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. In order to build the heatmap, we segmented the image using background subtraction, and used morphological transformations to remove noise and correct small failures on the objects.

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].

II. Fundamentals

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:*

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

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

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

Definition 7 (Background subtraction)**.** *Background subtraction (BS) is a technique used for detecting moving objects in videos from static cameras. It calculates the foreground performing a subtraction between the current frame and a background model, which contains everything that can be considered as background.*

III. Proposed Approach

The dataset used for the experiments was CAVIAR[1]. In order to detect people in the scene we follow the Figure 1.

A. Gaussian filter

For each frame of the input video we use a Gaussain filter to reduce noise. This filter produces an output image blurrier than the original image, but as we are not interested on small details, this effect has no relevance.

[1] http://homepages.inf.ed.ac.uk/rbf/CAVIARDATA1/

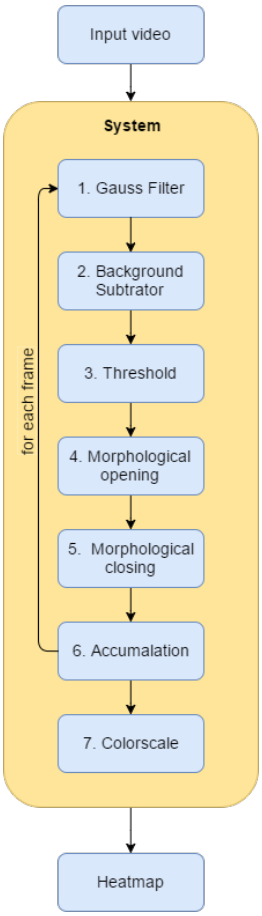

Fig. 1. pudim

B. Background subtraction

With each filtered frame, the system perform a background subtraction in order to segment the image and detect people in the scene. While there are many BS implementations, our application demands an adaptive technique that is able to update its background model when the scene changes permanently, for example when a customer removes a product from the shelve. For that reason, we used the BS technique proposed by Zivkovic [2], which is implemented in OpenCV [4]. The parameters used for the algorithm were experimentally defined, according to the dataset used in order to better segment people on scene.

IV. Experimental results

V. Concluding Remarks

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