Research Article
Content Based Image Retrieval Based Search Engines: A Clear Study and Comparison

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Abstract: People use the technology to its fullest, but they are not aware of most of the technologies that are available to them and are still in search of those advancements that have already been made available to them. This study helps to understand the number of such availabilities and for what it can be used. Action speaks louder than words. Similarly an image speaks a thousand words than a thousand worded articles. With the rather fast moving world, we don't find time to read an article, we would prefer to look at its diagrammatic representation and understand what is inside the article rather than reading it. To find any particular information about an author or creator or any document, we type in the keywords in the search bar and look for the required information. But what if you do not know any details about the author and all you do have is just an image. How will you figure out who is the person, what are his works, who has that particular picture of his and all others details you wish to know. This is where the Content Based Image Retrieval (CBIR) comes into picture. The availability of image search engines makes your work become much simpler. It's not just for an image of humans, but those of animals, birds and dresses could also be crossed referenced using one among the several CBIR engines. With the development of technology people expect the results to be more accurate and approximate. Mere similarity between colours and texture of the material does not satisfy the user. The images that are compared and given as results seem to be the comparison of colour and category and the material, but not the actual comparison to that image. A proposed plan have been put forward which could bring about a change in the working of CBIR, giving more exact results. The plan states how to exactly compare the image rather than just the colour or texture.

Keywords: Chic engine, immenselab, incogna, macroglossa, picalike, plan, TinEye, yandex

INTRODUCTION

With the development of internet and multimedia image retrieval has become very common. Content Base Image Retrieval (CBIR) which is also known as Query By Image Content (QBIC) is an application of computer version techniques to the image retrieval problem. The problem is searching a digital image in large database which would use a large amount of resource. There are so many image search engines available in the market. But there is no proper knowledge for it among the common. Most of the engines are closed for the public. Yet they can have a free access for a temporary search and usage. Getting licence would provide them to enjoy further services of the company. Some licence are free of cost and some are paid. Especially the paid ones are for the usage of business people which can be added on to their website, or adding their information into the Engine's website literally increasing the business. Under such cases for investment in such a technical promotion for the business or for any general access the people must know the best place to reach and get the maximum out

of the technology present. [en.wikipedia.org/wiki/Content-based_image_retrieval] Image search engines are mainly of two types-general, specific. General engines are used to search all forms of images and data about any image like fruits, animals and similar things. [www.yandex.com/about]. Specific engines, as they are classified will work only for a specific task [www.picalike.com/about, www.chicengine.com/about]. For Example, Id My Pill is a search engine which gives all the details about a pill including its name with just an image of the pill. Also there are fashion image search engines used only for accessories and apparels search, like Shopachu [www.incogna.com]. All these engines donot follow a common technique for searching. There are various techniques as Reverse image search (www.tineye.com/about), hashing (www.kbkgroup.org), pattern search, pixel matching and many more. Some engines also have their own techniques like compact indexing by Immenselab (www.kbkgroup.org). Also the companies may use more than one technique based on the criteria. The workings of these engines are not open to the common. Yet a close and efficient way of working involved in various techniques used in these
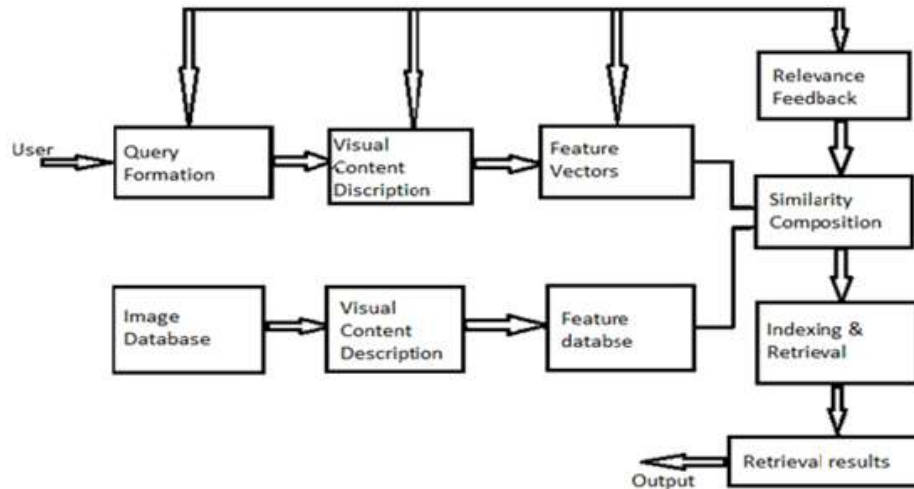
Fig. 1: Describes the various steps involved in CBIR image search

engines are described to provide you a brief knowledge about their working and efficiency. This study would guide you to gain knowledge about these engines and access the best for any criteria after analysing them. Figure 1 briefly describes the steps involved in CBIR image search.

MATERIALS AND METHODS

Macroglossa: Macroglossa, a web-based application, was developed by an Italian Group, Francesco Soccolini in April 2010, for comparison of images. (www.macroglossa.com/about). Its first version was known as alpha. Depending on the content of the image that is being uploaded, the search is made. It does not use any technology as Optical Character Recognition (OCR) (converting data into text) or tags (similar to a cache) nor vocabulary trees. The comparison is directly based on the content of the image. In September 2011 beta version was released. Installation of API is required to get access to this search engine. It supports all popular video and image formats. Macroglossa the visual search engine helps in identifying and understanding an image. Some technical features about the engine are as follows:

Time: The time taken to find an image similar to that of the uploaded one, on an average is 0.235 sec if the image has been taken off the internet, where as if the image had been clicked on site and then checked in macroglossa it takes 2 sec on an average.

Relevancy: The images are searched mostly based on the colour and the category chosen. If you upload an image of humans and search for animals, the images that comes as result is the animals of prominent colour from the image. If the category and the image are chosen appropriately then the result is as expected but even then the colour is given more importance than the actual image, images with similar colours are displayed than the physical structure of the image.

General: Apart from just the search option, Macroglossa also gives us a choice to edit the image and search and video search. The minimum size of the uploaded image should be 160×160 pixels and the maximum size of the video shouldn't exceed 40 MB. Their site is still under development hence their results may take time as they aim to give an up-to-date and accurate result. They aim to increase their speed, image, precision and search it has six categories. Macroglossa is also available as iPhone app android OS app, Chrome and Safari extensions. It has six categories:

- Animals
- Biological
- Artistic
- Panoramic
- Biological
- Colours

It uses Engine Comparer Technology. If the image that you are searching for is not available in the engine, it searches against all the images in the web too. In the result page of the visual references, the link of the site on which the image was found is also displayed.

Let's take a look at Macroglassa:

- www. macroglossa. com is their official website. Figure 2 shows the homepage of Macroglossa.
- The browse option enables you to select the image you want to search, from your computer.
  And after the upload is done, select the category of the image. Figure 3 shows the Macroglossa search page.

Fig. 2: Macroglossa homepage

Fig. 3: Macroglossa search page

Table 1: Detailed description of Macroglossa subscriptions

Subscription	Basic	Premium	Free
Requests	Unlimited	Unlimited	Limited
Custom services	No	Yes	No

- Once the category has been selected allow the web page to find a similar image

Access: The license of the engine is closed. So for a user to access the engine he must pay to get the API under conditions. The licence of macroglossa was completely closed in the alpha version. It was opened to common people free of cost only at the release of beta version. Thus macroglossa became Software as a Service (SaaS). Macroglossa offers three types of subscriptions and the subscriptions offered by Macroglossa family (Table 1):

- Basic
- Premium
- Free

Subscriptions: Some custom services and advantages of premium subscription are as follows. It easily adapts to your business. The interface is highly customizable within different platforms. It is also possible to develop visual search for any web or mobile clients with their

standard interfaces. You can design your business home page with image search categories from macroglossa. The API are fully compatible with all programming languages, as they are based on standard http method. They already have different types of search combined and delivered as search by affinity, search by shape and many more. While subscribing for the API itself you will be prompted to select one of the available profiles. It is also possible to embed it into a device firmware. They can also develop the client, design and all other necessities for your business. They have a technical team always at the reach of the client to assist in any type of query.

The unique feature of the engine is that the elements are briefly categorized and more importantly the search can be done also from specific part of an image or from a video format. Its main function is to just find similarities of the unknown subject. A main advantage is it allows users to pull results without using tags. Also the visuals can be easily crowd sourced, that is can get all needed services, ideas, or contents from a group of people of an online community and their vocabulary can be recognised much faster than any tool. It can also be used for Reverse Image Search to find copyrighted works (orphan works) and find out various possible violation of copyrights of image. There is also a feature to filter result based on camera model.

Applications: Macroglossa applications are available for iPhone/iPad, also for android OS, Chrome, Safari, whereas videoglosssa, colorglossa and eyeglossa is available only for iPhone or iPad.

Macroglossa for iPhone or iPad has latest version, 5.1. It has fixed the bugs that were sighted earlier and along with that the image storage area has also been increased.

Macroglossa for android is much simpler to use rather than iPhone. Its latest version 3.0 was released in april4, 2012 which would require android 1.6 and above versions. It is completely renewed to give a entirely new experience to the user. Addition a crop tool has been added to select the region of interest in the image. To use crop button select the image and then just tap on the image or select crop option from menu button. The result has been much optimised such that the details page will also contain the preview of the source image and allows the user to share the result by e-mail.

Macroglossa Visual Engine Chrome extension is a Visual search plugin. It is simple and allows the user to search and compare web image and personal image. The latest version 3.1 was released in September 21, 2012. Once the plugin is installed inside chrome, you can search for any image using this. To do so right click on any picture in the chrome browser and select "Macroglossa- Visual Search Plugin" and then select search with Macroglossa. This makes image searches much simpler in chrome.

Registration: To register in macroglossa visit the above specified link and there will be a button on top

Fig. 4: Macroglossa login page

right "MyGlossa Login" inside the tab you will be prompted to enter the username and login. Figure 4 is the replication of the Macroglossa Login page.

If not you can register as a new client by filling the details in the consecutive page. In the API program field you can select the mode as free, basic or premium and the payments for basic and premium must be done. Figure 5 exactly shows the API registration page.

RESULTS AND DISCUSSION

Picalike: Picalike similarity search is an interactive visual search engine. It is designed by Picalike Visual technologies for online merchants, especially Business-to-Business (B2B) merchants of any product. It can be calibrated depending on the customer. It is easy to use software solution. This allows analysis of image data by artificially intelligent algorithm. When the customer gives a request, the technology detects all the products that are similar to it in real-time. The arrangement and organization of the images in the engine is based on the image characteristics. The results are filtered based on various criteria such as brand, price, name as well as employing own "business values". The efficiency of the engine is tremendous that the results are very fast and highly accurate. This increases the conversation rate i.e., increase in number of products searched by a user and helps the merchants, who own it, to increase their trade (www. picalike.com/about). Some famous brands that use Picalike for their online trades are:
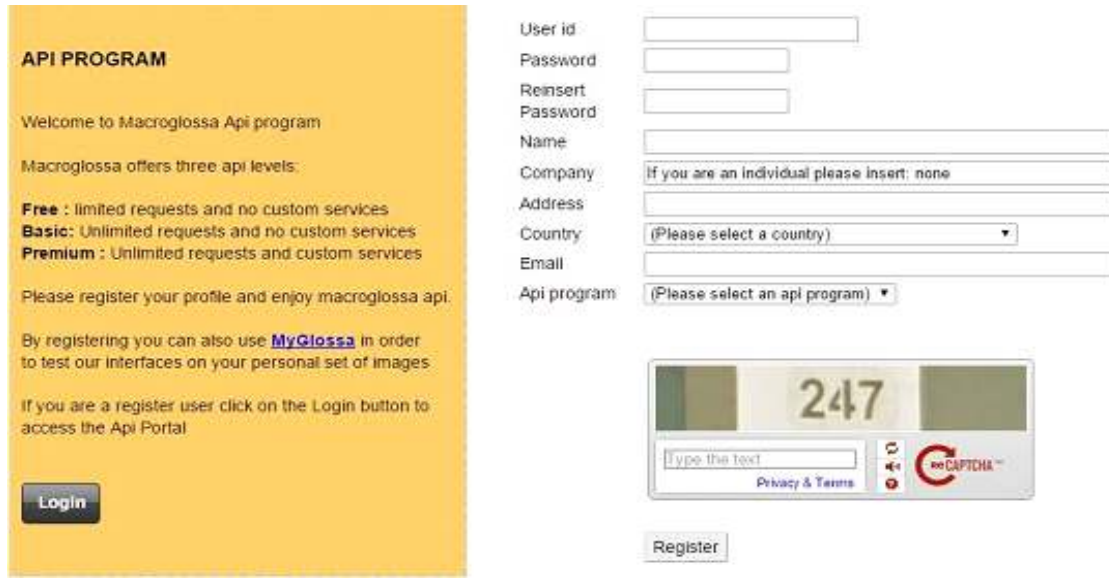
- OTTO
- Fashion DE

Fig. 5: Macroglossa API registration

- Shopping 24
- e.pages

Benefits of picalike:

- **Proper organisation:** Only the product characteristics that are mentioned above are taken into account for searching the image. The semantic parameters of the image are not considered.
- **"Visual sales agent" function:** The engine acts as a Visual Sales Agent. The favourite products related to the ones selected by the user are first shown. Also the alternatives are also immediately shown, especially for "sold out" products. Thus the engine efficiently mimics a real sales agent.
- Visual preferences of every customer is to keep track of () and thus creates an entirely new experience on visual search.
- **Increase in relative performance:** The efficient search results increase the conversation rate thus increases the net profit of the merchant who has purchased it and a higher satisfaction level is also reached at the consumer end.
- **Easy integration:** This can be integrated into any environment within minutes and this also depends on the version.
- **Success-based payment:** Charges are applicable only for a successful search.

On the whole with its results of extra-ordinary relevancy in a short time, this engine makes your business highly profitable.

Working of picalike similarity search: By using the artificial intelligent algorithms, Picalike similarity search analyses the picture from websites or data feed and gives similar products. In Picalike when a picture is given it automatically removes the background, human bodies, etc. After doing this several times the system analyse more than 600 products characteristics such as shape, colour, texture, etc. And then it produces the results for similar products. Picalike similarity search is straightforward and it obeys data protection regulation.

Picalike's visual Technology is a huge success. In addition to that there has been an increase in customer satisfaction due to interactive, intuitive and improvised recommendations which further helps in ease of navigation in finding the desired product.

Additional advantages of visual technology:

- Increased usability
- Easy navigation of products
- Increased customer satisfaction
- Business Intelligence

Figure 6 diagrammatically shows the Visual technology used in PicAlike.

Mobile application: Picalike is now also available as a mobile application. Visual tagging, a method which enables the image to be linked with information, enables you to upload a piece of clothing either viewed in a magazine or on a shop window and the app searches its databases for products similar to that based on its colour and display the similar products.

Incogna: Incogna is one of the unique image search engines in the market. It is a Ottawa-based company and was found in 2007, by Kris Woodbeck. It breaks the image down to pixels and then searches the image directly. It uses highly parallel processors. It processes
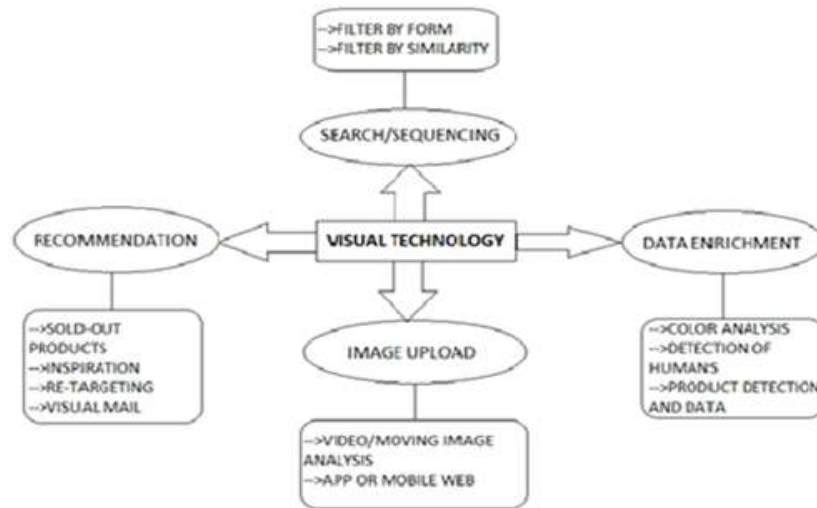
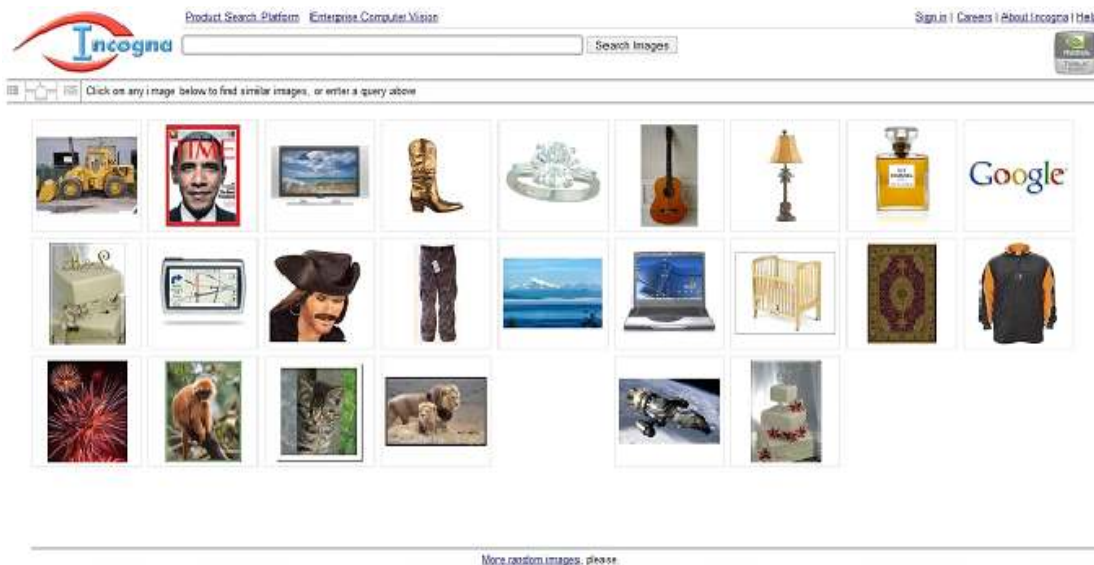Fig. 6: Diagrammatic representation of visual technology of picalikes

Fig. 7: Incogna homepage

the shape in every image, which is selected and uses it to build a large scale searchable visual index. With desktop processors it is not computationally feasible. Using processor parallelism to such a high degree which has been never done before lets it to explore the visual data in such a new way. This parallelising capability of the digital computers includes hardware like Graphic Processing Unit (GPU). Unlike other engines here image text's meta-data is not much concerned as it does not do 'meta-tag-search'. Thus it reduces the unrelated images that are usually clogged at other search engines.

It basically lets you type the name of the object you want to search for and displays images related to the search query. If the image you want is one among the displayed images, click on that image and many such similar images are displayed. Since it's still under

development the website does not let you select an image from your computer but the provision will be given soon.

Let's get to know Incogna:

- www.incogna.com is their official website. Figure 7 is the Incogna Homepage that will open from the above cited link.
  Images can be searched by using any of the images on the home screen or by using the 'More random images' link on the centre bottom of the page or by typing the query.
- When an image is clicked upon the images pops-up and such similar images are displayed. Figure 8 is the result of a sample search.
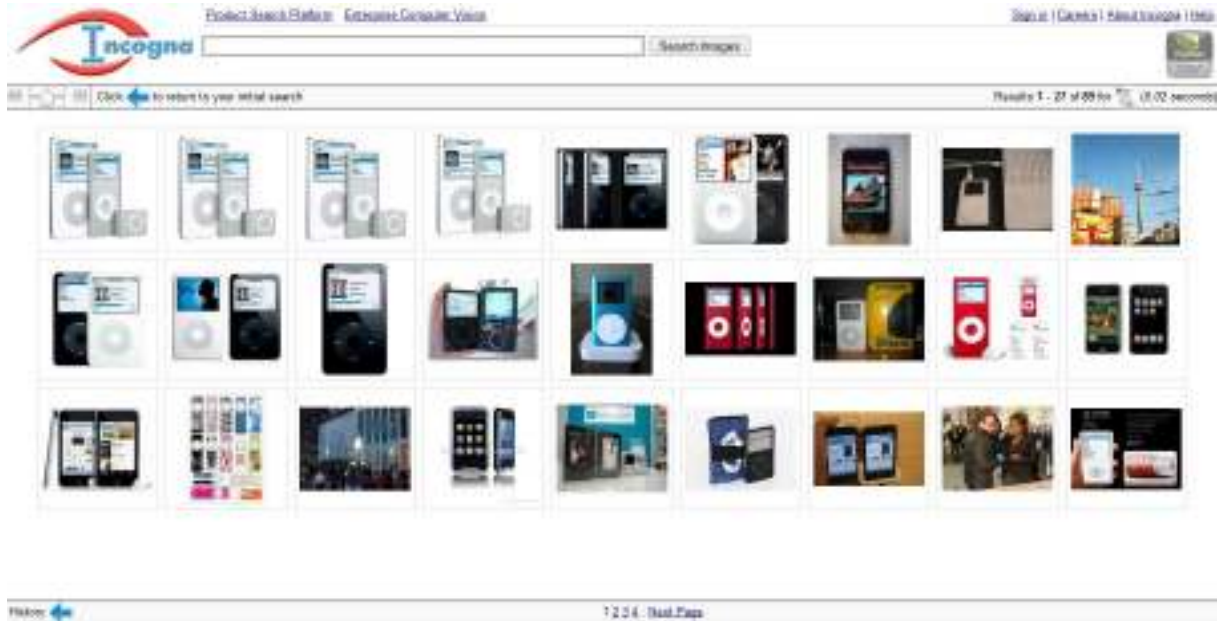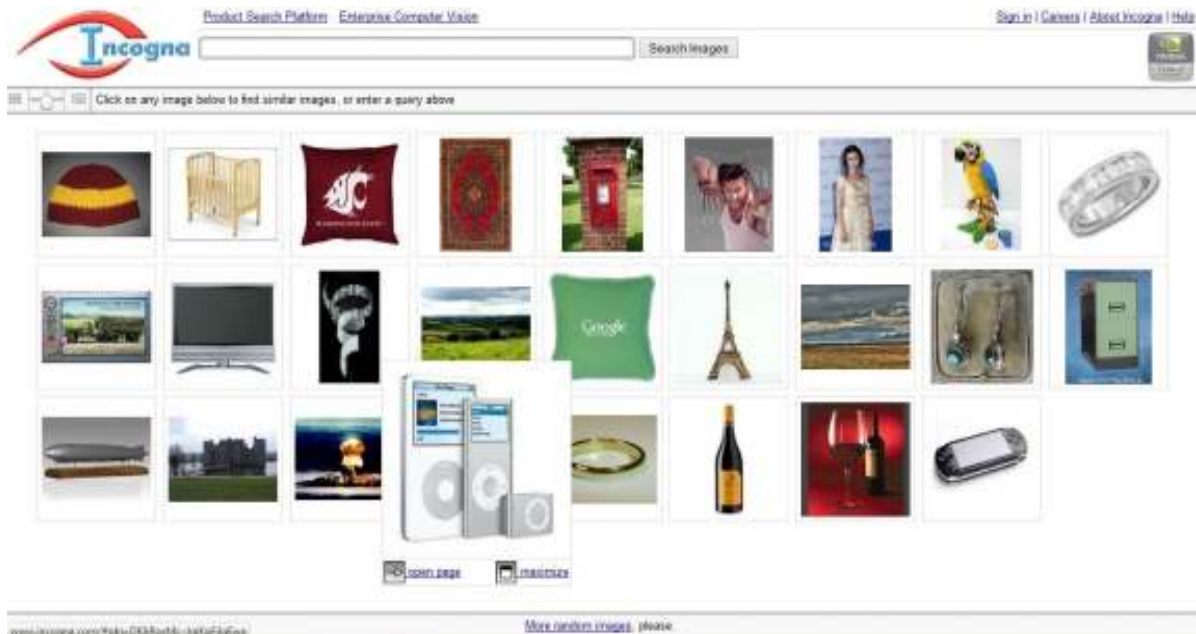
Fig. 8: Incogna search results

Fig. 9: `Incogna directions

- The information about the particular image can be accessed from the image by clicking the 'Open page' button on the bottom left corner of the image or to enlarge the image click on the 'maximize' button on the bottom right corner. Figure 9 shows the directions and assistance of Incogna.
- To return back to the previous page, either the browsers back button or the 'History' button at the bottom left corner of the web page or the blue arrow available right below the search bar can be used.

Time and relevancy: The time taken by the webpage to search for the images is less than a second. More accurately it does not take more than 0.05 sec to search for the image. But when it comes to relevancy, the image is not as accurate. In case the image being taken from the random images shown in the home page, the relevancy is 99% but when it comes to typed search query, the images shown are not as accurate. It gives a wide area of images to choose from. Once an image is chosen from the result page the relevancy becomes more accurate.

Fig. 10: Incogna login

About incogna: Their technology does not require any image meta-data, yet they integrate with full-text indexing engines. Their technology is patent-pending. It uses patent-pending distributed Single Instruction, Multiple Data (SIMD) algorithms to sort the data. After some beta tests the engine is opened for the public just some weeks ago. Presently Incogna feels that the quality of results are much important the number of indexes, because the Incogna's web robots might not scale so nicely if the image index grows to millions. If this draw is taken care of then Incogna has a pretty bright future in the market. The user interface uses Prototype to handle animation and talk to JSON (JavaScript Object Notation) API, which is a data interchange format for converting code into language independent. On uploading an image any engine will be ambiguous if the user is interested in the location in the picture or the product in the image or just the colour. There is no good way found till now for this problem. Incogna is working upon to allow the user to specify the user's part of interest in the image. Though Incogna's license for the public view is closed, an account can be created in Incogna. The people can also access the engine for basic visual search. The process of signing up is as follows:

- Open the above specified link.
- Click on "sign in" link in top right corner. Figure 10 is the illustration of the Incogna Login page.
- Click on the "sign up for an account"
- Fill the details asked. Figure 11 is the illustration of the Incogna Registration page.

Visual search platforms: Visual search platform matches the real world photos to relevant products. This platform is mainly for online merchants. It can be paid and bought and used separately on your web page based on your necessities. There are three different platforms

More like this: This is a visual selecting widgets that helps the merchants to show the similar looking products to users. By powering visually relevant navigation it increases the conversation rates i.e., increase in number of user searched products. It literally displays all similar products in a page, further on selecting a product the next page contains all the products that are similar to the selected product. This is displaying visual relevant suggestions and makes user's navigation through the pages easier. Inventories are synchronized daily and the database is maintained up-to-date. This platform is easy to set up, just paste the HTML widget on online shopping site and it is done. It can be used any were in the sites like detail pages, search pages, checkout pages, etc. Figure 12 is the copy of the Results page for a randomly selected product.

Match the look: Match this Look is mainly designed for fashion sites and apps. This platform helps the users to find the similar products of which is in the given picture. It enables users to search and find products across a range of common brands. Some brands that are a part of it are Old Navy, fcuk, Ralph Lauren and many more. This widget accepts the newly uploaded image and returns the best match from the inventories of the merchant. Data fed is always up to date. The merchants can become a part of the widget rather than the previous one, where you will be provided your unique business widget. The most advantageous feature is that the product and inventories updating is done by Incogna itself which is a highly tough job. Figure 13 shows the suggestions given to match a random search.

API and SDK: Incogna API is a highly adaptive tool that will transform your shopping experience. It gears the NVIDIA Tesla Graphical Processing Unit (GPU) to aid the user in finding:
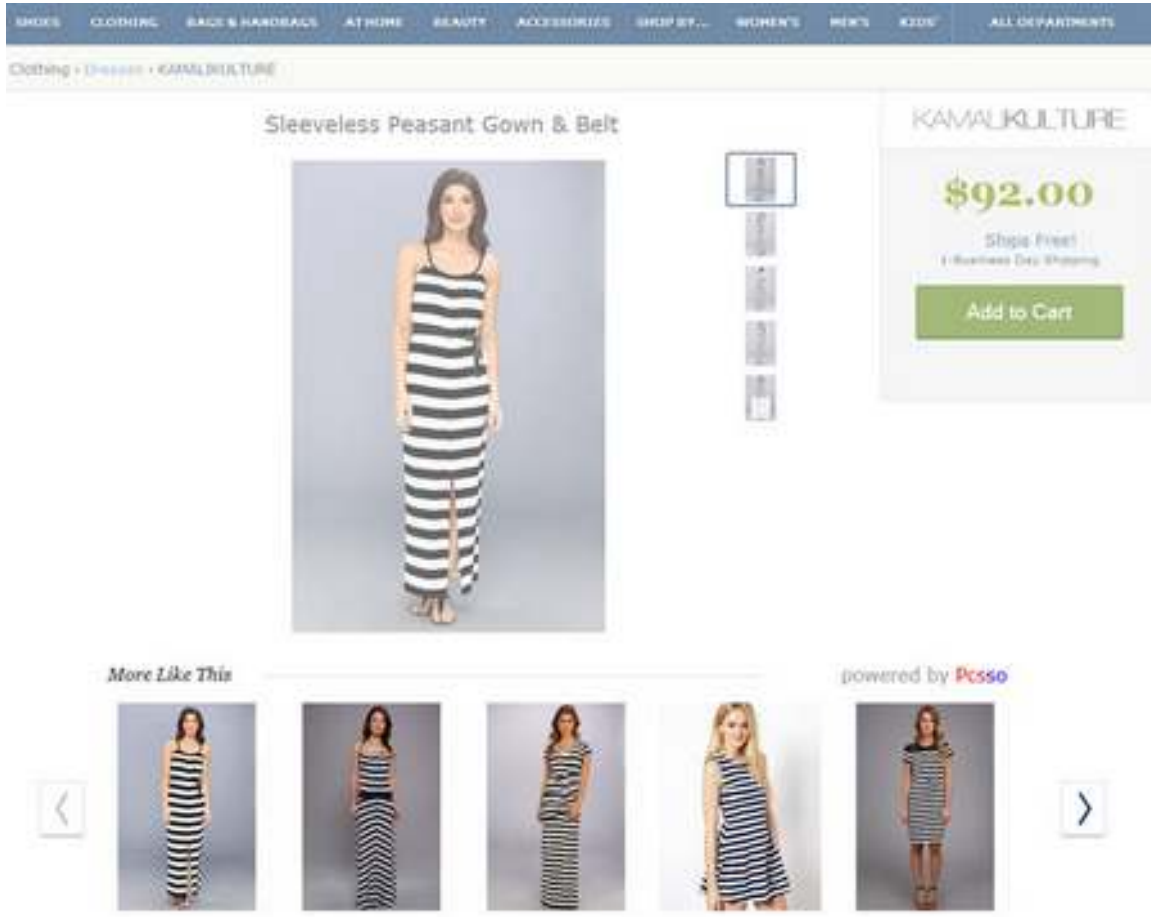

Fig. 11: Incogna registration

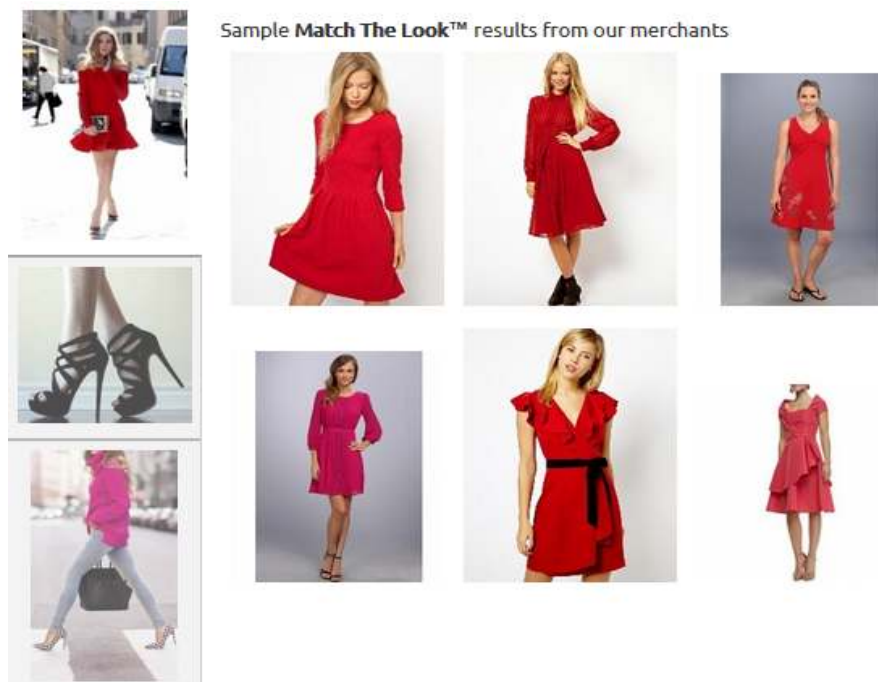Fig. 12: Results page of a selected product

Fig. 13: Suggestive images to match the one to be searched

Table 2: Appliances available and their criterial comparisons

	Incogna Fermi appliance	Incogna Kepler appliance	Incogna Maxwell appliance
Processing power/appliance	1.0+ teraflops	2.0+ teraflops	5.0+ teraflops
User	Singler user license	2 user license	4 user license
Processing system	Multi image	Multi image and multi user	Multi user and multi image
No. of images searched simultaneously	6	12	16
High availability and redundancy support	Yes	Yes	Yes

- What's in any image?
- Where to find the exact or a best match of the image?

Unlike the other two search platforms API and SDK are to be used by consumers for advantageous searching.
The API does the following works:

- Classification of the image
- Image retrieval
- Finding the foreground of the image
- Finding the primary and secondary colours
- Finding the shape, texture and colour
- An Apache Solr plug-in supporting faceting along with full text search is also present
- Thus completely makes it easy for the computer to understand any image and thus process and searching is done comparatively faster.

User can have their own image or also can use the pre-filled inventories.

Incogna enterprise appliance: Incogna Enterprise Computer Vision Appliance reduces the working time and cost of knowledge. Incogna give solutions which are powered by NVDIA Tesla GPU technology available as Computer Vision Appliances. It aids you in image outsourcing and image processing without much usage of resources. Incogna Content Recognition Engine (ICRE) consists of hardware and license (www.incogna.com/about). It can be used for various processes based on the requirements. The three appliances available and their criterial comparisons are given in Table 2.

Tineye:
About: Tineye is the world's first reverse image search engine launched in 2008. It was developed by Idée Inc., Toronto, Canada. It consists of over 4 billion images and millions of users. Instead of keywords, metadata or watermarks Tineye uses image identification technology. It finds the origin of the image, usage of the image and if any modified version of the image exists. Tineye's goal is to associate the creator of the image to his/her image and also provide more details about the image. Its features also include embeddable widgets and bookmark lets (www.tineye.com/about).

Working: When an image to be searched is uploaded, it creates a digital signature or also known as 'fingerprint' of the image and compare the fingerprint against the other images in their database. The images found are not just similar but they are the exact match of the uploaded image, its either a cropped, edited or resized version of the same image. The fingerprinting technology was created by Idée Inc.

Using tineye: User has a provision to either upload an image in the search engine or give a URL or the page containing the image, provided the image is of 20 MB. The search engine finds alternative usage of the image in the internet and it also searches for modification of the same images. Based on that modified image it reports the date and time at which that was uploaded. Object outline recognition or facial recognition cannot be done by Tineye. It can recognise the whole image and some changes in the image. It can also recognise smaller, larger, cropped versions of the same image. Tineye is capable of retrieving different images of same subject from its database. It can also search images in different formats, but mostly JPEG, GIF or PNG format. Tineye can categorise the search result as best match, worst match, biggest image or smallest image.
Results generated by Tineye have the following information:

- The total number of matches in the given database
- A preview image
- URL to every match
- A function called compare images.

Compare image-displays a window where the user has the provision to switch between original image and search result. The page is replicated in Fig. 14.

Algorithms: The exact execution or algorithm of the working is not disclosed to the common for business and technical reasons. One of the efficient algorithms used for this is perceptual hashing. It creates a hash from the sample image. Construction of a hash involves the following steps:

- **Size reduction:** Pictures are a combination of high and low frequencies. The low frequencies show the structure while the highs represent the details. Hashing concentrates much on the structure of the image. The fastest way to remove the higher frequencies is by just shrinking the image. It will form 64 pixel image as 8×8.
- **Colour reduction:** Just calculates the mean values of all 64 colours.

Fig. 14: Results page of TinEye

- **Average the colours:** To filter the minimum frequencies, it selects a smaller part of the already reduced image. If the image is reduced to 16×16, then it selects the top 8×8.
- **Calculate the bits:** Colour value of each pixel is checked, if it greater than the mean and the corresponding bit is set. All the other bits are cleared.
- **Hash construction:** Place all the 64 bits into a 64-bit integer in any order resulting in the hash.

This hash won't change if the images' scaling ratio is changed or the properties of the image like contrast, brightness, etc. are changed. Once the hash of two images is constructed then they can be compared for the position and value of each individual bit. The difference in position of the bits is termed as humming distance. If humming distance is 0, then the images are exactly the same. If it is less than 5, then the images are closely identical. But when the humming distance exceeds 10 the images are different. Other than this following efficient reverse image search algorithms may also play an important role:

- Scale-invariant feature transform
- Maximally stable extremal regions
- Vocabulary tree

What is it good for? TinEye has its own ability to search for images or its modified images in web. It can be used by the copyright holder in case of infringements. It also relates a possible road for the people who are looking to make use of imagery under orphan work. It is a work to find the copyright holders of that image. Orphan work is copyrighted works of unknown persons. It is one of the best duplicate finder rather than finding related images. Other than this is also used for:

- Finding an image on web
- Getting information about a particular image.

And all other common uses of any image search and reverse search engines.

Limitations: There is a limit to how many images that can be searched, for a non-commercial user its 50 images per day and 150 images per week. If the search has to be more than the specified limit or for commercial use the paid version of Tineye has to be purchased as it allows unlimited searches. The paid version of Tineye consists of 'easy manual searching'- an user interface and also an API for advanced automated searching. If not the paid version, the search can be continued the next day after the limit has been reset. And also if you are not a registered user, the history of the image you searched for will automatically be erased after 72 h. In case of registered user, the image can be saved if the 'History' option is enabled.

Lmmenselab: Immenselab is an open and general search engine developed by KBK group of companies, Japan. It is a prototype which helps in finding identical or similar images patterns. These images are retrieved

from databases, personal computers or client-server system. The images can be of poor quality or it can be just a fragment of an image and yet the search engine would bring up images similar to that of the one compared with. It uses complex indexing, allows advanced control, compares with a larger database and has high performance (www.kbkgroup.org).

The image can either be uploaded or chosen from the given list or the URL can be shared. The image is further searched and displayed in the central pane. A hashing agent is installed which forms a signature database (i.e., digital code of the image) and is uploaded to the cloud. This database is arranged and indexed based on similarity of images. The advantages of immenselab are:

- Compact indexing of large database
- User control over the search in real time
- High performance search using a pattern
- Multifunctional indexing

The indexed database contains around hundred billion images and is managed as a cloud. The indexes are 100 times more compact than the efficient binary tree indexing. Hence it is used. All the images in the database are indexed based on some properties and their weights. Their module creates a "DNA code" for each file and this forms the client's personal index base. All these indexes and DNA codes are disclosed even to the corresponding client.

One of the main advantages of immense lab image search engine is user controlled search. It gives the steering wheel to the user. User can scroll down to 10th or 100th page of the search result. User can search for identical and similar image patterns with user control. These options are available in the user interface. Some special features provided are:

- **Panel with search criteria:** Allows you to select the area of interest of the search as RGB difference, background, central area, colors, shapes or criteria.
- Further the criteria of the search can be specified by the user as landscape, car, person and many more.
- **ON-THE-FLY search control:** Sliders and menus that allows a user to adjust the range for accuracy or inaccuracy of search.
- **Fuzzy filter:** It is another slider used to explore various other opportunities for retrieving different images.
- **Storage buffer:** It is present in the right side of the central pane. After the results of any search there will be a star displayed at the image's top right corner. On clicking the star the search and the result is stored temporarily in the buffer.

User can change the settings and get different query results in real time. During the search for the image, a user can opt for diverse methods of image recognition and it also allows to set accuracy or inaccuracy of search at different levels. Setting higher accuracy will results in more similar looking images. If the search is on a general criteria like a specific bird or a flower then accuracy should be decreased to get a wide range of images in various angles and size. Whereas for search criteria like a personality or place the accuracy must be a little more increased.

The search of any image is based on a pattern. This is one of the efficient algorithms for searching images. Hence increase the efficiency of the engine. When the user uploads an image it uses pattern based content retrieval and introduces a hashing agent. This is compared with index of the images present in the database and the best matching images are returned. Along with the results the link of the webpage and some basic details are also returned.

Multiple indexing is processing the same image simultaneously for different results like searching it based on more than one criteria, searching for different angles and so on. This is done using the various parameters of the index given to the images.

It is used by internet surfers, publishing houses, advertising agencies, social networks, developers of mobile application, large museums etc. A pattern of image can be used to search for an identical image or similar image in indexed database.

Yandex:

About: Yandex is a search engine based at Russia. It's the most visited engine in Russia and the recent survey revealed 59.3% of the search traffic in Russia was due to Yandex. The term 'Yandex' was put together by its two founders Ilya Segalovich and Arkady Volozh in the year 1993. Segalovich was working on names that capture the essence of the technology, thus 'Yandex'. 'Ya' stand for 'I' in Russia, so everything together Yandex is 'Yet Another iNDEX'. The first web portal of Yandex www.yandex.ru was launched in the year 1997. Later in 2000 Yandex as a standalone company was established. The role of internet has changed over the years. The users don't just want to find solutions online, but they want real-life suggestions and much more. Yandex aims at providing just that. It serves people. Their products are based on a complex, unique technology which cannot be replicated quite easily. MatrixNet-the machine learning method they developed in 2009 is what is used in most of their products and services. Apart from creating products and working on developments, some of their experts train student and learning specialists. Since 2007, Yandex School of Data Analysis offers free course for graduates and senior students and also it runs a school for project manager, UI developers and IT specialists. They are partners with the leading research institute in Russia and they deliver lectures to high school students they sponsor various contests on Computer programming, Linguistics and Mathematics (www.yandex.com/about).

How it all happens? Yandex Reverse image search or searching is not based on visual content of the image and not on words. It works on "computer vision technology". This technology was created uniquely for Yandex by their developers. It is named as Sibir representing "Siberia" (Russian), from the acronym CBIR. It transforms pictures into "visual phrases". Visual phrases are a part of the image cut out form the original. These small Visual Phrases are literally converted into a set of numbers representing all the key features of the image. Then the engine selects images containing same visual phrase from the internet by comparing this numbers with those of the image in internet. This is the core step of the process and the scope of the search is reduced partially for speeding up the process. Once the images are selected the engine next checks for the position of the key features. Then ranks are given for the result based on accuracy of position of the features. The highest ranked image will be closest resemblance of the user submitted query. The mind blowing fact is all these process from uploading to returning of results all happens in less than a second. Computer vision search is done based on three important algorithms:

- Scale-invariant feature transform
- Maximally stable extremal regions
- Vocabulary Tree

Scale-invariant feature transform: It is used to find all local features of the image. This separated out feature is used in building suitable visual phrases. It was published by Lowe (1999). It has 5 key stages:

- Scale-invariant feature detection
- Feature matching and indexing
- Cluster identification and Hough transform voting
- Model verification by linear last squares
- Outlier detection

Maximally stable extremal regions: It is used as method to detect blob in images. Blobs are various different regions in an image which have common features like brightness, color, etc. It is of two types:

- Differential method, based on derivative of function with respect to position
- Local Extrema method, based on finding local maximum and local minimum of the function

It has a broad base in mathematical methods like laplacian formula, Gaussian formula and hessian formula.

Vocabulary tree: It is more commonly known as Bag-Of-Words (BoW) model. It treats image features as words and used for classify them like word classification. Here the image is represented as a Vocabulary tree considering the features. The representation of BoW has two steps:

- Feature representation
- Codebook generation

Feature representation: Once all the features are detected the image will be abstracted by all the local patches. Here we deal with representing the patches as numerical vectors. And the resulting vectors are called feature descriptors. It should keep track of intensity, rotation, scale and affine variation.

Codebook generation: Here the feature vectors are converted I to "codewords" leading to formation of a "codebook" with all different patches of the image. Then k-means clustering is performed over all vectors. This is basically done to partition the patches clearly. Then the codewords are declared as the centres for learning the clusters. Thus the number of clusters formed will be the same as the size of the codebook. This ensures each patch in the image is mapped to a particular codeword.

There may be some changes or additional functionalities to these algorithm for Yandex "computer vision technology" in particular but nothing such is revealed to the common people.

Why is it needed? Reverse image search is not in much demand but still it will grow for its popularity. Once a user use this engine then they will understand how useful and necessary it is. While searching in net sibir is useful for the following reasons:

- Validate the information given
- Increase your clarity
- Get the image in different formats and different angles
- Find out what is in the picture
- Safeguard your masterpiece
- Find the address of the image!

Authenticity "is it so?" When there is an image and some data related to the image given you can easily authenticate all the given data about the image. For example, while considering social networking sites sibir is useful to check whether the information provided by a person is genuine or not. It delivers accurate information after the search. When a user gives an unidentified picture sibir will give all information about that photo. Users will get an ease of mind by using this engine because it says whether the particular pictures provided in any website is as true as it is shown.

Fig. 15: Yandex homepage

High resolution "shall I have it much clearer?"
When there is a necessity you can get similar photos of high resolution. The search is based only on the key features and their position in the picture. Hence photos of same query will be available in various resolutions. Also if you have a photo with lower resolution, you can get a higher resolution model of the same one. It does not convert or increase the resolution of the picture uploaded, it just finds similar picture with better resolutions.

Find formats and angles "same thing indifferently":
Similar to getting image in different locations you will be able to get similar images in different formats. Sometimes you may look for different angle that, that time all the key features will be checked and the relative position of the key feature will also be checked. But the overall position of all key features as a whole in the background will not be taken care much, because tilting an image by any angle will not alter much of the relative positions of key features.

Accurate results "what is inside?": Whenever you have an image and you dint know much information about the image this will give high support. The search provides all accurate information about the image given in various web pages of the internet simply by searching the image added with it in the corresponding pages.

Copyright infringement "any copies available?":
Sibir also has a feature of learning about the copyright availability of any image. It is mainly useful in photography and art industries. Artist or photographers are allowed to search their own works and it informs whether any duplication has happened. Also it can be used by artist, photographers and business people to apply for a copyright of their masterpiece or business logo after checking availability. Sibir has the ability to work with Exabyte (10^{18}) of photos.

Image locating "where is it?": You can upload any image and can find the address of the webpage in which the image is placed and the location of the image in the corresponding web page. This will be useful in many cases especially in the craze of the 21st century, ecommerce sites. You can upload any product and find the web page or website where the image and the corresponding details are available.

Let's get to know Yandex:

- Its official site is www.yandex.com. Figure 15 shows the Yandex Homepage.
- It provides image, video, e-mail, location, performance and browser support
- The website is available only in countries such as:
  o Russia
  o Ukraine
  o Belarus
  o Kazakhstan
  o Turkey
- For any of the above mentioned categories, choose the category and just type the search query on the
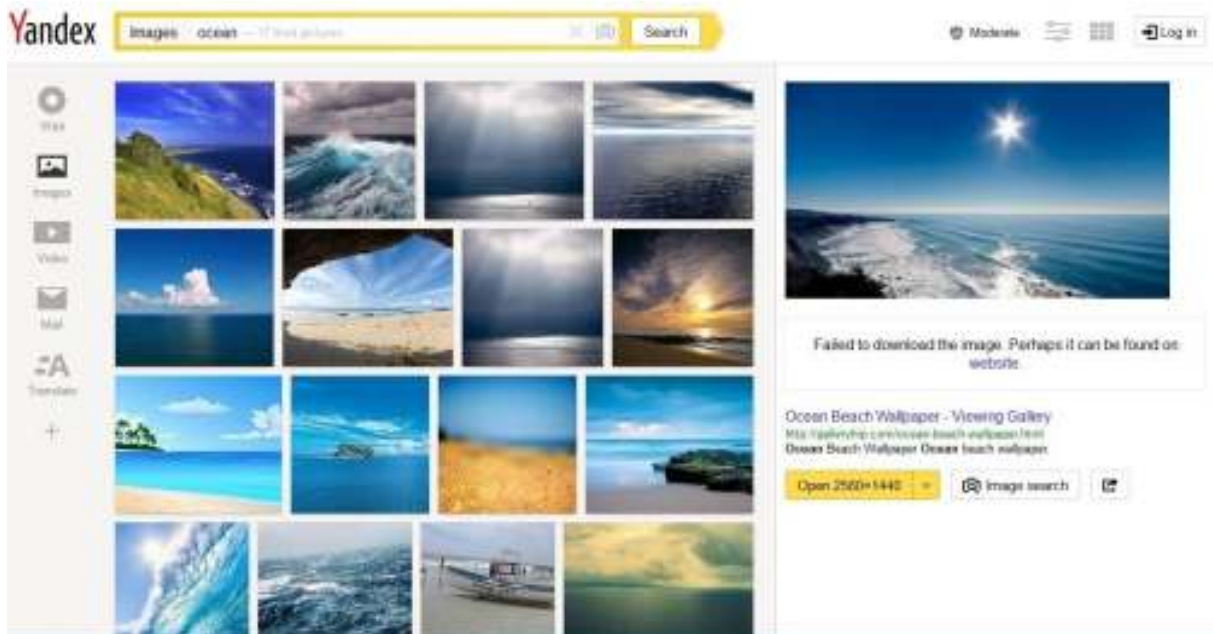
Fig. 16: Search results page

search bar and the corresponding image/video/location is displayed.
- For example, the image category, I search for 'Ocean'. Figure 16 is the result page.
- The setting icon ( ) on the web page will allow you to filter the search even better. The security of the images can also be filtered through
  o Moderate
  o Unsecure
  o Family settings

Image of the day: Every day an image is chosen as 'the image of the day' by the server, i.e., using an algorithm. A number of images from the mostly viewed images are automatically selected and those images are filtered further on the basis of graphic analysis such as gradient, texture, color, contrast etc. These images use deep neural networks technique to select the image. The selected images undergo moderation so as to not include any human portraits or sensual pictures among them and makes sure that varieties of themes are represented. These images are available for download for a day till the next image is put up.

Every 'Image of the day' links us to more information about the image and the author. The home page of image of the day holds two popups:

- Download
- Image's name

The Download button will allow you to download the image whereas the name gives the detailed information about the image and its author. The
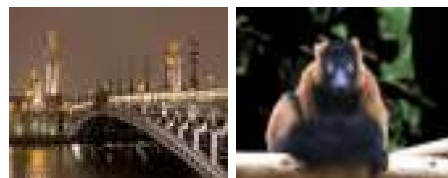

Fig. 17: Two of the image of the days

previous image of the days can be viewed, but cannot be downloaded. Figure 17 is an example of two images of the day.

Log in: Creating an account in Yandex will enable you to access more than 30 themes, spam-free mailbox, a mobile app and what not. The account passwords need not be remembered, login into Yandex using any of the social networking sites. Figure 18 is the Yandex login page.

Chic engine:
About: Chic Engine is a Visual engine, which helps you identify the type of clothes that you want to find. Similar to another search engine called Like.com, Chic Engine aims at helping one find the right clothes that they desired for. Instead of using key phrases for searching the type of dress, Chic Engine enables you to upload an image of the dress and search the database against it. Chic Enginge was started by Adrian Rosebrock, owner, managing partner and developer of Shifty Bits, LLC (www.chicengine.com/about).

Chic Engine is an app available only on iPhone App Store and for security reasons the working has not been revealed to the public. One has to download this

Fig. 18: Login page

Fig. 19: Chic engine home page

app to make use of this search engine. Figure 19 is the opening page of the app.

Once you take a snap of the dress you wanted to search and upload its image it will ask you for its category. The result images are shown mostly based on the category selected and the colour of the dress in the image. The image taken for the result page to load depends in the speed of your data connectivity in you iPhone. In the results pages you get a variety of dresses shown, on choosing any one among them, not only does

it show the images of the dress but also shows the price, availability of the dress, sizes it's available in, the colour of the dress and the material of the dress. Also you can purchase that dress through the app provided you have an account with Chic Engine. Figure 20 shows the results of the image.

RESULTS AND DISCUSSION

The proposed plan: The legacy method of building CBIR lacks in performance. Hence here is a better architecture and methodology placed by Shriram *et al.* (2014). This is only a basic architecture and most of the features must be reordered in the final states. The methodology has the following steps:

- Histogram
- Entropy
- GLCM and
- Region of Interest

Entropy: The total amount of information available in an image is represented as entropy. It also shows the redundancy of information present in it. It clearly serves us to find images closest to the search criteria. It just computes the number of colours present in the image:

$$\text{Entropy} = x \,(\log x)$$

The information gathered from the image can be modelled as probability process. P(E) be the probability
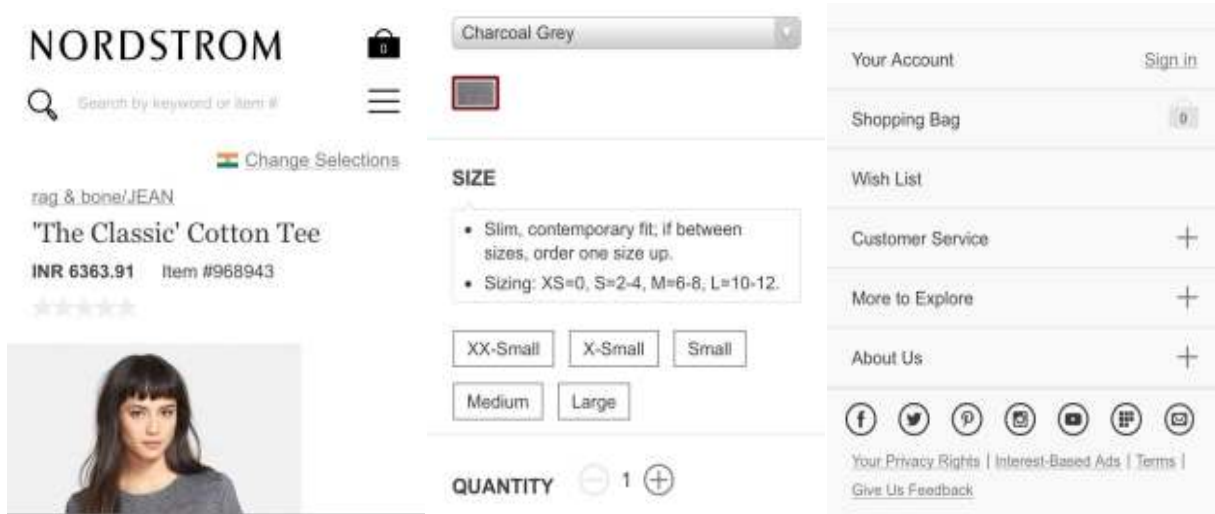
Fig. 20: Results age of the selected image

of occurrence of pixel values. I(E) be the information contained in the image. So if I(E) is 0, then there is no information contained in the image. All the logarithms are considered as base 2 so that it can be represented as bits. Entropy is also referred as uncertainty of the information present. Entropy is defined as:

$$\sum_{l=1}^{L} p(al) \log (p(al))$$

From entropy the total information of the image is obtained. This retrieved and stored in a text file. When the Entropy of the search image is obtained they are compared using Euclidean distance formula:

$$d(p, q) = d(q, p) =$$
$$\sqrt{(q_1 - p_1)^2 + (q_2 = p_2)^2 + \cdots + (q_n - p_n)^2}$$
$$\sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

Distance for various images is calculated. The image with smallest distance is the best match. If there was an image with distance as 0, then it is the duplicate of the same image.

Texture grey level co-occurrence of an image (GLCM): This method is adapted to get the second order statistic features about the texture of the image. It is one of the popular and efficient methods. It forms a square matrix called GLCM Matrix. The size of the matrix is the number of grey levels in the image. The inputs of this matrix are the relative frequency with which two corresponding pixels in any given neighbourhood are separated by a pixel distance (dx, dy). Here I and J indicate the intensity of the neighbouring pixels considered. From the resulting GLCM matrix various features like energy, Entropy, Homogeneity, contrast and similar basic features. Energy is derived as:

$$\sum_i \sum_j p^2(i, j)$$

For any constant image energy is always one. The energy is the square of sum of the probabilities calculated.

Homogeneity: The closeness of distribution of the GLCM matrix elements is referred as homogeneity. It ranges between 0 and 1. It is derived by:

$$\sum_i \sum_j \frac{p(i,j)}{(i+|i-j|)}$$

Correlation: In any pair of neighbouring pixels considered, there will be at least a little amount of correlation between them. This measures the amount of correlation between all the neighbourhood pixels. It ranges between -1 and 1:

$$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)(i,j)}{(\sigma i\ \sigma j)}$$

Contrast: It measures the Intensity of contrasts among neighbouring pixels in the entire image. It ranges between 0 and (size of GLCM-1)^2:

$$\sum_{i,j} |i - j|^2 p(i, j)$$

Region Of Interest (ROI): ROI is one of the most efficient interest point detectors and descriptors developed by Bay *et al*. (2006). The algorithm which is speeded up and has robust features is scale invariant and rotation-invariant. Hence the interest point detector is computationally fast. To make it this fast, it actually makes use of integral images. Fast-Hessian Matrix is used to detect the key points. The Haar-Wavelet distribution is described for the descriptor role of the engine.
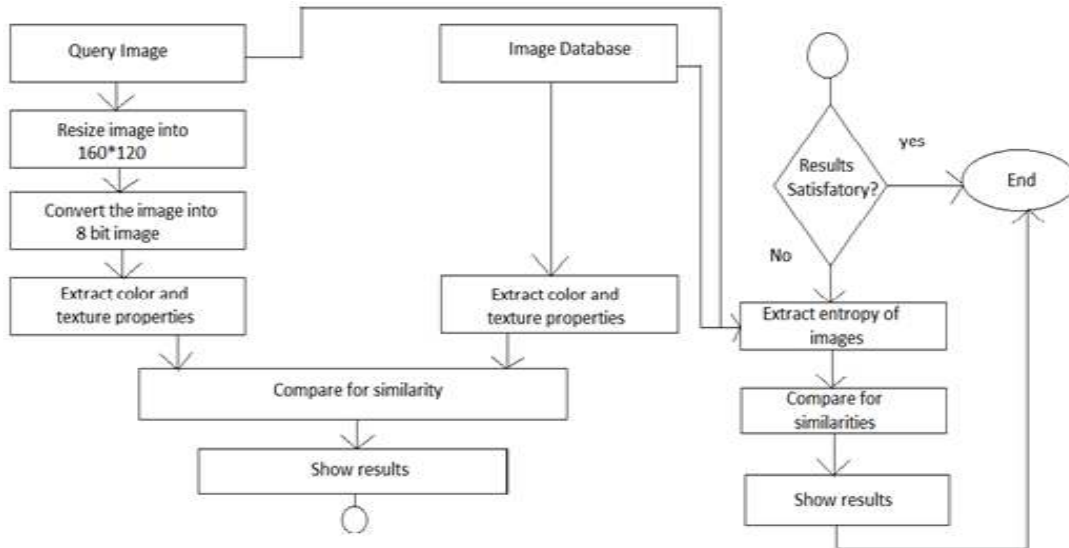
Fig. 21: Flowchart of the proposed plan

Here the retrieval is done in three stages. In the first stage the results are retrieved based on the color and if the user is satisfied then the search is stopped here. This does not give much work to the engine. If not moves to the next stage. The second stage is retrieving based on the structure of the image. If the user is still not satisfied, then the entropy of the image is calculated finally and then best results are found by comparing them.

Environment: Around 2500 images are to be placed in the image database to aid search while offline. The images are of different kinds and various formats as JPEG, BMP, PNG and TIFF and are placed randomly without following any specific pattern. The contents are common images as flowers, fruits, birds, animals and some more such common things. Initially for understanding MATLAB is used but for latter results OpenVC is being used, which is a freeware.

Prerequisite: This plan is proposed for research desktops with 2GB RAM with Intel Core 2 Duo processor. But the algorithm also works efficiently for Intel Pentium P4 with 1GB RAM. Ubuntu (Linux) is the prescribed operating system. Before uploading an image, its specification is checked. If it is not in 256 bit format, then it must be converted into 8 bit deep level image. rbg2ind() method is used for this conversion. The image size must be 160*120 for MATLAB. We use built-in imresize() to automatically converts the size of the image before uploading it.

Features: Other than efficiency some other interesting features of this proposed plan are:

- Search based on keyword
- Histogram
- Entropy

- Texture
- Region Of Interest (ROI)

Flow chart: Figure 21 shows the diagrammatic representation of the plan proposed.

More in the market: Other than these there are some more image search engines common around the market. The world's most popular Google search has its own image search engine. It works on a combination of algorithms involving various techniques rather than using a specific technique for different case efficiency.

Then is the Baidu image search. This belong to the Chinese company Baidu is constantly involved in search engines and has conquered the Chinese market. They are the standard competitors for google in china.

One such interesting engine is ID My Pill. Given the photo of a tablet it returns the name, specification or composition and why and how should it be taken.

The online store eBay has its own fashion image retrieval engine known as eBay image search. Some more engines for mobile and eCommerce like fashion sales are Picalike, Like.com, Empora, Shopachu (from incogna).

There is also an individual's online search site. It was developed by an individual and is open for the public to search similar images online. It is MiPai similarity search.

OddEye is and CBIR that uses odd concepts to find any product or video frame or catalogue. Tiltomo uses Flickr photos. Elastic Vision is a smart CBIR capable of clustering in a visual network. Other general image search engines are:

- Imense Image search by immense
- Imprezzo image search by imprezzo
- Visual Image search by Pixolution

- Pixolution Image search by Pixolution
- Piximilar, a demo engine by idee inc,.
- Visual Recognition Factory
- NoClone
- Querbie

CONCLUSION

The working of these search engines always pipes up our curiosity. For security reasons most of the companies maintain a closed licence and the technology behind them are not revealed to the common public. In spite of all these reasons and limitations we have brought the maximum technical details about the working behind these CBIR search engines. Even though these engines are highly efficient and provide satisfying results, as humans we tend to develop more with a higher technology. So we have also proposed a better and highly efficient architecture design for a CBIR search engine. Along with the working of some popular Image Search Engine we have also developed the availability of various engines in the market. The peculiarity and the use of each engine is explained briefly to help you take maximum advantage of the technology available. Also a review on common image search engines has been written and the relevancy of the image and the time taken to find the same has been included. This will allow you to choose the best engine for any work based on the criteria, necessities and efficiency in the particular area. Thus a brief image of CBIR search engines are presented for the access of the common people and to get benefit from the latest of technology.

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