as:*

$$B \circ K = (B \ominus K) \oplus K.$$

Definition 6 (Closing)**.** *The closing of image B by structuring element K is denoted by $B \circ K$ and is defined as:*

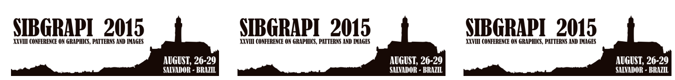
$$B \circ K = (B \oplus K) \ominus K.$$

III. Methodology

A. Dataset

B.

C. Result display



(a) First step (b) Second step (c) Result

Fig. 1. Technique overview

IV. Experiments

V. Results and Discussion

We performed the above-mentioned experiments on the following type of data: ... For each data, we used the following tuning parameters of our method.

A. Performances

We report on Table I the performances of our technique on a computer at xxGhz with this graphic card.

B. Quality

As observed on Fig. **??**, our method achieve good results in this situation. This can be measured by this criterion, and the results are reported on Table II.

TABLE I
PERFORMANCES RESULTS: TIMINGS ARE EXPRESSED IN MILLISECONDS.

Data	Size	Ours	Previous	Gain
Data 1	50	0.1	1 000	x10^3
Data 2	100	0.2	2 000	x10^3
Data 3	500	0.8	10 000	x10^3
Data 4	1 000	1.2	20 000	x10^3
Data 5	5 000	1.9	100 000	x10^4
Data 6	10 000	2.1	200 000	x10^4

TABLE II
QUALITY MEASURES: TIMINGS ARE EXPRESSED IN MILLISECONDS.

Images	PSNR	MSE
Image 1	40.2	0.02
Image 2	30.9	1.02
Image 3	20.1	0.18

C. Limitation

As mentioned in Section **??**, we expect our method to suit better this kind of data. On the other kind, this particularity does not fit into our formulation for this and that reason. Indeed, this can be observed in the results of Fig. **??**. We plan to improve for that kind of data in future work. However, our technique performed well on this data, which does not respect our condition, since this other aspect reduced the negative impact of its characteristic.

VI. CONCLUSION

In this paper, we introduced this technique and showed that it is particularly appropriate for that application. We obtained this and that improvements, and plan to extend this application in that direction in future work.

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