

# Method for Choosing the Image Content Attributes in Image Database System

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This paper proposes a method for choosing the attributes, which best describe the content of an image. The purpose is to enable more effective indexing in an image database system. To illustrate the method a collection consisting of herb photographs and drawings is entered into specially created for the purpose relational database.

**Keywords:** *Databases, Image Databases, Image Database Design*

## INTRODUCTION

Recently there has been a great interest in newly developed image database systems such as the *SQL Multimedia* offered by Digital Equipment Corporation, *Query By Image Content (QBIC)* research project designed by IBM Corporation [Flic95] and *Kodak Photo CD System* introduced by Kodak. The retrieval in such systems is content base and the characteristics of the image and its elements are described as a set of parameters. This set of parameters and the methods for their extraction are the crucial part in the functioning of image databases [Stan92]. The methodology for choosing those attributes in conventional databases is described in [Elma94], but there are not any publications dealing with the procedure for image databases. In this paper a method for choosing the most appropriate set of attributes for a particular image application domain is proposed.

The attributes that can be used to specify the content of an image could be divided in five categories: shape, colour, texture, measurable and subjective parameters [Stan96]. The idea of the proposed methods is first to design a temporary relational database that contains all related attributes for a particular domain application. The next step is to enter the characteristics of several pictures and drawings representing each of the objects and then filter out the most stable attributes for each of them.

## THE METHOD

An image database has to be created. Let's assume that the application domain consists of  $N$  objects and  $K$  elements and the  $j^{\text{th}}$  object consists of  $k_j$  elements. As well there are  $a_i$  attributes describing the  $i^{\text{th}}$  element. The following method is proposed for choosing the attributes that are most suitable for image database indexing:

a) a relational database is build, so that there is a separate relation for each element of the application domain;

b) the elements' attributes are designed based on its shape, colour, texture, measurable and subjective parameters;

c) the numerical attributes such as length, with, ratio, etc. are normalised in the interval  $[0, 1]$ ;

d) the textual parameters are converted in linguistic variables, which are approximated with fuzzy numbers [Stan87]. There are different approaches to order fuzzy numbers. A valuable comparison is given in [Pene96]. The method proposed in [Stan87] will be used in this algorithm. The textural colour values are mapped into integer values representing the colour length  $\lambda$  ( $\lambda = 400 \text{ nm}$  to  $760 \text{ nm}$ ) [Russ95] and then normalised in the interval  $[0,1]$ ;

e) subjective parameters are treated as textual parameters as shown in d);

f) the data in the relations are filled. During the procedure different drawings and photographs of the same object are entered;

g) standard deviation of every attribute for each object is calculated;

h) the mean of the calculated standard deviations for each object is calculated for every attribute. The resulting numbers represent the average deviation of the chosen attributes for each element.

i) next the database is refined and only those attributes for which the calculated in h) mean of standard deviations is less then a previously defined threshold are left in it. Those attributes are the ones that can provide best indexing in an image database system for the application domain.

## RESULTS

An image database catalogue for herb plants is under development. The database will contain pictures and drawing for more than 200 plants. A sample drawing used for data acquisition is given in Figure 1. The proposed in the method section algorithm was followed to choose the appropriate attributes for indexing. Using the Microsoft Access<sup>®</sup> relational database package a database for herb plants

named "Herbs" was designed and created. The database includes the following tables: root, leaf, stalk, fruit and blossom. The attributes of the relations in it represent the herbs' shape, colour, texture, measurable and subjective parameters. The chosen attributes' values for different plant parts are ordered and normalised in the interval [0, 1] (Figures 2 - 6). Data for 15 different plants from five different sources ([Kita87], [Stan86], [Gabe41], [Yord78] and [Mitr82]) are acquired from two experts on the subject. The results of applying the proposed method are given in Figures 7a-d. Only attributes that have similar values for different pictures and drawings of one and same plants (that is the obtained mean from standard deviation is less than a given threshold value) will be used for indexing the plant parts in the herb image database, which will be created.

## **DISCUSSION AND CONCLUSIONS**

The proposed method is easily applicable and gives objective criteria for choosing the index parameters in an image database. Note that the proposed method can be changed from taking the mean of the standard deviation for the herbs' attributes, by using another norm (such as  $l_2$  norm) and compare the results. The experiment shows that the subjective parameters give greatest deviation and therefore are most unusable. For the fuzzy parameters this can be explained in the inaccuracy in the method that converts them from linguistic to fuzzy numbers. Another result worth noticing is that the normalised means (i.e. in [0,1]) for the different parameters describing the element form, texture, measurable, subjective and colour attributes are comparatively close (Figure 7f). A different observation of the results points out that form attributes are better suited for indexing than the shape attributes. As well while the colour attribute for the stalk is stable, this is not true for other herbs parts. Interesting result is also that the measurable parameters could some time give bigger differences than some subjective parameters.

Since the attributes depend on the application area, general prescription of using attributes could not be drawn. The proposed method is only a screening one. A refined method for separating the attribute domain between objects is under development.

## **ACKNOWLEDGEMENT**

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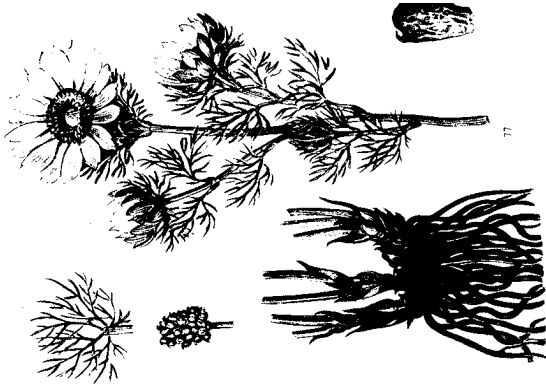


Figure 1. Drawing of the herb "Spring Adonis"

|        |        |               |               |      |   |
|--------|--------|---------------|---------------|------|---|
| 0.25 - | violet |               |               |      | corn  |
|        |        | assembly      | symmetric     |      | winged<br>pip<br>strawberry<br>stone fruit  |
| 0.50 - | blue   |               | discus-shaped |      | flattened out<br>assembly<br>many fruit<br>short-hair<br>elliptical<br>strobile<br>pulpy<br>bag-shaped<br>bowl-shaped |
| 0.75 - | brown  | false         | hooked        |      |   |
| 1.00 - | black  | many blossoms | asymmetry     | bent |   |

Figure 2. The attributes in the relational table "Fruit"

| Value  | thickness | colour        | root    | approx.     | length | branchiness | metamorphosis                | shape                  |
|--------|-----------|---------------|---------|-------------|--------|-------------|------------------------------|------------------------|
| 0.00 - | thick     | yellow        | bearded | curved      | long   | too many    | tuberiferous<br>tuber        | filiform<br>tuberiform |
| 0.25 - |           | red<br>violet |         |             |        | many        | towing<br>husk<br>short hair | spindle<br>turnip-like |
| 0.50 - | middle    |               |         |             | middle | middle      |                              |                        |
| 0.75 - |           | brown         |         |             |        | forked      |                              |                        |
| 1.00 - | thin      | black brown   | spindle | rectangular | short  | none        | faded leaves<br>none         | bearded<br>tuft-like   |

Figure 3. The attributes in the relational table "Root"

| Value  | colour | symmetry | subjective | structure          |
|--------|--------|----------|------------|--------------------|
| 0.00 - | white  | axle     | long       | little box<br>bean |
|        | red    |          | round      | pod<br>nut         |

| Value  | thickness | colour | calyx type  | cut type    | metamorphosis | approx.     | length | branchiness | leaf placement | young       | surface         | placement |
|--------|-----------|--------|-------------|-------------|---------------|-------------|--------|-------------|----------------|-------------|-----------------|-----------|
| 0.00 - | thick     | red    | bell-shaped | triangular  | root part     | rectangular | long   | strongly    | leafless       | whole       | smoothly        | upright   |
| 0.25 - |           | blue   |             | rectangular | tuber         |             |        | side        | opposite       | overground  | thorny          | raised    |
| 0.50 - | middle    |        |             | n-angular   |               |             | middle |             | successive     | underground | hairiness       |           |
| 0.75 - |           | green  | round       |             | bulb          |             |        | slightly    | nodulous       |             | short hairiness |           |
| 1.00 - | thin      | brown  | other       |             | none          | 2 curves    | short  | none        | rosette        | none        | rough           | reclined  |
|        |           |        |             |             |               |             |        |             | spiral         | fruitless   | leaves          | climbing  |
|        |           |        |             |             |               |             |        |             | ring-shaped    |             | bulging ribs    | climbing  |
|        |           |        |             |             |               |             |        |             | tuft           |             | nodulous        |           |
|        |           |        |             |             |               |             |        |             | only leaves    |             | chappy          |           |
|        |           |        |             |             |               |             |        |             |                |             | bristles        | winding   |
|        |           |        |             |             |               |             |        |             |                |             | itendril        |           |
|        |           |        |             |             |               |             |        |             |                |             | woolly          | tuft-like |
|        |           |        |             |             |               |             |        |             |                |             | furrowed        |           |

Figure 4. The attributes in the relational table "Stalk"

| Value  | colour       | calyx type  | corolla type        | floscule type            | approx.      | metamorphosis          | symmetry  | type      |
|--------|--------------|-------------|---------------------|--------------------------|--------------|------------------------|-----------|-----------|
| 0.00 - | white        | bell-shaped | tube-shaped         | single                   | triangle     | long anthers           | axle      | regular   |
|        | green yellow |             |                     | ear                      |              | fruit-leaves accreting |           |           |
|        |              |             |                     | stump                    |              | thick shield           |           |           |
|        |              |             |                     | sunshade                 |              | short hair             |           |           |
| 0.25 - | yellow       |             | bell-shaped         | little head              | rectangle    | hard bowl              |           |           |
|        |              |             |                     | little basket            |              | stamen like a tube     |           |           |
|        |              |             |                     | shield                   |              | simple perianth        |           |           |
|        |              |             |                     | collected sunshade       | Gauss' curve | no perianth            |           |           |
|        |              |             |                     | little sorghum           |              | bristles               |           |           |
|        | red          |             | funnel shaped       | shield bunch             |              | no bract               |           |           |
| 0.50 - | purple       | four parts  | ring-shaped         | floscule                 | parabola     | fringe-shaped calyx    |           |           |
|        |              |             |                     | fringe-shaped floscule   |              | awl-shaped bract       |           |           |
|        |              |             |                     | cylinder-shaped fringes  |              | downy corollas         |           |           |
|        |              |             |                     | bunch-shaped floscule    |              | sitting                |           |           |
|        |              |             |                     | shield-shaped floscule   | ellipse      | runcinate calyx        |           |           |
| 0.75 - | violet       |             | double mouth-shaped | sunshade-shaped floscule |              | indented               |           |           |
|        | blue         |             |                     | shield-shaped besom      |              | silky pappus           |           |           |
|        |              |             |                     | ear-shaped bunch         | 2 ellipses   | unisexual              |           |           |
|        | green        |             | tongue-shaped       | spherical floscule       |              | accreting anthers      |           |           |
| 1.00 - | brown        | five parts  | none                | half sunshade            | circle       | no calyx               |           |           |
|        |              |             |                     | bundle                   |              | none                   | asymmetry | irregular |

Figure 5. The attributes in the relational table "Blossom"

| Volume | colour       | type            | vein         | approx.     | stick length | edge blade type | no stick        | matamorphosis   | symmetry  | shape                                       |
|--------|--------------|-----------------|--------------|-------------|--------------|-----------------|-----------------|-----------------|-----------|---|
| 0.00 - | colourless   | double-feathery | parallel     | triangle    | long         | whole           | blade & envelop | big stipules    | axle      | acerose<br>lineal                           |
|        |              |                 |              |             |              | filed           |                 |                 |           |   |
| 0.25 - | green yellow | odd-feathery    | arched       | rhombi      | runcinate    | sharp filed     |                 |                 |           | opposite lanceolate<br>elliptic             |
|        |              |                 |              |             |              | runcinate       | blade down      | little bristles |           | egg-shaped<br>opposite egg-shaped           |
|        |              |                 |              |             |              | filed runcinate |                 |                 |           | shovel-shaped                               |
| 0.50 - | yellow       | threefold       |              | irregularly | irregularly  |                 |                 |                 |           | rhombic<br>cordate                          |
|        |              |                 |              |             |              | irregularly     |                 |                 |           | reniform<br>sagittate                       |
|        |              |                 |              |             |              | wavy toothed    | sitting         | short hair      |           | lanceolate<br>long-lanceolate               |
|        |              |                 |              |             |              | wavy            |                 |                 |           | featherly-lyriform<br>lineal-lanceolate     |
| 0.75 - | green        | palmate         | feathery     | ellipse     | feather cut  |                 |                 |                 |           | rudimentary husk<br>egg-shaped-lanceolate   |
|        |              |                 |              |             |              | lemniscat       | tendrils        |                 |           | palmate                                     |
|        |              |                 |              |             |              | lemniscat       |                 |                 |           | long-egg-shaped                             |
| 1.00 - | dark green   | pair-feadery    | palmate      | lemniscat   | lemniscat    | blade around    | blade around    | thorns          |           | long opposite cordate<br>lineal long        |
|        |              |                 |              |             |              | feathery        |                 |                 |           | elliptic egg-shaped<br>short elliptic       |
|        |              |                 |              |             |              | feather divided |                 | woolly          |           | middle elliptic<br>long opposite egg-shaped |
| 1.00 - | mutly        | simple          | reiticulated | 2 triangles | lyriform     |                 | none            | none            | asymmetry | egg-shaped triangle<br>egg-&-shovel-shaped  |
|        |              |                 |              |             |              | lyriform        |                 |                 |           |   |

Figure 6. The attributes in the relational table "Leaf"

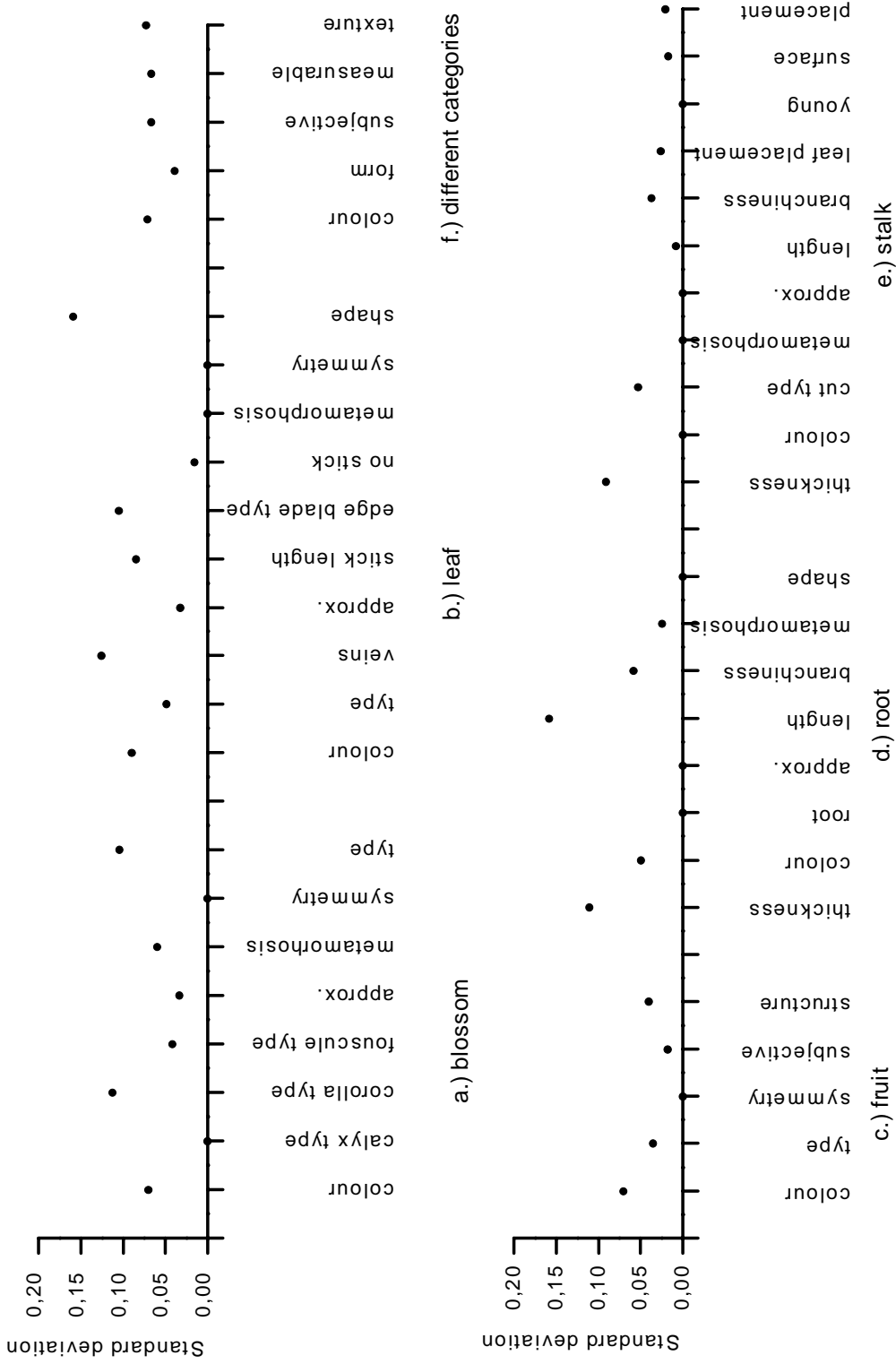


Figure 7. The results of the experiment