
Image search engine feature analysis

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Abstract

Investigates image search engines (ISEs) on the Internet. A total of 23 ISEs were examined in an attempt to investigate, evaluate, and characterise their common features. Each individual ISE was evaluated against the common features. Attempts to summarise the most comprehensive and complete ISE by looking at their significant features.

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Introduction

Images allow users to visualise things and concepts around them. Image Information Retrieval Systems are concerned with the retrieval of digital images or image sequences from a database. They are an extension of traditional information retrieval but are designed to include visual information.

A digital image is an image that a computer can store, read, and display. It is composed of a set of pixels arranged according to a predefined ratio of columns and rows. Each pixel presents a portion of the image in a particular colour or shade of grey (Getty Research Institute, 2000a).

Until recently, collections of digital images were not widely used resources because of limitations in the means of duplication and dissemination (Rasmussen, 1997). But, with new technologies that enable people to store and retrieve images effectively, these physical problems have been overcome. Digital image databases and image processing techniques have developed significantly over the last few years. Today, a growing number of digital image databases and libraries are available, and are providing usable and effective access to image collections.

In order to access these resources, users need reliable tools to access images. Because of the huge amount of information, it is like looking for a needle in a haystack. The tool that enables users to find and locate images is an image search engine (ISE).

Internet image retrieval has recently attracted the attention of researchers. Studies have focused on the analysis of ISE basic requirements and their capabilities (Berinstein, 1998a), as well as exploration of available ISEs and their applications (Berinstein and Fieldman, 1996). Other studies have addressed image search queries (Stix, 1997), problems encountered in locating online images (Jacsó, 1997a, b), definitions of essential elements for image organisation (Jacsó, 1999), discovery of event-oriented image collections (Berinstein, 1999), and royalty-free use of Internet images (Berinstein, 1998b). Obviously, a comprehensive comparison and analysis of ISE features have not been discussed.

Research on ISEs comprises two perspectives: one is system-oriented and the other is user-oriented. In this paper we are going to focus on the former. The objectives

of this research are to discover available Internet ISEs, to identify searchable image features, to compare them based on their features, and to analyse the possible impact of these features on retrieval.

The significance of this research is that the findings of this study may provide useful information for ISE designers to identify and integrate valuable and potential features in the search engine design. Integration of these features will ultimately allow common users to make full use of ISE functionality. In other words, both the users and designers benefit from this research.

Digitalised image information

Image collections are created to support research and instruction in almost every discipline. They can cover cultural, educational, scientific, governmental and commercial aspects. The cultural applications include digital art galleries, holography, interferometry and fashion design. Educational applications include digital libraries and distance education. The scientific applications of digital images include medical image databases and medical photography, aerial surveys and remote sensing, applications in astronomy and technical laboratory applications. Examples of the governmental applications are forensic science and police work, which include face/fingerprint databases. The commercial applications include trademark collections (which are important in product protection), entertainment, and commercial and industrial photography.

The implementation of useful image databases depends on four aspects which influence the construction of databases (Turner, 1999). The physical aspect refers to the physical size of the database and image storage structure. This involves the number of images and some other factors such as image quality and resolution, the means by which the images are scanned, and the type of the image file format. The institutional factor refers to the affiliation of the image database and who is responsible for its contents and services. Then the user aspect refers to the potential users of the database and the user needs. The last aspect is the intellectual aspect, which involves the legal access to this

kind of database and associated copyright issues.

Image search engine features and analyses

Search engines are important tools for resource discovery on the Internet and have been growing in popularity since their introduction in 1994 (Su, 1997). The Internet contains a tremendous amount of information. It is estimated that there are 180 million images on the publicly indexable Web and the total amount of images represents about three terabytes of data (Goodrum and Spink, 1999). Because of the enormous amount of image resources, users need an effective search tool to locate the images that they need. This huge number of images is beyond effective access without the support of powerful image search tools. Without a comprehensive index to all Internet images, finding a specific image on the Internet can be a very difficult and time-consuming process.

The ISEs that were investigated in this study are shown in Table I. Choosing the search engines was a very important step. We

Table I Image search engines on the Net

Title	URL
1stopstock	http://www.1stopstock.com
AltaVista	http://www.altavista.com
Comstock	http://www.Comstock.com
Corbisimages	http://www.corbisimages.com
Ditto	http://www.ditto.com
Excite Photosearch	http://www.excite.com/search/photosearch/
FBG	http://www.fbg.com
Imagebank	http://www.imagebank.com
Infoseek	http://www.infoseek.com
Ixquick	http://www.ixquick.com
Lycos Multimedia	http://www.multimedia.lycos.com
PhotoDesk	http://www.photodesc.com
Photostogo	http://www.photostogo.com
Pictor	http://www.pictor.com
Scour	http://www.soure.com
Search	http://www.search.com/search?channel=3&cat=29
Stockmarket	http://www.stockmarketphoto.com
TonyStone	http://www.tonystone.com
WebSeek	http://disney.ctr.columbia.edu/webseek/
Webshots	http://www.webshots.com
Weststock	http://www.weststock.com
Workbook	http://www.workbook.com/stock/index.lasso
Yahoo Image Surfer	http://www.ipix.yahoo.com

attempted to include as many available search engines as possible.

Note that the ISEs were investigated in June and July 2000 and due to the rapid changes in the Internet their interfaces, contents and features may be different now.

By investigating these ISEs, we could identify some common features. It is clear that no single search engine contains all features. We tried to categorise all search features, to compare these features across all search engines studied, to identify the unique features, and then to present the more complete and comprehensive ISEs. Search features were classified into the following seven major categories:

- (1) keyword search related features;
- (2) search limitations;
- (3) browsing capabilities;
- (4) image source;
- (5) search output;
- (6) help file structure;
- (7) miscellaneous features.

Keyword related features

Keyword related features include keyword searching, which is one of the basic and most useful features in any ISE. All of these search engines have the capacity to search by keywords. Boolean searching is another common feature associated with keyword searching. Very few ISEs do not have a Boolean search capability. The format, however, may differ from one search engine to another. Most of the search engines investigated allow users to form a complete Boolean-based query by themselves. Two search engines (Pictor and Stockmarket (see Figure 1)) have a structured Boolean search

mechanism with which users can just click on a radio button to select meaningful logical operations for a Boolean-based query. This feature enables beginners to easily perform a Boolean search. Truncation and proximity are advanced features in search engines, and are not available on all services. The best example of these features is AltaVista.

Query modification is another feature, and is available on just seven search engines. Both TonyStone and Imagebank have a special feature called clarification. This feature lets users put a keyword in a specific context. For example, if looking for images on "cats" and putting the word "cats" in the search box, the user can clarify the cats either as pets or as wild cats (see Figure 2). This results in more relevant hits for the search.

A similar feature is the display of related keywords. In other words, some search engines give users related keywords for the search after a specific term is identified. It provides the users with related topics to their search and it may open new horizons to them.

The final results for this category appear in Table II.

Search limitations

Search limitations include the ability to limit retrieved items to a certain file format or a specific file size. These features are available only in the advanced search mode of Ditto. Within this mode users can choose a JPG or GIF image format in a large, medium or

Figure 1 Structured Boolean in Stockmarket



Figure 2 Clarification feature in TonyStone and Imagebank



Table II Keyword search related features

Search engine	Keyword searching features							
	Keyword	Boolean		Truncation	Proximity	Query modification	Related KW	Case sensitivity
		Structured	Common					
1stopstock	*					*		
AltaVista	*		*	*	*			*
Comstock	*						*	
Corbisimages	*		*	*		*	*	
Ditto	*		*		*	*	*	
Excite	*		*		*			
FBG	*						*	
Imagebank	*		*	*	*	*	*	
Infoseek	*				*			
Ixquick	*		*	*	*			
Lycos	*			*			*	
PhotoDesk	*		*	*	*			
Photostogo	*		*	*	*		*	
Pictor	*	*			*		*	
Scour	*		*		*			
Search	*		*		*			*
Stockmarket	*	*						
TonyStone	*		*	*	*	*	*	
WebSeek	*					*		
Webshots	*		*	*	*			
Webstock	*		*	*		*	*	
Workbook	*		*	*	*			
Yahoo Image Surfer	*		*	*	*			

small file size. The second limitation feature relates to the physical image limitation, such as image resolution, orientation, colour and picture type. The resolution limitation enables users to limit their search to a high, medium or low resolution for the retrieved images. This feature is also available only in the advanced search mode of Ditto. The image orientation limitation allows users to control a retrieved image set to horizontal, vertical, panoramic or square images. This feature is accessible on Comstock, Imagebank and TonyStone. Colour limitations are available on six search engines, by which users can restrict their search to colour or black and white images. The picture type limitation is fairly rare. It enables users to narrow their search to photos, graphics or illustrations.

Limitation by a geographical location is available only in Workbook, where users can focus on a specified geographical location of photographers. AltaVista is the only ISE offering case sensitivity for query keywords. Another uncommon limitation feature is publication date limitation, by which users can limit their search to a date when the image was published.

Browsing capabilities

Browsing is extremely important for image searching. Browsing capabilities vary from one search engine to another. It is available in all search engines except for Search, which only displays links to retrieved images. More than half of the search engines have subject categories from which users can browse a subject system to guide their search. Pictor and Stockmarket have visualised categories by which users can see a thumbnail of the category along with its title. Some of the search engines also have hierarchical structures for subject categories that range from one to five levels. The FBG category system has a visualised hierarchy with five levels where users can see the structural relationships among the categories. For an example of the visual subject category see Figure 3.

The final results for this category appear in Table III.

Image providers

The image provider refers to the photographers who produce images or companies that publish images. ISEs provide users with two kinds of information related to

Figure 3 Visual categories in Stockmarket



image providers: the input, which allows users to put the image photographers as a search entry and to retrieve all images created by

them; the output, where users can trace information on the image photographers such as their names and addresses in a result list, or can observe all of their related pictures in this search engine or database.

The final results for this category appear in Table IV.

Output

The output format differs from one search engine to another. Thumbnails, image links or URLs are basic output elements. Twenty-two ISEs display thumbnails in the search results. The number of thumbnails per page differs. It ranges from six to 90 images per page. 1stopstock is a meta search engine for images (it covers 12 image search engines). It displays the results in pop-up windows that can vary from one to 12 windows depending on the number of search engines users select. Each window displays output for a search engine. FBG provides a grid system where users can specify the number of images displayed horizontally and vertically. In Ditto, if a user clicks on a search result, a pop-up window appears with the retrieved picture along with the corresponding site. Search is

Table III Searching limitations

Search engine	Search limitations								
	Physical features			Image features			Geographical	Date	Domain
	File format	File size	Resolution	Orientation	Colour	Image type	location	published	search
1stopstock									
AltaVista					*	*			
Comstock									
Corbisimages				*	*				
Ditto	*	*	*		*			*	
Excite									
FBG									
Imagebank				*	*				
Infoseek									
Ixquick									
Lycos									
PhotoDesk									
Photostogo									
Pictor									
Scour									
Search									
Stockmarket									
TonyStone				*	*				
WebSeek					*	*			
Webshots									
Webstock									
Workbook						*	*		
Yahoo Image Surfer									

Table IV Browsing capabilities and image source

Search engine	Browsing capabilities			Image source		
	Image	Subject categories	Visual categories	Categories hierarchical levels	Input (search entry)	Output (related info)
1stopstock	*					
AltaVista	*					
Comstock	*	*		4		
Corbisimages	*	*		4		
Ditto	*	*		1		
Excite	*					
FBG	*	*		5		*
Imagebank	*	*				*
Infoseek	*					
Ixquick	*					
Lycos	*					*
PhotoDesk	*			1	*	*
Photostogo	*	*		3		*
Pictor	*	*	*	1		
Scour	*					
Search						
Stockmarket	*	*	*	3		*
TonyStone	*	*				
WebSeek	*	*				
Webshots	*	*		2		
Webstock	*	*		3		*
Workbook	*			9	*	*
Yahoo Image Surfer	*	*		4		

the only search engine that does not display the results as thumbnails. It displays them as active links to the images. PhotoDesk gives users two choices: a thumbnail or an image link. Only six search engines give users the URL of an image. The relevance indicator is a very user-friendly feature. It expresses the degree of the result relevance by selecting one to five stars. It is available only on one search engine, Ixquick.

The final results for this category appear in Table V.

Help file structure

All the search engines have online help files and some even have a feedback screen. Both AltaVista and WebSeek have a content sensitive help file structure. It is unusual that the Lycos search engine does not even have online help.

The final results for this category appear in Table V.

Miscellaneous features

Most of these miscellaneous features cannot be classified under any of the previous categories. One of these features is the image ID searching. This is available only on the search

engines that are associated with internal databases where each image has a unique ID number. The domain search is another feature, and is available only on AltaVista. Users can focus their search on certain domains such as com, edu, gov, or net. Infoseek gives users recommended sites that are related to their search. Filtering is a good feature where users can filter out adult content. It is available on AltaVista, Lycos and Excite.

The user preference rating is a special feature that is accessible only in Webshots. Users can assign their preference for retrieved images. For an example, see Figure 4. This feature is also available on Excite because Excite is a partner of Webshots. When users search Excite for images, they are actually searching Webshots simultaneously.

Istopstock, Ixquick and Search have the capacity to perform multiple searches across more than one search engine. Istopstock can search 12 image search engines, including Comstock, Corbisimages, FBG, Imagebank, Johnfoxx (for technical reasons, it is not included in this study), PhotoDesk, Photostogo, Pictor, Stockmarket, TonyStone, Webstock and Workbook. Ixquick searches

Table V Output and help

Search engine	Output			Relevance indicator	Help file structure	
	Thumbnails	Image links	URI		General	Content sensitive
1stopstock	*				*	
AltaVista	*		*			*
Comstock	*	*			*	
Corbisimages	*				*	
Ditto	*		*		*	
Excite	*				*	
FBG	*				*	
Imagebank	*				*	
Infoseek	*		*		*	
Ixquick	*	*	*	*		
Lycos	*					
PhotoDesk	*	*			*	
Photostogo	*				*	
Pictor	*					
Scour	*	*	*		*	
Search			*		*	
Stockmarket	*					
TonyStone	*				*	
WebSeek	*					*
Webshots	*				*	
Webstock	*				*	
Workbook	*					
Yahoo Image Surfer	*		*		*	

AltaVista, Art.com, Go, Lycos, Pictures Now, SF Art Museum and Yahoo. Search covers AltaVista, Excite, Lycos, Scour, WebSeek and Yahoo.

Most of the ISEs charge users for downloading images from their Web sites, especially if the search engine is associated with an internal database. These search engines also have a copyright protection mechanism, which puts a watermark on each retrieved image to protect it from illegal use. All of the search engines display photographer names for their works to protect their intellectual rights.

The final results for this category appear in Table VI.

In Table VII, the number indicates the number of the search features the ISE (row) possesses within the category (column). For

instance, AltaVista has five features in the Keyword related feature category.

When analysing these features we found that the file size, file format, resolution, geographical location, case sensitivity, date published, domain search, and recommended sites were features that occurred only once in the 23 image search engines. None of the search engines includes all these search features. Each search engine contains at least one of these features.

Within the keyword searching feature category (see Table II), keyword search (100 percent), Boolean (73.9 percent), proximity (65.2 percent), and truncation (52.2 percent) appear in most of the ISEs. This suggests that the primary search functionality of ISEs is developed based on traditional keyword indexing techniques. In other words, images are indexed primarily by keywords. At present, keyword searching is still a primary way to access image information resources. Query modification (30.4 percent) and related keyword display (43.4 percent) features are important for a complicated search. Sometimes user search strategies need dynamic adjustment according to feedback information.

Figure 4 User preference rating in Excite and Webshots

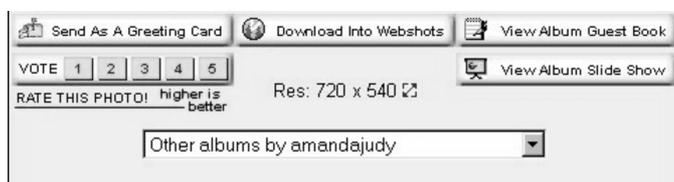


Table VI Miscellaneous features

Search engine	Image ID search	Recommended sites	Miscellaneous				
			Filtering	User preference rating	Multiple search	Charge	Copyright protection
1stopstock					*	*	*
AltaVista			*				
Comstock	*					*	*
Corbisimages						*	*
Ditto							
Excite			*	*			*
FBG						*	*
Imagebank						*	*
Infoseek		*					
Ixquick					*		
Lycos			*			*	*
PhotoDesk	*					*	*
Photostogo						*	*
Pictor						*	*
Scour							
Search					*		
Stockmarket	*					*	*
TonyStone						*	*
WebSeek							
Webshots				*			*
Webstock						*	*
Workbook	*					*	*
Yahoo Image Surfer							

Table VII Summary of image search engine features

Search engine	Keyword related features	Searching limitation	Browsing capabilities	Output and help	Miscellaneous	Total
1stopstock	2	0	1	2	3	8
AltaVista	5	2	1	3	1	12
Comstock	2	0	3	3	3	11
Corbisimages	5	3	3	2	2	15
Ditto	5	5	3	3	0	16
Excite	3	0	1	2	3	9
FBG	2	0	4	2	2	10
Imagebank	6	2	3	2	2	15
Infoseek	2	0	1	3	1	7
Ixquick	4	0	1	4	1	10
Lycos	3	0	2	1	3	9
PhotoDesk	4	0	4	3	3	14
Photostogo	5	0	4	2	2	13
Pictor	4	0	4	1	2	11
Scour	3	0	1	4	0	8
Search	4	0	0	2	1	7
Stockmarket	2	0	5	1	3	11
TonyStone	6	2	2	2	2	14
WebSeek	2	2	2	2	0	8
Webshots	4	0	3	2	2	11
Webstock	5	0	4	2	2	13
Workbook	4	2	3	1	3	13
Yahoo Image Surfer	4	0	3	3	0	10

Within the search limitation category (see Table III), colour (26.1 percent), picture orientation (13 percent), and image type (13 percent) are the primary options for search limitation. These features reflect physical characteristics of an image. They are considered as limitation features to narrow a retrieved image set, or they may be combined with others to form a query. They are unique to image searching.

Within the browsing category (see Table IV), image browsing (95.7 percent) and subject category (56.5 percent) are ranked first and second respectively. Almost all of the search engines offer the image-browsing feature due to the nature of images. An image search engine ultimately should offer retrieved images rather than textual descriptions for users. The findings show that the subject category is still a major image organisation approach. It provides an effective way to control the scope of a search.

Within the output category and help structure category (see Table V), thumbnails and general help file structures are available – 95.7 percent and 78.3 percent of the services investigated, respectively.

A total of 65 percent of ISEs have copyright mechanisms and 56.5 percent of them charge users for their services.

Note that low frequencies of the features among the ISEs are not absolute indicators of less useful or less effective features. On the contrary, it is the low-frequency features that make ISEs different from one another. The feature of visual category (8.7 percent) and hierarchical structure (47.8 percent) are visual displays of subject categories. They facilitate users, especially the inexperienced, to navigate the subject category system in an image search. User preference ratings (8.7 percent) enable users to make a satisfactory judgement and allow them to retrieve images and take advantage of the judgements of other searchers. Multiple searches (13 percent), content sensitive help file structures (8.7 percent), and related keywords (43.5 percent) would meet different search needs of users. Here the low-frequency feature is a relative concept. It is defined against other features in the same category. Therefore, hierarchical structure (47.8 percent) and related keywords (43.5 percent) can be defined as low-frequency features.

Among the investigated ISEs (see Table VII), Imagebank (6), TonyStone (6),

AltaVista (5), Corbisimages (5), Ditto (5), Photostogo (5), and Webstock (5) rank high in the keyword searching feature category (the number within the parentheses following an ISE name refers to the number of the search features that it has within the corresponding category); Ditto (2), AltaVista (2), Corbisimages (2), Imagebank (2), TonyStone (2), WebSeek (2), and Workbook(2) rank high in the search limitation category; Pictor(4), StockMarket(4), Corbisimages(3), Ditto(3), FBG(3), Webshots(3), Comstock(3), Photostogo(3), Yahoo Image Surfer(3), and Webstock(3) rank high in the browsing category; Ixquick(4), Scour(3), AltaVista(2), Comstock(2), Ditto(2), Infoseek(2), PhotoDesk(2), and Yahoo Image Surfer(2) rank high in the output category; and PhotoDesk(6), 1stopstock(5), Stockmarket(5), and Workbook(5) achieve high scores in the other categories.

According to the above analysis, Ditto, AltaVista, and Corbisimages are the most comprehensive ISEs in terms of search features.

The feature frequency distributions for the investigated ISEs are shown in both Table VIII and Figure 5.

Conclusion

The rapid growth in the number of images published on the Web makes finding specific images more difficult. To get useful images users need to employ an efficient and effective search tool that enables them to retrieve what they need from huge image collections. Berinstein and Fieldman (1996) outlined some of the characteristics of the ideal ISE, saying that it should:

- allow keyword searching of image content, date and creator;
- let users search by colour, shape and other formal attributes;
- search databases internal to a site;
- display the image as part of the search results;
- allows users to find the rights-holder;
- furnish the rights status and terms for licensing.

Most of the time, our success in locating something on the Web depends on the image search tool that we are using (Berinstein, 1998a). Analysing search features of ISEs

Table VIII Searching features analysis

Category	Feature	Occurrence	Percentage
Word related features	Keyword search	23	100.0
	Boolean	17	73.9
	Truncation	12	52.2
	Proximity	15	65.2
	Query modification	7	30.4
	Related keywords	10	43.5
Searching limitations	File size	1	4.35
	File format	1	4.35
	Resolution	1	4.35
	Orientation	3	13.0
	Colour	6	26.1
	Picture type	3	13.0
	Geographic location	1	4.35
	Case sensitivity	1	4.35
Browsing capabilities	Date published	1	4.35
	Image browse	22	95.7
	Subject categories	13	56.5
	Visual categories	2	8.7
	Hierarchical levels	11	47.8
Image source	Provider search	2	8.7
	Provider output	8	34.8
Output	Thumbnails	22	95.7
	Image link	4	17.4
	URL	7	30.4
	Relevance indicator	2	8.7
Help	General help	18	78.3
	Sensitive help	2	8.7
Miscellaneous	Image ID search	4	17.4
	Domain search	1	4.35
	Recommended sites	1	4.35
	Filtering	3	13.0
	User preference rating	2	8.7
	Multiple search	3	13.0
	Charge	13	56.5
	Copyright	15	65.2

would make users understand them better and use them more effectively.

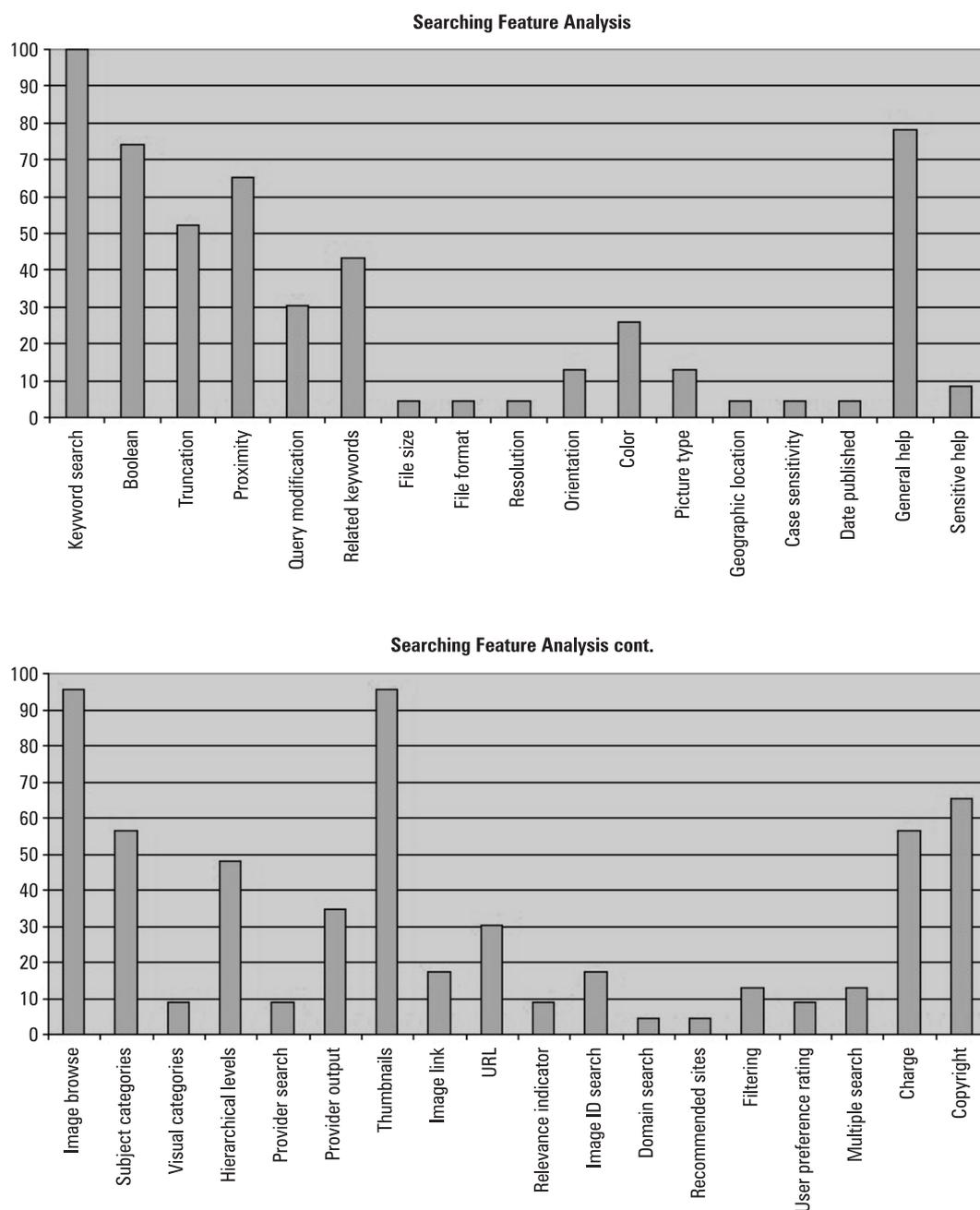
By examining the search engines described above we can recommend search engines from the image search feature perspective. Our judgement was based on the number of search features available on these search engines. We found that Ditto has the largest number of those features. It has 16 different features including four unique ones. Although it has a very simple interface, it has a lot of search capabilities. It is highly recommended for users.

It is widely recognized that the search feature of an ISE is just one of the important factors that affect its efficiency and effectiveness. Users search satisfaction can

also be affected by other critical factors such as interface design, quality of indexing, organisation approaches to image information, database coverage, data storage structure, and so on. High-frequency features appearing in search engines do not mean that they are the most effective and efficient. Low-frequency features do not indicate that they are not important and useful.

A further research direction on this topic includes a user study to investigate which features identified in this paper are most useful and which search engine(s) is/are more effective from users' perspectives. A study examining the impact of image quantity and quality on image searching is also planned.

Figure 5 Search feature distributions



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