Experiment Report: Indexing Images for Content Based Retrieval

Dang Fan[*]
School of Software
Tsinghua University
dangf09@gmail.com

Ding Peng[†]
School of Software
Tsinghua University
dingpeng09@gmail.com

Wang Shuhao[‡]
School of Software
Tsinghua University
shudiwsh2009@gmail.com

ABSTRACT

The aim of this paper is to provide a report of an experiment using image features to index and search images by content. It presents the main method of features extraction based on histogram, the comparison of effectiveness and relevance by varing the number and type of features, and the approach to improve the performance of R-tree.

Categories and Subject Descriptors

I.4.7 [**Image Processing and Computer Vision**]: Feature Measurement; H.2.8 [**Database Management**]: Database Applications

General Terms

Experimentation

Keywords

image index, histogram, r-tree

1. OUTLINE

1.1 Experimental System

This experimental system is written in Python. However, the imaging package (Python Imaging Library)[1] and the core of R-tree package (libspatialindex) are written in C/C++.

The Python Imaging Library (PIL) can be downloaded from `http://effbot.org/downloads/Imaging-1.1.7.tar.gz`. Notice that it is required to install libjpeg first in order to deal with JPEG files according to the installation instruction.

The R-tree libraries are located at `/experiment1/libs/`. libspatialindex (`spatialindex-src-1.7.1.tar.gz`) is a library to provide a framework that supports spatial indexing methods, which can be found at `http://libspatialindex.github.com/`. Rtree (`Rtree-0.7.0.tar.gz`) is a ctypes Python wrapper of libspatialindex, which can be found at `http://pypi.python.org/pypi/Rtree/`. In this experiment, we modified these two libraries to achieve the requirement of this experiment, including counting the number of node access and adjustment of parameters of Rtree.

This experimental system consist of 4 files:

- `ImageFeatureExtractorV1.py`
- `ImageFeatureExtractorV2.py`
- `Queries.py`
- `Main.py`

The first two files are implementations of two different approaches of color histogram features, which is defined in section 1.2. To use these two programs, you need to put them in the parent directory of `image`. Then excuting `python ImageFeatureExtractorVx.py`, the files like `color_feature_4.txt`, `imagelist_8.txt` will be generated. The format of these files is identical to the format of files provided by the project.

The third file is used to generate the number of node access with respect to the various number of features and the number of data objects inserted. It also generates the correctness rate, which is defined in section **??**.

The last file is a program that provided an interface for querying by example.

1.2 Definitions of the features

aaa

2. THE *BODY* OF THE PAPER

Typically, the body of a paper is organized into a hierarchical structure, with numbered or unnumbered headings for sections, subsections, sub-subsections, and even smaller sections. The command `\section` that precedes this paragraph is part of such a hierarchy.[1] LATEX handles the numbering and placement of these headings for you, when you use the appropriate heading commands around the titles of the

---

[*]Student ID: 2009013215
[†]Student ID: 2009013219
[‡]Student ID: 2009013229

---

[1]This is the second footnote. It starts a series of three footnotes that add nothing informational, but just give an idea of how footnotes work and look. It is a wordy one, just so you see how a longish one plays out.

headings. If you want a sub-subsection or smaller part to be unnumbered in your output, simply append an asterisk to the command name. Examples of both numbered and unnumbered headings will appear throughout the balance of this sample document.

Because the entire article is contained in the **document** environment, you can indicate the start of a new paragraph with a blank line in your input file; that is why this sentence forms a separate paragraph.

2.1 Type Changes and *Special* Characters

We have already seen several typeface changes in this sample. You can indicate italicized words or phrases in your text with the command `\textit`; emboldening with the command `\textbf` and typewriter-style (for instance, for computer code) with `\texttt`. But remember, you do not have to indicate typestyle changes when such changes are part of the *structural* elements of your article; for instance, the heading of this subsection will be in a sans serif[2] typeface, but that is handled by the document class file. Take care with the use of[3] the curly braces in typeface changes; they mark the beginning and end of the text that is to be in the different typeface.

You can use whatever symbols, accented characters, or non-English characters you need anywhere in your document; you can find a complete list of what is available in the *LaTeX User's Guide*[**?**].

2.2 Math Equations

You may want to display math equations in three distinct styles: inline, numbered or non-numbered display. Each of the three are discussed in the next sections.

2.2.1 Inline (In-text) Equations

A formula that appears in the running text is called an inline or in-text formula. It is produced by the **math** environment, which can be invoked with the usual `\begin. . .\end` construction or with the short form `$. . .$`. You can use any of the symbols and structures, from α to ω, available in LaTeX[**?**]; this section will simply show a few examples of in-text equations in context. Notice how this equation: $\lim_{n\to\infty} x = 0$, set here in in-line math style, looks slightly different when set in display style. (See next section).

2.2.2 Display Equations

A numbered display equation – one set off by vertical space from the text and centered horizontally – is produced by the **equation** environment. An unnumbered display equation is produced by the **displaymath** environment.

Again, in either environment, you can use any of the symbols and structures available in LaTeX; this section will just give a couple of examples of display equations in context. First, consider the equation, shown as an inline equation above:

$$\lim_{n\to\infty} x = 0 \tag{1}$$

---

[2] A third footnote, here. Let's make this a rather short one to see how it looks.
[3] A fourth, and last, footnote.

Table 1: Frequency of Special Characters

Non-English or Math	Frequency	Comments
$\emptyset$	1 in 1,000	For Swedish names
π	1 in 5	Common in math
\$	4 in 5	Used in business
Ψ_1^2	1 in 40,000	Unexplained usage

Notice how it is formatted somewhat differently in the **displaymath** environment. Now, we'll enter an unnumbered equation:

$$\sum_{i=0}^{\infty} x + 1$$

and follow it with another numbered equation:

$$\sum_{i=0}^{\infty} x_i = \int_0^{\pi+2} f \tag{2}$$

just to demonstrate LaTeX's able handling of numbering.

2.3 Citations

Citations to articles [**?**, **?**, **?**, **?**], conference proceedings [**?**] or books [**?**, **?**] listed in the Bibliography section of your article will occur throughout the text of your article. You should use BibTeX to automatically produce this bibliography; you simply need to insert one of several citation commands with a key of the item cited in the proper location in the `.tex` file [**?**]. The key is a short reference you invent to uniquely identify each work; in this sample document, the key is the first author's surname and a word from the title. This identifying key is included with each item in the `.bib` file for your article.

The details of the construction of the `.bib` file are beyond the scope of this sample document, but more information can be found in the *Author's Guide*, and exhaustive details in the *LaTeX User's Guide*[**?**].

This article shows only the plainest form of the citation command, using `\cite`. This is what is stipulated in the SIGS style specifications. No other citation format is endorsed.

2.4 Tables

Because tables cannot be split across pages, the best placement for them is typically the top of the page nearest their initial cite. To ensure this proper "floating" placement of tables, use the environment **table** to enclose the table's contents and the table caption. The contents of the table itself must go in the **tabular** environment, to be aligned properly in rows and columns, with the desired horizontal and vertical rules. Again, detailed instructions on **tabular** material is found in the *LaTeX User's Guide*.

Immediately following this sentence is the point at which Table 1 is included in the input file; compare the placement of the table here with the table in the printed dvi output of this document.

To set a wider table, which takes up the whole width of the page's live area, use the environment **table*** to enclose the table's contents and the table caption. As with

Figure 1: A sample black and white graphic (.eps format).

Figure 2: A sample black and white graphic (.eps format) that has been resized with the `epsfig` command.

a single-column table, this wide table will "float" to a location deemed more desirable. Immediately following this sentence is the point at which Table 2 is included in the input file; again, it is instructive to compare the placement of the table here with the table in the printed dvi output of this document.

2.5 Figures

Like tables, figures cannot be split across pages; the best placement for them is typically the top or the bottom of the page nearest their initial cite. To ensure this proper "floating" placement of figures, use the environment **figure** to enclose the figure and its caption.

This sample document contains examples of **.eps** and **.ps** files to be displayable with LaTeX. More details on each of these is found in the *Author's Guide*.

As was the case with tables, you may want a figure that spans two columns. To do this, and still to ensure proper "floating" placement of tables, use the environment **figure*** to enclose the figure and its caption.

Note that either **.ps** or **.eps** formats are used; use the `\epsfig` or `\psfig` commands as appropriate for the different file types.

2.6 Theorem-like Constructs

Other common constructs that may occur in your article are the forms for logical constructs like theorems, axioms, corollaries and proofs. There are two forms, one produced by the command `\newtheorem` and the other by the command `\newdef`; perhaps the clearest and easiest way to distinguish them is to compare the two in the output of this sample document:

This uses the **theorem** environment, created by the `\newtheorem` command:

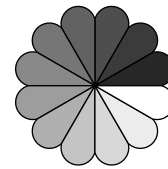THEOREM 1. *Let f be continuous on $[a, b]$. If G is an*

Figure 3: A sample black and white graphic (.ps format) that has been resized with the `psfig` command.

antiderivative for f on $[a, b]$, then

$$\int_a^b f(t)dt = G(b) - G(a).$$

The other uses the **definition** environment, created by the `\newdef` command:

Definition 1. If z is irrational, then by e^z we mean the unique number which has logarithm z:

$$\log e^z = z$$

Two lists of constructs that use one of these forms is given in the *Author's Guidelines.*

and don't forget to end the environment with figure*, not figure!

There is one other similar construct environment, which is already set up for you; i.e. you must *not* use a `\newdef` command to create it: the **proof** environment. Here is a example of its use:

PROOF. Suppose on the contrary there exists a real number L such that

$$\lim_{x \to \infty} \frac{f(x)}{g(x)} = L.$$

Then

$$l = \lim_{x \to c} f(x) = \lim_{x \to c} \left[gx \cdot \frac{f(x)}{g(x)} \right] = \lim_{x \to c} g(x) \cdot \lim_{x \to c} \frac{f(x)}{g(x)} = 0 \cdot L = 0,$$

which contradicts our assumption that $l \neq 0$. □

Complete rules about using these environments and using the two different creation commands are in the *Author's Guide*; please consult it for more detailed instructions. If you need to use another construct, not listed therein, which you want to have the same formatting as the Theorem or the Definition[**?**] shown above, use the `\newtheorem` or the `\newdef` command, respectively, to create it.

A *Caveat* for the TeX Expert

Because you have just been given permission to use the `\newdef` command to create a new form, you might think you can use TeX's `\def` to create a new command: *Please refrain from doing this!* Remember that your LaTeX source code is primarily intended to create camera-ready copy, but may be converted to other forms – e.g. HTML. If you inadvertently omit some or all of the `\def`s recompilation will be, to say the least, problematic.

Table 2: Some Typical Commands

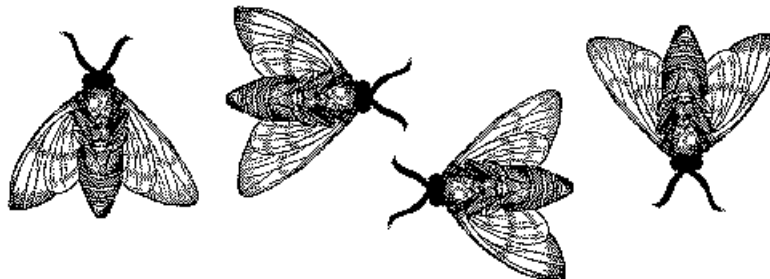| Command	A Number	Comments
`\alignauthor`	100	Author alignment
`\numberofauthors`	200	Author enumeration
`\table`	300	For tables
`\table*`	400	For wider tables

Figure 4: A sample black and white graphic (.eps format) that needs to span two columns of text.

3. CONCLUSIONS

This paragraph will end the body of this sample document. Remember that you might still have Acknowledgments or Appendices; brief samples of these follow. There is still the Bibliography to deal with; and we will make a disclaimer about that here: with the exception of the reference to the LaTeX book, the citations in this paper are to articles which have nothing to do with the present subject and are used as examples only.

4. ACKNOWLEDGMENTS

This section is optional; it is a location for you to acknowledge grants, funding, editing assistance and what have you. In the present case, for example, the authors would like to thank Gerald Murray of ACM for his help in codifying this *Author's Guide* and the **.cls** and **.tex** files that it describes.

5. REFERENCES

[1] Secret Labs AB and Fredrik Lundh. Python imaging library (pil).
http://www.pythonware.com/products/pil/, 2011.