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Using ImgSeek to Support Pharmacy Students for Pill Identification

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Abstract: The number of tablets and capsules has been increasing very fast. It is difficult to identify all of them correctly. To support pharmacy students recognize more medicines, we need some tools that have ability of searching by images. The purpose of this study was to investigate the usability of the imgSeek, image processing open source software, for pills (tablets and capsules) identification. The photographs from both sides, i.e., front and back of 100 pairs of different pills were used for investigated. Two experiments were done, i.e., difference on a pair of identical pills and difference on patterns of physical characteristics. For patterns of physical characteristics, differences of color patterns, imprints and scorings are considered. The percentage of similarity and rank of the correct images were collected. The mean/median differences of these values were evaluated by statistical methods with 95% confidence level. The results from both of the percentage of similarity and rank for difference on a pair of identical pills and difference on patterns of physical characteristics were high significantly different ($p<0.01$). From the results, imgSeek could be applied for tablets and capsules identification. Students should be informed that a long ranked list of pills might be considered especially, a pill with simple physical characteristics.

Key words: Pill identification, imgseek, physical characteristics, image processing, confidence

INTRODUCTION

Pill identification is the process to find out what a pill is i.e., the trade name, strength of a pill, including some properties of a pill should be clarified. It is necessary to identify a pill in order to provide correct information to patients. Information calls about pill identification was significantly increased (Spiller and Griffith, 2009). Nowadays, the number of medicines has been increasing very fast from diverse reasons such as growth of medication using, demand and generic brands from medical companies (Aimsa-ard, 2000). Normally, pharmacists in a hospital and a drug store identify a pill by its physical characteristics. Various physical characteristics can be applied to a pill. From these reasons, identification of pills correctly is more difficult. The identification method based on external physical characteristics is widely used in hospitals and drug stores. With this method, two patterns of input can be applied, i.e., searching with external physical characteristics given by users and searching by images of pills (Chen *et al*., 2012).

Firstly, finding a pill with its physical characteristics given by users. This pattern is used in majority of pill identification systems. Presently, there are some public pill databases to service users for searching by this pattern (Pill-identifier, 2016). However, pills in these databases are usually limited to their regions. Some limitations of this pattern are found. For instances, it depends on user's ability to fill external physical characteristics, e.g., shape, color and imprint, in an identification form to get a set of pills which the pill we would like to identify is included in the set. User's knowledge and experiences can affect searching time and searching accuracy (Chen *et al*., 2012). Therefore, this searching pattern may have some inconsistencies. An advantage of this pattern of searching is that no intervention with a pill is necessary in a process of pill identification.

Secondly, an image of a pill is used as an input to a system. With this pattern, it can reduce restrictions and inconsistencies of the first searching pattern (Chen *et al*., 2012). The advantage of searching by images is that no information about the pill is need. However, the method to get appropriated photographs of a pill is an essential step. When pharmacy students begin to study pharmaceutical products, only a few products they can recognize. To support pharmacy students recognize more medicines, we need some tools that have ability of searching by images. Some criteria are set for selecting a tool. It should be open

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source software. Therefore, we can use and modify the code under GNU General Public License (GPL). It should be easy to use with a short-period training. Moreover, if possible, it should range a set of images and ordered by similarity between an input image (unknown) and standard images of pills in a database. This tool will be used for blended learning for pharmacy students. The result from searching shows a set of pill's images which these images are closed to the input image in at least some characteristics. From these reasons, we interest to investigate the usability of imgSeek, image processing open source software, for pills identification by images. The photographs from 100 pairs of different pills which are taken at the same control environment, are used for investigated. External physical characteristics of pills, directly affect to results from imgSeek (Owen, 2003; Jacobs *et al*., 1995). In this study, three physical characteristics are taken into account, i.e., difference on a pair of identical pills, difference on patterns of physical characteristics and difference on finding the correct pill using both sides. Details of physical characteristics on tablets and capsules as well as the imgSeek are described, respectively.

Physical characteristics of tablets and capsules: Several external physical characteristics of pills are usually applied for drug identification, e.g., size, shape, color, scoring and imprint (Knoben and Phillips, 2014; Hoover *et al*., 2016). Size of pills depends on the volume of ingredients which are combined in drug formulas and drug administration. In case of a pill is composed of a large volume of active ingredients and/or excipients, it should be large size. In addition, drug administration is a factor for determining size of a pill. For example, sublingual pills should have small size for comfortable use. For shape, round, oblong and oval are general shapes of pills because they are easy to swallow and produce. However, some other shapes may be produced, e.g., triangle, rectangle, pentagon and hexagon. At present, shape of pills has variety as market competition. The original drug companies want to construct their brand's identity. Therefore, dissimilar shapes are successful alternative (Aimsa-ard, 2000). When shapes are remindful, other companies will produce the same shape as the original company's shape is. Color pattern of pills is not only a part of brand's identity but also impact to patient's emotion. White color and light colors are frequently used because of it make patients feel safe to take. Sometimes, active colors are used to warning patients about potent drugs. Pills can be one color or multi-color. For capsule dosage form, it is often to find capsule bodies and caps having different colors. Moreover, colors of pills may affect emotional of alertness, bitterness and efficiency in reduce anxiety (Wan *et al*., 2015). Scorings on surface of pills is a benefit to cut up the pill to equal parts. Different shapes, sizes and styles can be used for pill identification. The imprint consists of characters, numbers and/or symbols which are painted or hammered on surface of pills. Imprints usually concise details about trade name, active ingredient, strength or manufacturer (logo of the company). As above-mentioned details, all five patterns of physical characteristics are usually used for pills identification (Caban *et al*., 2012; Lee *et al*., 2012). In this study, four groups of pills were classified based on their color patterns, imprints and scorings.

The imgSeek: The imgSeek is free open source software for searching a collection of images using visual similarity. Therefore, the searching image can be expressed as photographs or rough paints of objects. Searching algorithm of imgSeek is multiresolution (wavelet) decompositions. This algorithm considers the basic shape and color information (Jacobs *et al*., 1995). In a processing step, the collection of the training set is created into a database (Fig. 1). The imgSeek performs a wavelet transform on every image in the database and then distills a small signature for each image. All of the signatures are collected for organized searching because it is easy and fast to compare them with a new signature. When users submit query images, there are extracted their signature. Then the imgSeek compare the query image signatures with the signatures of the database images. The match results are retrieved to users as the percentage of similarity and rank (Fig. 2).Two types of image input for imgSeek can be used, i.e., an image file and a crude picture from painting on the screen. The imgSeek supports several file formats, e.g., jpg, png, gif and bmp. Images in imgSeeks are easy to manage to be a good collection. The imgSeek was applied on some research works for object identification (Owen, 2003; Liu and Lu, 2010; Aletras and Stevenson, 2012). However, pills have various external physical characteristics. Some pills may look different from the others while a set of pills may look alike. Besides the image searching, metadata for each image can be edited. Some attributes about tablets and capsules should be added into metadata, e.g., trade name, generic name, strength, dosage form, indication and precaution. Advanced keyword searching on metadata may be useful. In our previous work, the background setting to take a photograph tablets and capsules identification by imgSeek was studied.

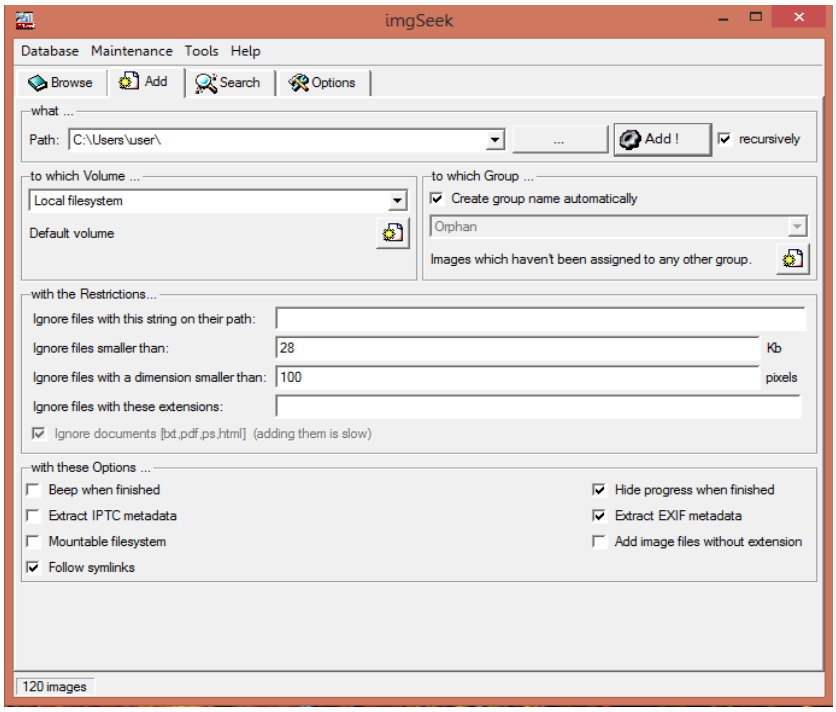

Fig. 1: The user interface for managing images

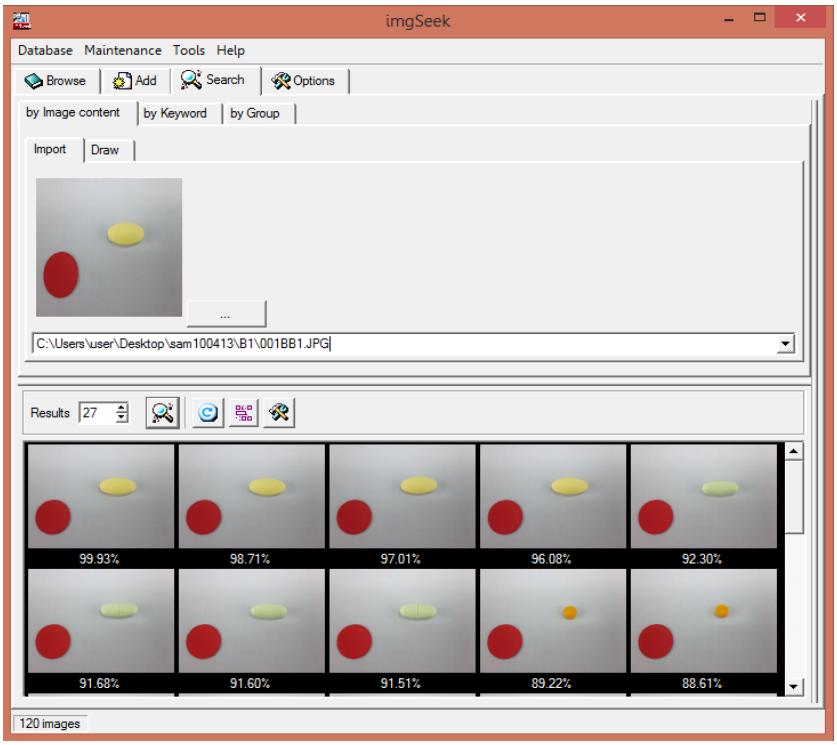

Fig. 2: The user interface for searching an image

MATERIALS AND METHODS

Experimental settings: In order to evaluate the imgSeek for tablets and capsules identification, one hundred of difference pills (60 tablets and 40 capsules) were used. We selected two pills for each medicine randomly. In case of different patterns on both sides on a selected pill, it was taken photographs from both sides, i.e., front and back. Two sets of photographs were taken from the first set of pills. The first set of photographs was used as a training set and the other set was used as a test set. This test set was called "test A". A set of photographs was taken from the second set of pills. This set was used as the other test set. This test collection was called "test B". The diagram of using training and test sets in experiments is shown in Fig. 3.

All photographs were taken by a compact camera at the same control environment. The 18% of black color paper (natural grey paper) with a red circle which is used as a referencing object was used as a background. The diameter of the circle was two centimeters and located at the left lower corner. The resolution of 12 megapixels is applied on all images. Photographs on both sides of pills if they are different were used. The results were analyzed in two experiments as follow

A pair of identical pills: The difference on a pair of identical pills was evaluated. Both test sets, i.e., test A and test B were identified by the imgSeek. The percentages of similarity and ranks of the correct images were recorded. The mean difference of the percentage of similarity was evaluated by student's t-test and the rank was evaluated by Mann-Whitney U test at 95% confidence level, respectively.

The different patterns of physical characteristics of pills: The difference on patterns of physical characteristics was investigated. We consider about difference of color patterns, imprints and scorings. The test B was separated into four groups according to physical characteristics of a pill (Fig. 3). The first group consists of pills which have one background color and all similar patterns of imprint and scoring on both sides. The second and the third groups both have one background color on both sides of a pill. The one side of the second group has imprint and/or scoring while at the other side of a pill does not have any patterns. For the third group, either imprint or scoring on both sides was different (Table 1).

The multiple colors of background on one side or both sides were the main characteristics of the last group. It may have differences on imprint and/or scoring. The percentage of similarity and rank of the correct images

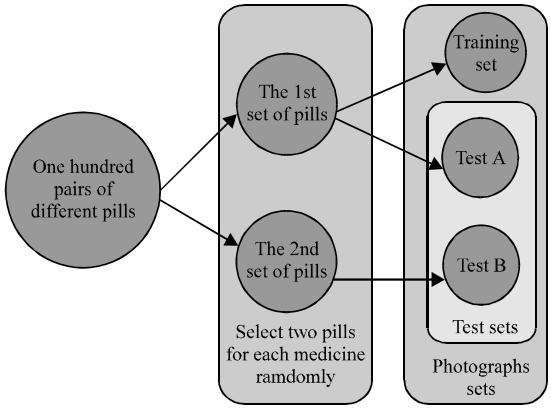

Fig. 3: The photographs are used for investigated

Table 1: Four Groups of the test set according to difference on physical characteristics of pills between both sides

Difference on Physical Characteristics of pills		
Color	Imprint and scoring	Examples
One background color	Same	
One background color	The one side has imprint and/or scoring while at the other side does not have any pattern	
One background color	Different	
Multi-color background	Maybe different	

were calculated. The mean difference for values of percentages similarity was evaluated by one-way ANOVA and rank was evaluated by Kruskal-Wallis Test at 95% confidence level, respectively.

RESULTS AND DICUSSION

A pair of identical pills: An average percentage of similarity and an average rank of the test A were 97.59% and 3.56, respectively. For the test B, these results were 87.64 and 11.84%, respectively. The p-value of both the percentage of similarity and rank between test A and test B were 0.00 at 95% confidence level.

The mean difference on a pair of identical pills was highly significant on both the percentage of similarity and rank ($p<0.01$). In case of the test image was matched with the same image of that pill in the database, the percentage of similarity returned from imgSeek should be closed to 100% and the rank should be equal to 1 (the top rank). Therefore, the test A was taken from the similar pill as with the same control environment (the same pill but not

Table 2: Percentages of Similarity and ranks of the correct images for each group

Percentages of similarity	Median of ranks
88.59	10
88.17	12
88.35	15
83.61	03

the same image). The average percentage of similarity was 97.59% and the average rank was 3.56. On the other hand, the test B was taken from the other pill of the same medicine. With the same control environment, the average percentage of similarity was 87.64% and the average rank was 11.84. The lower average percentage of similarity and higher average rank were results of difference on a pair of identical pills due to both images were not exactly the same. In the real situation, an image is taken from another pill. From the results, we should inform students that the correct medicine might not be the first rank. They should consider more pills to get the correct pill. Moreover, images surround the correct images may highly similar to the test image. In the real world, several medicines may be look alike.

The different patterns of physical characteristics of pills: The average percentage of similarity and median of ranks from the four groups of pills is shown in the Table 2.

The p-value of both the percentage of similarity and rank among four groups, were both 0.00 at 95% confidence level. Study about difference on patterns of physical characteristics. The fourth group of pills which had multi-color background and might have difference on imprint or scoring, had lower average percentage of similarity than other groups because of difference on color patterns in background of a pill. However, the fourth group had better rank than the others did. The reason was that the unique pattern for each pill made it easy to find. Moreover, the number of multi-color pills was less than the number of single color pill. Therefore, imgSeek ranked these pills on top of the list. From the results, patterns of physical characteristics affected to imgSeek's results. However, difference on color patterns (multiple colors of background at least on one side) was more impact than difference on imprint and scoring patterns. A pill with simple pattern should be more concerned when pill identification is performed.

CONCLUSION

This research investigated the usability of the imgSeek for pill identification. The photographs from both sides, i.e., front and back from 100 pairs of different pills were used for investigated. Two experiments were done, i.e., difference on a pair of identical pills and difference on patterns of physical characteristics. For patterns of physical characteristics, differences of color patterns, imprints and scorings were considered. The percentage of similarity and rank of the correct images were collected. The mean differences of these values were evaluated by statistical methods with 95% confidence level. The results from both of the percentage of similarity and rank for difference on a pair of identical pills and difference on patterns of physical characteristics were highly significant differences. An average percentage of similarity and an average rank of the test A, that were taken from the similar pill, were 97.59 and 3.56%, respectively. For the test B, each test image was taken from another pill of the same medicine, the results were 87.64 and 11.84%, respectively. The group of pills which had multi-color on at least one side, got better rank than the other groups. From the results, the imgSeek could be applied for tablets and capsules identification. In the real situation, a long ranked list of pills should be considered, especially, a pill with simple physical characteristics. The concept of searching by images of pills is recommended to reduce limitations and inconsistencies of searching with physical characteristics given by users. The imgSeek can be applied to support pharmacy students for the topic of pills (drugs) identification. A standard set of pill's images that are used in a hospital or a drug store, should be loaded into a collection of pills. Students need to be trained to take a photo of a pill. When a query image is put into the system, a set of images should be considered rather than the first ranked image on the list. Moreover, a set of look-alike drugs may be kept in mind.

In this research, pill identification is processed by image processing software. A long ranked list is provided. To alleviate this problem, some physical characteristics of a pill, provided by a user can be combined with image processing to obtain a short ranked list. We left this issue for our future research.

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