Map of Dermatology: Web image browser for differential diagnosis in dermatology

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Key Message

- *Dermatology is a very visual discipline*
- *The Internet is increasingly becoming an indispensable tool in everyday clinical practice*
- *Map of Dermatology is an added-value regional/morphological search interface for harnessing Internet dermatology image searches to meet clinicians' needs*

Google Image Search (http://images.google.com/) currently offers access to the largest online dermatology image collection (indexed from multiple sources). However, the raw Google Image Search is not very well suited for regional/morphological dermatology searches, hence the need for an added-value, special regional/morphological search layer/interface like Map of Dermatology (http://healthcybermap.org/dermap/) to harness Google.

Background

The Evolution of the Web from Text to Multimedia and Image Search Engines

The Web has very rapidly evolved over the last decade, from a mostly text-based information channel to a powerful multimedia publishing medium rivalling the traditional print media. Today, millions of images exist on the Web in different sizes and image formats, covering a very wide range of topics. Most Internet search engines have matched this evolution of the Web from text to multimedia by developing their own dedicated image search tools and interfaces, and some search engines have even been launched that specialise only in image searching. Examples of image search engines on the Web include Cydral (http://en.cydral.com/), Ditto Image Search (http://www.ditto.com/), Google Image Search (http://images.google.com/), Picsearch (http://www.picsearch.com/), and Yahoo! Image Search (http://images.search.yahoo.com).

These search engines index images on Web pages they crawl based on the text surrounding those images (e.g., figure captions). The results are not always accurate or relevant. The UK Technical Advisory Service for Images (TASI) recently surveyed all image search engines currently available on the Web, and concluded that Google Image Search is the most effective image search engine, with the broadest index/coverage of images from the Web among all surveyed engines.[1]

In November 2004, this author also tested the major Web image search engines using dermatology-specific search terms. Again, Google ranked first as the most "clever" of all tested engines, delivering the most relevant results and offering the most comprehensive index available today of dermatology Web images.

Value-added Services

Online services that leverage existing search engines have also existed for some time. Examples include Soople for Google (http://www.soople.com/), and metacrawler (http://www.metacrawler.com/). This paper reports on one such service, a dermatology-specific "add-on" to Google Image Search that is intended to produce results that might be hard to achieve by the average user using the basic Google Image Search interface.

Introducing the Map of Dermatology

The Web has opened new efficient and effective ways for storing, retrieving and distributing clinical images.[2,3] Today, anyone with Internet access can browse thousands of high quality dermatology images on the Web at no cost, apart from that of connecting to the Internet. This free and easy access to online dermatology image collections has multiple educational, clinical and research applications.[3-6]

However, users cannot search for images of a condition if they don't know its name. Moreover, current image search engines are not very helpful in searching images of skin conditions by using only words describing lesion morphology and affected body regions, and any results returned from such queries are not properly sorted in a usable and useful way.

Lack of meta-information and indexing services specialised in retrieving clinical images makes finding specific dermatology images on the Web difficult.[3] Manual indexing (i.e., by specialised humans) of images on the Web, though having the potential of producing the best search results, will always remain limited regarding the number of images that are practically possible to index in this way. That's where the Map of Dermatology comes in to help.

Dermatology is a very visual discipline. For skin conditions, regional (affected body region(s)/sub-region(s)) and morphological (type of skin lesion, e.g., macule, papule, plaque, nodule, etc.) groupings of digital dermatology image collections (and other resource types) have sometimes proved useful in various clinical (differential diagnosis) and educational settings.[5-9]

Map of Dermatology (http://healthcybermap.org/dermap/) enables users to search for images of skin conditions by body region/morphology rather than by condition name, which is much more useful and natural in answering questions about unknown clinical presentations/diagnoses, especially for non-specialists like General Practitioners (GPs) in the UK.

(The differential diagnosis of lesions with generalized distribution (i.e., lesions not confined to a specific body region), including characteristic patterns, can be displayed by clicking the 'Generalized Distribution' link below the human body map in the left pane of Map of Dermatology (http://healthcybermap.org/dermap/). Users will then be presented with eight broad categories of lesions to choose from. Clicking any of these morphological categories will fetch conditions belonging to it. These can then be clicked to display the corresponding images.)

When faced with a non-familiar dermatological presentation, non-specialist users usually do not have a full list of differential diagnoses ready in their minds. They would rather prefer a tool that would help them answer questions like "which condition(s) is more likely to present in a given body region with a particular morphology?" Using the Map of Dermatology, non-specialists can pinpoint a diagnosis/differential diagnosis by browsing the resultant image sets and comparing them to the clinical presentation at hand ("does it *look like* this?").

The main *raison d'être* for the current Map of Dermatology is to provide a value-added interface that is better and more useful to our users than the raw Google Image Search (http://images.google.com/) upon which it is based. The demonstrator's maps are based on regional/morphological differential diagnosis lists from Fitzpatrick's *Color Atlas and Synopsis of Clinical Dermatology*.[10]

It is noteworthy that Map of Dermatology is now an OMNI/NMAP-catalogued resource (OMNI: Organising Medical Networked Information—

http://omni.ac.uk/cgi/fullRecord.cgi?key=30115444&gateway=omni ; NMAP:

Nursing, Midwifery and Allied health Professions—

http://nmap.ac.uk/cgi/fullRecord.cgi?key=30115444&gateway=nmap). OMNI and

NMAP are gateways to hand-selected and evaluated, quality Internet resources in health and medicine.

Why Map of Dermatology?

The challenges of the early days of the Web (e.g., hardware and Internet connection speed issues)[4] have been superseded today by new ones related to information overload and knowledge management. The question is no longer how to download and display high resolution Web images, but how to find such images that would be relevant to a user's current information need, among millions of existing Web images.

The Limitations of Current Online Dermatology Atlases and Tools

Currently, Dermatlas (http://dermatlas.org/derm/), DOIA and PeDOIA (Dermatology OnlIne Atlas and its Paediatric version— http://dermis.multimedica.de/index_e.htm), and the Brazilian Atlas Dermatologico (http://www.atlasdermatologico.com.br/) all together hold a total of about 18,000 images for all dermatological diagnoses in their databases (combined), while Google Image Search indexes over 13,600 images related to psoriasis alone (though Google will not actually allow its users to browse

beyond the first eight or nine hundred images in any result set). In fact, Google

indexes 1,187,630,000 images in total (all figures current as of April 2005)—of them

tens of thousands are related to dermatology.

Google's image index includes images from existing databases like Dermatlas, Atlas

Dermatologico and the University of Iowa Dermatology ImageBase

(http://tray.dermatology.uiowa.edu/ImageBase.html), among other dermatology

collections. In fact, Google can be thought of like a raw image "meta-search" engine,

searching across existing dermatology image databases on the Web.

Though DOIA/PeDOIA and Dermatlas feature regional search (i.e., by body region—

see http://dermis.multimedica.de/doia/dbrowser.asp?zugr=d&lang=e&benr=A and

http://dermatlas.med.jhmi.edu/derm/homunculus.cfm), they provide very limited or

no morphological or combined regional/morphological searches (plus the fact that

they are limited to searching in only their own relatively small collections). This

somewhat limits their educational potential and value in answering differential

diagnosis queries. The Brazilian Atlas Dermatologico offers no regional or

morphological searches.

Trip Database (http://www.tripdatabase.com/) also has an image search facility

searching only external databases like Dermatlas, but again their image search is of

very limited value in regional/morphological dermatology-type queries.

Map of Dermatology as a Value-added Service

Map of Dermatology relies on tens of thousands of images produced by

dermatologists and the academia worldwide (rather than producing our own limited

and costly content).

But, one might ask, isn't Google Image Search already around to help with our

dermatology image queries? The answer, as also stated above, is that the raw Google

Image Search is not very well suited for regional/morphological dermatology searches, hence the need for an added-value, special regional/morphological search layer/interface to harness Google to better serve our information needs.

Map of Dermatology interface allows users to query Google's image index for dermatology images by skin lesion morphology and affected body regions by "translating" such queries into lists of possible diagnoses (named skin conditions), and "pre-refining" the basic Google Image Search accordingly, thus saving users' time and effort, and reducing the scope for time-wasting error.

Using the Boolean operator 'OR', the pre-formulated Map of Dermatology image queries were hand-tweaked to care for the many synonyms of some skin conditions (and characteristic lesions, e.g., shagreen patch in tuberous sclerosis), plus localisation (and its synonyms/sub-regions too), and produce the best results within Google's limit of ten terms per query.

Map of Dermatology potential applications and uses include:

− educational uses (e.g., by medical students);

− to support ward round/outpatient clinic differential diagnosis discussions; and

− as an online image service (e.g., to prepare clinical presentations) and a crude differential diagnosis tool for nurses, physicians and dermatologists. (Users must obtain the appropriate permissions to use any image, linked to from Map of Dermatology/Google, from the owner(s) of that material.)

Map of Dermatology Limitations

Sometimes, the image results returned by Map of Dermatology seem a bit irrelevant, e.g., user clicks on some leg condition and gets images of the same skin condition but on hands and arms. However, the utility of the Map of Dermatology and overall relevance, selectivity and comprehensiveness of results returned using its hand-

tweaked queries and the regional/morphological differential diagnosis layer it adds to Google still outweigh these limitations and outperform the results that the average user can achieved using the raw Google Image Search alone to search by morphology and body region.

Future Directions

Following are some possibilities for further improving Map of Dermatology.

Better and more comprehensive maps can also be developed based on the differential diagnosis algorithms/trees in Ashton and Leppard's *Differential Diagnosis in Dermatology* (subject to receiving the necessary permission from authors/publisher, and human and financial resource availability).[11] The improved maps could also allow users to further refine the results for some body regions by selecting specific sub-regions/parts, e.g., the nails (under hands and feet), take into consideration the many other aspects of patients and their skin lesions that are equally important in pinpointing a correct diagnosis (e.g., patient age and gender, occupational history, lesions that are itchy vs. non-itchy or showing loss of sensation, etc.), and point to categorised written resources about the condition at hand (e.g., research papers, care guidelines, patient information leaflets, etc.), in addition to images. (Currently, users can do some of this (finding related written resources) by switching to 'Web' in the Google Image results pane; this will pass the current image query to Google Web Search, but the results of the latter cannot be quality assured.)

The list of differential diagnoses could also be sorted in order of frequency/probability (though such order can sometimes be country/geographical region specific), with more common conditions displayed higher up the differential diagnosis lists.

The current Map of Dermatology proof-of-concept demonstrator uses static pages to enable rapid production/prototyping (it only took this author few days to develop it)

and keep it simple, but a database-driven version is also a possibility to more efficiently and effectively manage everything as the maps expand.

New options can be added to allow users to limit retrieved images to a particular image filetype [Any filetype; JPEG (Joint Photographic Experts Group) files; GIF (Graphics Interchange Format) files; PNG (Portable Network Graphic) files], and image size [All sizes; Large; Medium; Small]. This can be achieved using Google Image Search query options, namely 'as_filetype' and 'imgsz'. For example, the following query will only retrieve keratoacanthoma images that are in JPEG format and of medium size:

http://images.google.com/images?q=keratoacanthoma&as_filetype=jpg&imgsz=medium

Similarly, users can be offered the option to retrieve images from only academic domains. For example, the following query will retrieve dermatofibroma images from only US academic domains:

http://images.google.com/images?q=dermatofibroma+site:edu

Also, it should be possible to intercept Google results and scan/filter them for dead links or search further within results (as a workaround to Google's limit of ten words per query) before displaying them. (We also thought of the possibility of using the free APIs (Application Programming Interfaces) offered by Google (http://www.google.com/apis/), but found that they currently only apply to Google Web Search and do not cover, or offer any way to access Google Image Search.)

A friendlier, non frames-based version could be developed (avoiding popup windows or opening too much new browser windows). Instead of relying only on textual terms, a typical image or colour drawing for each top category of skin lesion/morphology could also be included in the differential diagnosis lists (currently displayed in the upper right pane), e.g., an image example of a macule, papule, vesicle, etc.

Finally, the possibility of developing a dedicated, clinically/dermatology-aware image search engine (instead of relying on general search engines like Google Image Search) could be explored. Such dedicated engine would spider Web pages for images in a way similar to Google, but would process the text surrounding images and automatically index those images using a specialised medical text indexer.[12] This has the potential of producing much more relevant and accurate results in response to clinical/dermatology queries, and could also improve the support of disease synonyms in image queries.

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