Literature Review of Image Based Online Product Search

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***Abstract*— In this information era internet is the primary tool to find our resources whether on the professional front or the personal space. The shopping spree continues virtually too with the added joy of home delivery. As e-commerce sites are growing at a rapid rate, so are the demands for efficient and effective tools for retrieval of query images. Image based online product search (IBOPS) system aims at identifying product and retrieving similar products from a database based on a user specified image. Finding information based on an object's visual appearance is useful when specific keywords for the object are not known. This paper is an attempt to explore the various techniques and their usage in this application domain.**

***Index Terms*— Canny edge detector, Gaussian filtering, Harris corner detection, Image based product search, SIFT, SVM.**

I. INTRODUCTION

Many have the notion that if a product is not on Flipkart (or any online shopping site) then it doesn't exist in the real world. When almost everything seems to be fine, there is one issue that needs serious addressing: expressiveness. With this kind of dependency, we surely need better ways to input our queries; a better method to describe what is desired. A picture is by all means provides more information than written scripts. It is easy to upload a pic shot on camera than to describe it in words. While shopping online, Consumers are now demanding image-based search functionalities rather than text-based keyword queries. An image-based search system takes images of objects as queries and finds relevant web pages by matching them to similar images on the web.

The application holds great popularity because of commercial importance and wide user demands. Thus with the development of IBOPS system, the growth of online shopping sites is all about to increase. This saves the customer the effort of walking to each store to check for its availability. If it is available online, all needs to be done is to order a home delivery. Due to the wide application of images in the real world, we are in bad need of excellent as well as accurate image comprehension algorithms to address problems in image classification. Various research journals were consulted to find relevant information regarding image based search applications. The literature reviewed is organized as follows: firstly, we discuss various techniques in image processing, secondly, the existing research and development in this field are explored, and thirdly, the similar products in the market identified are presented.

The remainder of this paper is organized as follows. Section II presents various image processing techniques with recent advancements. Section III outlines the existing research and development in the field of image based product search. Section IV describes our proposed system for IBOPS. Section V presents the similar products in the market.

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II. IMAGE PROCESSING TECHNIQUES

Before retrieving similar images from the database, the query image as well as all database images must undergo certain preprocessing. Preprocessing is very useful in a variety of situations since it helps to suppress information that is not relevant to the specific image processing or analysis task. Therefore, the aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features important for further processing. There are various preprocessing techniques namely filtering, edge detection, corner detection etc.

Filtering is a technique for modifying or enhancing an image. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel [1]. There are literally hundreds of types of filters that are used in image processing. However, we will concentrate on the best one: Gaussian filter. The Gaussian smoothing operator is a 2-D convolution that uses a kernel which represents the shape of a Gaussian (`bell-shaped') hump. The Gaussian outputs a 'weighted average' of each pixel's neighborhood, with the average weighted more towards the value of the central pixels. Because of this, a Gaussian provides gentler smoothing and preserves edges better than a similarly sized mean filter. In [2], they have implemented a Gaussian Filter on FPGA. This hardware implementation method saves

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the image in the Line Buffer for parallel processing, sends the saved valued to the Window buffer and then the result of the passed Gaussian Filter is derived, through calculating the Gaussian mask and saved Window Buffer. A new algorithm for Color image enhancement system based on Gaussian is proposed in [3]. The original image is read in RGB color space. The color components are separated followed by the selection of window size as 5×5 for each of the R, G and B components. In each color component, the selected window is convolved with 5×5 Gaussian kernel in order to smooth the image. Next, Logarithmic operation is accomplished. Finally, Gain/Offset adjustment is done and the separated R, G and B components are combined into composite RGB in order to obtain the enhanced image.

In an image, an edge is a curve that follows a path of rapid change in image intensity [1]. Edges are often associated with the boundaries of objects in a scene. Edge detection is used to identify the edges in an image. There are some techniques developed to achieve this task such as Sobel, Prewitt, Laplacian, Laplacian of Gaussian (LoG) and Canny, but we will concentrate on the Canny edge detector. The Canny edge detector detects all strong edges plus it will find weak edges that are associated with strong edges. As discussed in [4] there are three major steps namely filtering, enhancement and detection in Edge detection. Canny's algorithm is computationally more expensive than Sobel, Prewitt and Robert's operator. However under almost all scenarios, the Canny's edge detection algorithm performs better than all these operators. In [5], they have proposed a mechanism to implement the Canny algorithm at the block level without any loss in performance compared to the original frame level Canny algorithm. This distributed algorithm adaptively computes the edge detection thresholds based on the block type and the local distribution of the gradients in the image block.

In many cases it is advantageous to find pairs of corresponding points in two similar images. Corners in images can be located using local detectors [6]; input to the corner detector is the gray-level image, and output is the image in which values are proportional to the likelihood that the pixel is a corner. Interest points are obtained by thresholding the result of the corner detector. A corner pixel has surroundings different from all of its neighbors in all directions. The Harris corner detector is an improved version of Moravec's detector. The Harris comer detector has been very popular. It's advantages are insensitivity to 2D shift and rotation. A novel approach [7] combines B-spline wavelet multi-scale theory and Harris, and has proposed multi-scale Harris corner detection method based on B-spline. In [8], they have used Harris Corner Detector to extract interest points, and additional descriptor FREAK (Fast Retina Keypoint) to match and find the object. Once the object is found, they used classification algorithm to classify and label the object based on the extracted features. This technique is precise and robust.

Interesting points provide a "feature description" of the whole object. This description, extracted from a training image, can then be used to identify the object in the image. Scale Invariant Feature Transform (SIFT) is an image descriptor for image-based matching and recognition developed by David Lowe [9]. The SIFT descriptor is invariant to rotations, translations and scaling transformations in the image domain. It is also robust to illumination variations and perspective transformations. A novel digital image stabilization approach using Harris and Scale Invariant Feature Transform (SIFT) was presented in [10]. The proposed approach uses SIFT to detect feature points and incorporate the Harris criterion to select the most stable feature points. With these feature points, they use feature descriptor and matching algorithm to achieve the image stabilization. The proposed algorithm not only brings down the probability of wrong matching and more accurate matches, but also reduces the computational burden effectively.

SURF (Speeded Up Robust Features) is a robust local feature detector [11]. It is partly inspired by the SIFT descriptor The standard version of SURF is several times faster than SIFT. The difference between SIFT and SURF as mentioned in [12] lies in the implementation of scale-space, SIFT typically implemented image pyramid where the input image is iteratively convolved with Gaussian kernel and repeatedly sub-sampled; while SURF created scale-space by applying kernels of increasing size to the original image. A new approach for product identification task was proposed in [13] using open-source library LIRe and SURF. The LIRe library offers different feature extraction possibilities. In [12], SURF is combined with Bag-of-Visual-Words (BoVW) to yield a good classification result and retrieval. In [14], comparison is made among four most commonly used feature detectors: Harris, SIFT, SURF and FAST detectors. They found that the SURF detector is the most suitable feature point detector for 2D and 3D objects classification method.

In computer vision, the bag-of-words model (BoW model) can be applied to image classification, by treating image features as words [15]. BoW model can be thought as an histogram representation based on independent features. [16] has proposed an image classification algorithm based on Bag of Visual Words model and multikernel learning. First of all, they extracted the Dense-SIFT features from images in the training set and constructed visual vocabulary via K-means clustering. The local features of original images are mapped to vectors of fixed length through visual vocabulary and spatial pyramid model. At last, the final classification results were given by generalized multiple kernels. A new image retrieval system [17] is proposed that combines the bag-of-words (BoW) model and Probabilistic Latent Semantic Analysis (PLSA). Given a query, its nearest images are returned by calculating the Euclidean distances between the query and the BoW vectors of the training images.

A Support Vector Machine (SVM) is a discriminative classifier [1]. Given labeled training data, the algorithm outputs an optimal hyperplane which categorizes new examples. It follows supervised learning. In the work [18], they have shown that SVM can be implemented quantum mechanically with complexity logarithmic in feature size and the number of training data. Thus it provides one example of a quantum big data algorithm. A new robust version of SVM based on Value-at-Risk (VaR) measure referred to as VaR-SVM is proposed in [19]. In contrast to classical SVMs (such as hard-margin, soft-margin and ν-SVM), VaR-SVM is more stable to data outliers.

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III. Existing Research And Development

In [20], a new approach to retrieve visually similar product images is proposed. Their approach consists of mainly two steps: Object localization and object extraction. In localization process, a weighted object mask voting algorithm was proposed based on a spatially-constrained model. They iterated the outlier removal and vote aggregation process multiple times to refine the object location. Each database image accumulated a mask with a weight. They used the generated soft map for Grabcut. They filled the query image with a clean background and re-extracted features to obtain better feature consistency which are then used to perform search in the database.

iLike, a CBIR technique in real time applications is introduced in [21]. This approach combines textual features from web pages, and visual features from image content for better image search. They have mainly focused on the domain of apparels and accessories. A novel technique using bag of hash bits is presented in [22]. On the client side, local features are compressed to tens of bits by hashing. On the server side, after receiving hash bits of each local feature, the whole image is represented as bag of hash bits. With matched local features, they then apply an image-level spatial filtering to re-rank the images and chose the top returned results.

An image mining using CBIR [23] is a process to search similar images based on user input. This approach uses hue-saturation-value (HSV) color space. In feature extraction, a feature vector is generated which represents the content of each image. Image retrieval is mainly based on two similarity measures namely Euclidean distance (ED) and sum of precision and recall. The overall performance of retrieval was measured by average precision and recall performance. In [24], an optimized Product Quantization (PQ) was applied to compact encoding, where a data point is vector-quantized to its nearest codeword in a predefined codebook. The essence of PQ is to reduce the original high-dimensional space into the Cartesian product of a small number of low-dimensional subspaces that are separately quantized. In this paper, they optimize product quantization by decreasing quantization distortions w.r.t. the space decomposition and the quantization codebooks.

A new CBIR technique based on principle region is presented in [25]. This technique begins by segmenting an image to the most general principal regions and applies a feature histogram to define the color and texture properties of each segmented region. The proposed approach generates a nearest neighbor graph for the segmented regions, and finally applies a greedy graph matching algorithm with a modified scoring function to determine the image rank. Ravindra Gupta and Monika Rathore have proposed a fast multi-feature image retrieval technique [26] which is based on dominant color method for color feature extraction, Logical Edge for texture extraction and binarization for shape feature extraction. The proposed approach is giving efficient results for images having all the three kinds of features.

A novel approach which interfaces with a Content-Based Image Retrieval engine for online shopping in the fashion domain is defined in [27]. The proposed application is based on client-server architecture. The client is responsible for the interactive graphical user interface. It composes the query based on the dress type and obtained image and sends it to the server. Based on the specified focus mask, the server finds the object of interest using segmentation and returns a list of similar products to the client.

Anjan Goswami, Naren Chittar and others studied the importance of image based features on the click-through rate (CTR) in a large scale product search engine [28]. They present a novel idea of using image based features along with text based features. They used a regression model based on stochastic gradient boosting to learn relationships between features and CTR. They have also discussed what kind of image features are important for online product images and presented a study on how they can improve regression CTR ranking models using these features. In [29], a two-shot interactive segmentation technique is introduced in the front-end. The image taken by user is interactively segmented. The segmented image is used to query the database. Their method requires the user to take two images: one with the object and one without the object, but against the same background and then it automatically determine the area of the scene that changes between the two images. The baseline approach employs a direct contour-drawing. The main weakness of the system: it is not applicable to immobile objects such as a statue in a museum.

A CBIR system based on dominant color, texture and shape is implemented in [30]. They have used RGB model for color space description. An image will be divided uniformly into coarse partitions. Dominant color will be selected as the centroid of each partition. Texture will be obtained by the presence of a spatial pattern that has some properties of homogeneity. Impressions of shape can be conveyed by color or intensity patterns, or texture, from which a geometrical representation can be derived. A novel yet simple algorithm to rank images based on their visual similarities is introduced in [31]. The importance of each vertex is measured in the given graph with a set of weighted edges. They have used Eigen-vector Centrality for this purpose. Related images are considered using visual-hyperlinks. They used SIFT and Difference of Gaussian (DoG) interest point detector in object generation. Given the image pyramid, interest points at the local extrema of image space and scale space are selected. A large amount of computation is required and presence of large volume of images in the image data collection is necessary to obtain efficient results.

In the work presented by Ning Zhangy and others in [32], visual search based on contextual model is proposed. On the client side, user takes a photo and indicates an object-of-interest via circle based region called “O” gesture. Both selected region as well as surrounding visual context region in photo are used in obtaining a search-based recognition for retrieving similar images based on a large-scale visual vocabulary tree.

A probabilistic framework for modeling the similarity measure between features is proposed in [33]. They derive a query adaptive distance appropriate for global similarity evaluation. The visual similarities among features are modeled based on a pairwise measurement. Experimental results show that this method improves the retrieval accuracy significantly.

IV. Proposed System

In this section we discuss the general architecture of our proposed system for IBOPS. Block diagram of our proposed system is shown in Fig 1. The system starts by receiving an

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image of an item associated with a user constituting a first user query. It is followed by recognizing the object in the image using an image recognition engine. The recognition engine performs several tasks such as Image acquisition, gray scale conversion, image enhancement, segmentation, interest points detection and construction of feature vector.

It is clear that invariant features may carry more object-specific information than other features as they are insensitive to the accidental imaging conditions.

Our aim is to select only a subset of useful features avoiding redundant and irrelevant features and finally transforming them into more suitable form for greatest saliency and proven robustness. Then the system searches the online shopping websites with reference to the features extracted from the item.

The principal idea is to do the search in an iterative fashion starting with a reduced representation that contains only the most salient object characteristics. Only matches that result from this first pass are investigated closer by using a richer representation of the image and the object.

Typically this search proceeds in a couple of rounds until a sufficiently good matches of required product. If found, the system finally displays the links directing to the purchase page of the site(s) containing the product of interest.

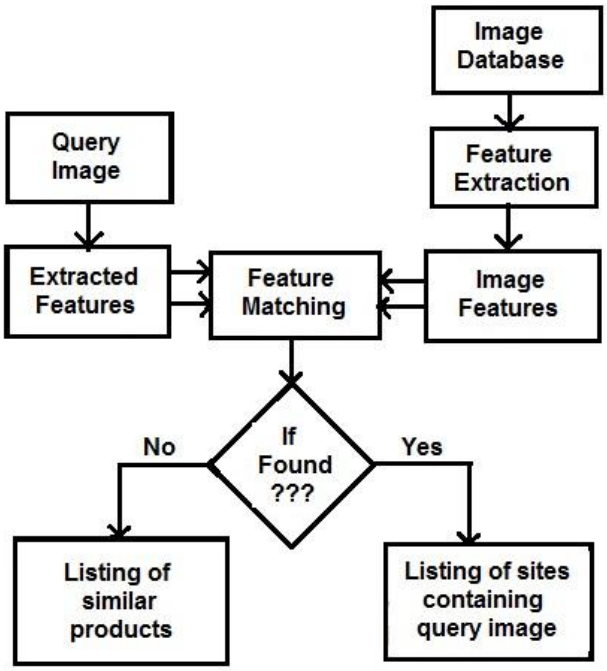

Figure 1. Architecture of the proposed system

The attractiveness of the proposed system lies in:

i. Ability to clearly express the required product's features.
ii. The list of shopping sites where the product in question can be bought.
iii. Eliminates the recursive hierarchical searching under the categories of sites.

V. Existing Systems In The Market

In this section we discuss the existing IBOPS systems in the current market. Google Goggles is a mobile application developed by Google which recognizes images [34]. The system can recognize various labels or landmarks, where user can learn about such items. The system can also identify product barcodes that help users to search for similar products and prices. The system also recognizes printed text and use optical character recognition (OCR) to produce a text snippet, and translate that snippet into another language. Google Goggles works better with few types of queries namely books, landmark, barcode, text, contact info [35]. Currently, it is not successful while working with pictures of Cars, Furniture and Apparel.

SnapTell, a startup purchased by A9.com, Amazon's search engine technology arm that gives importance to image-recognition based mobile marketing [36]. SnapTell allows users to take a snap of the cover of any CD, DVD, book, or video game, and will automatically locate the product and find ratings and pricing information from online shopping websites. The disadvantage of this application is that it doesn't produce accurate results for products namely shoes, electronic gadgets, cars, cups etc.

Nokia Point & Find is a Nokia developed cell phone application, which uses image recognition algorithm to identify objects, images and places in the real world [37]. One can use this application to find information on movies by pointing the camera at movie posters, landmark tagging, barcode scanning for comparison shopping and obtaining information related to products and services. The Point & Find application is limited to a specific set of Nokia smartphone devices.

VI. Conclusion

The image based product search engine will make the lives of online shoppers more picturesque. There is a huge gap between what the customer wants to convey and what the computer understands. IBOPS system will take this interaction to a new dimension of pictures. Thus with minimum loss of information desired results can be expected. This paper has surveyed the essential concepts of Image based product search systems. This survey attempts to introduce the existing research, development and practical applications of IBOPS techniques. We have proposed an architecture for IBOPS system, which is under development.

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