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A proposal of an index to measure press-through package design similarity

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Abstract

In this study, we proposed the distances of PTP sheet designs to measure their similarities. Under the assumption that the design repeats in the direction of row, it was decomposed into the parts of repetition unit. We employed template matching to obtain the best matching of the parts, and defined intermediate expressions of the designs to absorb the aperiodicity in the designs of the parts. We defined two distances, the extension of Euclid distance of the intermediate expressions in *CIE L*a*b** combining low pass filter in frequency domain, and the distance to measure the difference of the shifts. We calculated the distances for each pair of 198 PTP designs, and searched the designs that have short distance to randomly selected input designs. As a result, for three input images, we could extract PTP sheet designs similar to the inputs. It was also found that, if the ratio of forecolor part to background color part is small, the distance tends to have small value. Because of this, it is necessary to limit the use of d_{int} to search PTP sheet images which is similar to an input image.

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1. Introduction

Proper use of proper drugs prevents medical accidents which originate from drugs. There are many causes that inhibit proper drug use, and confusing packages of drugs are one of major causes of mixing-up the drugs. It was reported that there were 16 incidents in Japanese pharmacies which originated from the similarity of tablet packages in 2011.

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In order to prevent accidents caused by confusing packages, Ministry of Health, Labour and Welfare in Japan discusses and adopts countermeasures, including submittance of notices. Press-Through-Package (PTP) sheets is a packaging unit of medical drug tablets. There is, unfortunately, no systematic measure to identify what PTP sheets are similar to each other. The reason why there is no systematic measure is the lack of a quantitative measurement of packages' similarities.

We assumed that the busy situation of pharmacists makes them roughly see the designs and get confused for similar ones. It is known that, for pharmacists, it takes only one second to see the backside of a PTP design during preparing drugs [1].

In our past study [2], we employed Fourier analysis to the periodical design of PTP sheets to extract their features. Since periodicity of the design is two dimensional, we applied two dimensional Fourier transform to the design. From the result, we clarified that we can separately deal with the atom part of design (prototile) and the periodicity of its copies. Under the assumption of busy situation, we employed rectangular approximation of a prototile to realize course-graining and compared it to the original prototile. The result showed that the transformed images in low frequency region hold information to distinguish/identify designs in prototiles. However, we limited ourselves to discuss gray scale PTP sheet designs and did not clarify how to measure the extent of similarity of PTP sheets.

In this study, we extend the above study to take account of color distribution in PTP sheets and propose their similarity index. A color in each pixel is mapped to a point in *CIE L*a*b** color system. We assume the design is the union of copied parts assigned to each row of tablets. As for the copied parts, we apply Fourier transformation to the distribution of each color and apply a low pass filter. We propose similarity index of a pattern in low frequency region based on relative perceptual difference of colors, namely, Euclid distance in $L^*a^*b^*$ color system. Besides, we propose the similarity index for displacement of the copies.

As an experiment, we calculated the distances for the PTP sheet designs of medical drugs in the market, investigated the distribution of the distances and searched the designs that had short distance to randomly selected input designs.

2. Method

Let W denote the width of original PTP sheet and H its height. If the PTP sheet has N rows of tablets, under the assumption that the PTP sheet is the union of the parts assigned to each row of tablets, the height of each part is given as $h = H/N$.

Then, we can define the RGB-valued function that shows the color at the point (x, y):

$$\boldsymbol{P}(x,y) = \sum_{k=1}^{N} \boldsymbol{\rho}_k(x, y - kh), \tag{1}$$

where $\boldsymbol{\rho}_k(x,y)$ is a vector value function that defines the color at the point (x,y) in the k^{th} part $(k = 1, 2, \dots)$. Note that the domain of the function $\boldsymbol{P}(x,y)$ is the rectangle, $0 \le x \le W \; and \; 0 \le y \le H$, and $\boldsymbol{\rho}_k(x,y)$ has its support in the area, $0 \le x \le W \; and \; 0 \le y \le h$.

Basically, we can assume that $\boldsymbol{\rho}_k(x,y)$ for $k > 1$ is almost the same as $\boldsymbol{\rho}_1(x,y)$, if the target PTP sheet is in pitch type printing, and we need to shift $\boldsymbol{\rho}_k(x,y)$ to make it coincide with $\boldsymbol{\rho}_1(x,y)$, if the target PTP sheet is in random type printing. However, there are the cases that the design of each part is different in some PTP sheets. We therefore generalize this idea so that our method can be applicable even for such cases.

In order to formulate this, we introduce the shift function,

$$S^{a,b}\big(\boldsymbol{f}(x,y)\big) = \boldsymbol{f}((x-a) \; mod \; W, (y-b) \; mod \; h), \tag{2}$$

where mod denotes modulo operation, and the function to measure the similarity based on template matching,