SpatioTag: A Strategic Approach for Recommending Image Tags for Socially Relevant Photos using Spatial Information

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***Abstract* - Social Networking is one of the most successful trends to share friendships over the World Wide Web and it has emerged as a repository of a large number of photographs as social actors share their photographs over the Social networking platform. Every photograph uploaded on the Social networking site requires social tagging to structure and organize the photographs that are posted by individuals. In order to achieve, the best quality of social tags without any falsified or over ridden tag information, a tag recommendation strategy by automatically assigning relevant tags is implemented with a focus given to user preferences. The user defined geographical location is considered to geographically locate the photo. Tags that are semantically similar for a specific photo are analyzed and the best tag is ordered first. In case of several heterogeneous tags availability for a photograph, a methodology to identify the most relevant tag by ordering them to their context is proposed. The System is specific to Community Contributed Photos and thus to ensure the tag validity and increase the elements in recommended tags, content based similarity and text based similarity is computed using the Normalized Pointwise Mutual Information Strategy. Experiments were conducted on a large data sets collected from Flickr and further integrated into the social tagger for verification of the efficiency of the proposed system. An overall accuracy percentage of 82.02 is achieved by the proposed SpatioTag System.**

Keywords: Image Tagging, Recommender Systems, Semantic Similarity, Spatial Tagging, Tag Recommendation**.**

1. INTRODUCTION

The recent trends in social networking have given rise to a number of social networking sites which enable the social actors to post a number of photographs. Sometimes the photos that are in a context that can be directly linked to a community who is directly interested in. Each photo that is uploaded in the Online Social Network System must be properly tagged. Tag of a photograph refers to the indication of the photo and provides an identity of a photo. Tagging is quite important as it provides a unique identification identity to recognize a specific photo. Tagging can become noisy as it involves information from several users. Several problems are associated with tagging such as correctness of the tags given and the acceptance of an annotated tag to the specific entity correctly.

Recommendation of a tag for a photograph is the underlying problem which is focused in this paper. Personalization of Tags and in turn spatially aligning to the geography of the location is focused in this paper. Apart from this, tags are recommended using a set expansion problem and the expanded sets are in turn optimized by calculating relevance scores. The semantic similarity between the photographs used for training and the uploaded photographs is computed in order to automate the process of recommendation of the tags. The proposed system takes tags as input from the users and tags are analyzed with reference to the training data sets and the noise in the tags are computed and validation of the tags is done such that the tags are semantically similar. The users can suggest their own tags for their respective photos personally. Geographical Tag Specification refers to the concept to add the longitude and the latitude information to their photos. Also the user can suggest multiple tag recommendations for the same image to find out the most relevant image on the Social Network Platform.

Due to the popularity of Global Positioning System (GPS), the camera and mobile devices can enable the GPS and capture the photos; it records the location of the place with all the EXIF (Exchangeable image format) information of the images. EXIF information helps to easily identify the location of the place that photo captures. EXIF also include image metadata like height, width, camera apertures, latitude, longitude, date and time. Almost everyone is using smartphones these days and all the smartphones are integrated with GPS that enables the users to upload the photograph along with its spatial information that is specified by the user through its GPS feature. There are many problems that arise while tagging an image. One of the main problems is the

Lack of Technical Knowledge by the users while uploading a photograph.Most of the people are very poor in technical knowledge and don't know about uploading photos, adding tags, organization and classification of images. Thus users face several problems that lead to confusion and chaos.

Other problems can be uploading photos without even a single reference tag. This is when the Image features and content based tag prediction plays an essential role. People can capture photos and upload them into social websites without specifying proper name or tags. Users can search the image in the social website but could not find the proper image because of not giving the proper tags even though the image present in the website. Upload a photo without name or tag is pointless and useless. Owing to this, the proposed methodology provides user tags while uploading images to the online photo sharing websites.Sometimes the Spatial information is ignored by the user that should be overcome. Avoiding non-tagged photos in a social website and the provision of the user defined tags related to images along with the addition of latitude-longitude information of the image facilitates the finding out the image without a tag or name. Some ignorant users have a Legacy of giving wrong tags to the right images without knowing the proper information. Possibility of giving wrong information to the image leads to confusion to the users when user searches a particular name or tag it shows the photos based on the search query.

Motivation: Owing to the fact that millions users who upload different photos in the Online Social Networking platform, there is a need to organize and structure these photos specifically the ones which are of an interest to an online community in large. Tagging these images with respect to the semantic similarity of the context of the photograph is a huge challenge. Manual tagging alone will create a dilemma in the web space of the photograph as the variations in the texts can be hugely deviated. There is a need for automatic tag recommendation with a high relevance rate for all the tags defined. There must be a proper representation for the text in the photo to make it available to the community of interest in large. Proper rendition of the photographs tagging is a mandate which should never be a contradiction and also the tags recommended must be suitable in all aspects to the image.

Contribution:The model that is implemented here bridges the semantic gap between the existing manual tag specification systems and elevates the system to an automated tag recommendation system. An approach that makes use of Spatial Information and carries out the similarity computation between textual features and image contents has been proposed. The proposed system checks the semantic similarity between the tags that are user defined with the longitude/ latitude information of the photograph. Also the correctness of the photograph with the reference photographs in data set is checked by computing the semantic similarity of the photographs. Thus a proper, non-redundant tag recommendation system based on the geographical information of the user is modeled. The strategy incorporates NPMI measure for computing the semantic similarity between text and image contents. Also, the performance of the proposed system is evaluated and the justification of the same is done to show that the proposed system is efficient.

Organization*:* The organization of this paper is as follows. The Section 2 provides a brief overview of related research work. Section 3 presents the Proposed Architecture. The implementation is discussed in Section 4. The experimentation and performance analysis is depicted in the Section 5. The paper is concluded in Section 6.

2. RELATED WORKS

Jing et al.. [1] have proposed a methodology by focussing on the personalized tag suggestion task by discovering user preferred tags. The semantically relevant tags for a specific image uploaded are discovered by semantically incorporating a subspace learning methodology which recommends tags by the experimentation conducted using FlickR datasets.

Shen et al., [2] have proposed an innovative strategy which evaluates the inter-object connection by explicit identification of objects involved in learning. The learning is implemented in a way such many related classifiers are used with the objective of increasing the power of favouritism in recommending the tags.Berg et al., [3] have proposed a strategy of sampling text data and image data from the Internet. The strategy proposed characterizes various attributes based on type, visual representation, color, texture and shape. The proposed methodology mainly focuses on attribute discovery based on their appearance visually. Tang et al., [4] have overcome the problem of semantic inference of concepts from images that are of social importance with their associated. With the objective of increasing the overall accuracy, a semi-supervised learning strategy has been proposed with the usage of a sparse graph to control the propagation of labelled and unlabelled data at the exact time instance. A graph based framework is used with the motive of handling noisy tags have been proposed such that the links that are not relevant to the concept are eliminated based on this strategy.

Li et al., [5] have put forth the concept of exploitation of geographical tags based on the geo context for visual search. The geographical context varies and the concept based image search engine that integrates concept detection and geographical context is proposed. The system proposed is trained using socially tagged images without the intervention of human interaction. This strategy helps in coping with several concepts.X. Li et al., [6] proposed a technique for correlation estimation using Multi correlation Probabilistic Matrix Factorization.

The strategy proposed incorporates image word correlation, word relation deduction and image similarity estimation. The usage of the strategies discussed gives better results which are more accurate and precise.Chen et al., [7] have proposed a framework termed as SheepDog to recommend labels for several clients on Flickr. The photographs are included as fitting gatherings where the proposed framework also includes a strategy of idea discovery where the issue of information gathering by concepts arrangement is also induced in the strategy. The recommendation of labels is done using the current Flickr data imbibing a positioning based strategy such that the recommended tags are relevant to the photos uploaded.

Song et al., [8] have proposed a labelling technique using social bookmarking strategy to mention the activity of partner towards a pertinent watchword or expression with an entity like a report, picture, or video. The approach is integrated with sites like Flickr that permit clients to indicate watchwords. Aixin et al., [9] have recommended tags by connecting with social pictures that serve as important data hotspot for unrivalled picture hunt and recovery encounters. A novel label suggestion procedure is proposed where the client given labels are connected with pictures. Every hopeful tag to be prescribed is portrayed by a couple label ideas got from the aggregate learning implanted in the label co-event sets. The competitor labels connected with the coordinating ideas are then prescribed. Influences are mainly on the much focused Information Retrieval methods. Also, the proposed approach eases the process of recommending relevant tags. Sigurbjörnsson et al., [10] have examined a delegate preview of Flickr and have presented the outcomes by a method ofCharacterization of labels such that the data is well reflected in the recommended tags. The fine strategy of evaluating the tags has been included such that the suggestions by clients are also taken into consideration while a photo is uploaded.

Morgan et al,. [11] have explored the motivating forces for explanation in Flickr, a famous electronic photograph sharing framework, and ZoneTag, a camera phone photograph catches and comment device that transfers pictures to Flickr. A subjective investigation of ZoneTag/Flickr is incorporated by the client that is uncovered for different labelling designs and rising inspirations for photograph comment. Pavel et al., [12] have put forth techniques where augmentation characterization is instilled into the system such that to spatial equivocalness is adopted. Moreover, the techniques for consolidating GeoNames are proposed for expanding the tags out of the limits of the database which is more suited for varying levels of data granularity. Emily et al., [13] have referenced geo-labelled," photograph information by consolidating tag re-ranking taking into account geographic setting with substance based picture examination, a methodology is proposed for geologically important labels for photographs labelled with GPS. These label proposals are utilized to help clients to sort out their photograph accumulations by enhancing recovery frameworks. A weighted label approach is proposed for computing the relevance of items, occasions, neighbourhoods, and exercises in a locale.

Jim et al., [14] have displayed an efficient framework for giving programmed explanation on accumulations of geo-referenced photographs. As a client transfers a photo a position of starting point is evaluated from visual elements which the client's refine. Once the right area is given, labels are proposed taking into account geographic and picture similitude from Flickr Database. The framework adequately mines topographically applicable terms and positions potential recommendation terms by their back likelihood given watched visual and geo-coordinate highlights.Moxley et al., [15] have scrutinized the capability of learning the semantics involved in the labelling an item in the Web. The strategy involves mining geo-referenced picture accumulation from Flickr such that the programmed comment framework is improved. The sets of labels as spots, historic points, and visual descriptors is ordered by sorting out the dataset into a quad tree who can effectively discover geographic territories with adequate thickness to give helpful results to place and point of interest extraction.

Wadekar et al., [16] have inferred that labelling is advanced by numerous social sharing sites, which permits the addition of the interrogation. Utilizing labels clients can compose their information with the goal that it will be useful for seeking and searching. The presentation of a hyper graph learning discovers the joint significance between visual and literary spaces. Given a photograph with Geo-location and without labels, the proposed system utilizes closest neighbour in pursuit of some labels as per users' and geo-area preference labels independently. It finds the semantically and outwardly related pictures, and investigates the possibility of comment via quest to suggest labels for untagged photographs. In totality, the labels recommended are relevant to the user. Pushpa et al., [17] have proposed a hybridized strategy for modelling ontologies using Latent Semantic Analysis and content based filtering. This word emphasizes the usage of knowledge in the proposed approach and differentiates it b increasing the recommendation accuracy. Gerard et al., [18] have proposed a co-occurrence based measure in recommending web pages using semantic techniques. This word emphasizes the importance of semantic word co-occurrence measures in recommending web contents. Deepak G et al., [19] have proposed a unique annotation system that imbibes social information and its context. The approach uses semantic collaborative filtering as its core mechanism. Pushpa et al., [20] have proposed a collaborative semantic framework for modeling of ontologies that are based on a review-based strategy which focuses on modeling knowledge for increasing the recommendation accuracy.

3. PROPOSED ARCHITECTURE

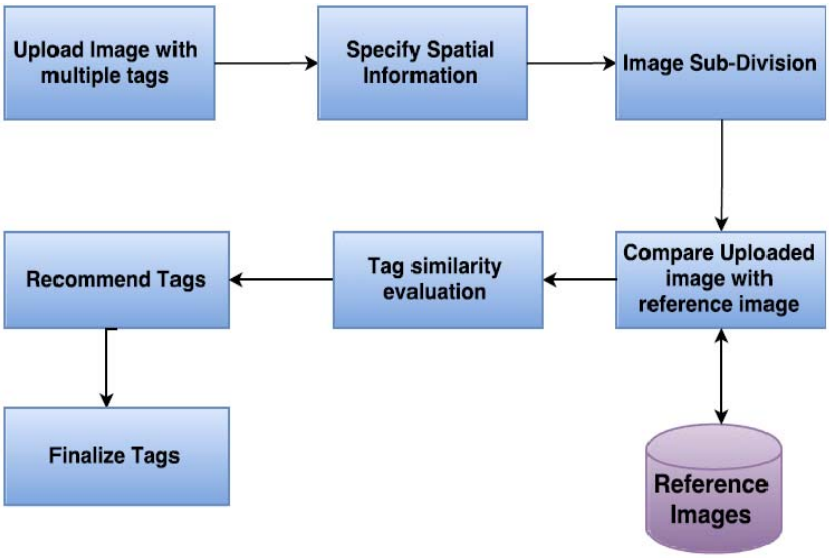

Figure 1: Proposed SpatioTag System Architecture

The uploaded image is subject to background subtraction and image sub-division at first. Once the Image is subdivided, the features of the image are extracted and its Eigen values are computed to construct its corresponding Eigen Space. The images in the Image Space are also subject to feature extraction and construction of Eigen Space. The images in the Tag Space are matched by computing the semantic similarity between the elements in the Eigen Space of the uploaded image and the images in the tag space. If the images exhibit a similarity of 75%, then the tags of such matching images are extracted and are included into the Tag Space that is initialized. The reason for consideration of 75% of similarity index between the images to be matched is because the images can be of a different scale with varied focal lengths. Sometimes, the camera parameters like viewing angle, resolution and expertise of photography would differ at a large between the photographs.

On validating the features between the images, the text features of tags also need to be semantically validated. To ensure this, the semantic similarity is computed between the manual tags and the tags in the tag space. If the probability of similarity between the defined tags and manual tags is high, then the tags are semantically sorted and are recommended to the user. Ultimately the system finalizes the tags by approval of the user who has uploaded the photographs. Since the proposed system computes the similarity between the image features as well as the textual features, the proposed framework yields tags that are highly relevant and correct.

The Semantic Similarity is computed using the Normalized Point-wise Mutual Information (NPMI) between the two tags [21]. The Normalized Pointwise Mutual information depicted in equation (1) is the negative logarithmic quotient of the probability of occurrence of a pair of terms to its Pointwise Mutual Information. The Pointwise Mutual Information measure proposed by Church & Hanks is depicted in equation (2). The NPMI is computed by initially computing the PMI between the pair of terms. 'h' function denotes the self-information.

$$NPMI(x;y) = \frac{PMI(x;y)}{-\log[p(x,y)]} (1)$$

$$PMI(x;y) = h(x) + h(y) - h(x,y) \qquad (2)$$

4. IMPLEMENTATION

The proposed tag recommendation system is a specialized tagger as it has the capability of recommending tags based on the manual tags specified by the user as well as validating the tags by extracting the image features from the images that match a specific geographical location. The proposed Tag Recommender is implemented in JAVA with Eclipse as the IDE. The concept of Modularity is incorporated wherein separate individual classes are implemented for validating the Manual Tags and extracting a number of similar tags. Also a separate Class is implemented for matching the features of the uploaded image and the images stored in the database. A Flickr API is used to dynamically load the relevant images based on the Spatial Information either defined by the user or available as metadata or EXIF information with the image.

TABLE I: PROPOSED TAG RECOMMENDATION ALGORITHM INCORPORATING SPATIAL IMAGE VALIDATION

Input: The Photo P_i uploaded by a user U_i with manual tags M_t and its corresponding Lat-Long Information, Tag Space
Output: Finally Recommended Valid Tag Set T_s for P_i

begin

Step 1 : Pre-process the manually recommended Tags and Extract unique tag words.
Step 2 : Using the Lat-Long information, the images are loaded from the database for matching the images into an image space I_s.
Step 3 : Formulate the EigenSpace for the Image P_i by obtaining its features.
Step 4 : for each image in I_s
Extract the features from I_s
Formulate Eigen Space containing features of I_s.
Compute the number of matches between P_i &each of I_s by semantic similarity
computation of the elements of the EigenSpace using NPMI.
Step 5: Extract the image tags for I_s with 75% similarity and Formulate intermediate Tag Space I_t
Step 6: Compute NPMI (M_t, I_t).
if (NPMI<0.25)
Construct HashMap RecTags (I_t, NPMI)
Step 7 : Arrange RecTags in its increasing order of NPMI Value & Recommend to the user.
end

5. PERFORMANCE ANALYSIS & RESULTS

The data sets for experimentation were collected from Flickr. The experimentation was carried out on Flickr images that have some social relevance and were of interest to a community in large. The data sets included images of historical monuments and famous places that had some pre-defined tags associated with them. The Median filtering approach is used for background subtraction which increases the response time of the system. The Semantic Similarity of the system is computed using the Normalized Pointwise Mutual Information strategy that yields a higher performance as it's a semantically driven strategy.

TABLE II: TOP TAGS RECOMMENDED FOR IMAGES INPUT

Tested Images	Top Tags Recommended
Pamban Bridge	Pamban Palam, Pamban, Beach Bridge, Sea Bridge**.**
Vidhana Souda	Vidhana Souda, Secretariat, Vikas Souda, Bangalore Building
Mysore Palace	Mysore Palace, Palace, Wadiyar Palace, Mysore Kings Palace, Maharaja Palace Mysore,
Francis Xavier Cathedral, Bangalore.	Xavier's Church, Archdiocese of Bangalore, Cathedral SFX Cathedral. Francis Xavier's Church, Catholic, Worship Place
Rameshwaram Temple	Temple, Kovil, Rameshwaram Koil, Worship, Hinduism, Indian Temple

The final tagging output is depicted in Table II in which several photos which are interested to a community are tagged based on tag recommendation. Community Contributed Images were used as an input and tested for the tags which were eventually recommended by means of semantic similarity computation of the extracted terms that are homogenous and have high likelihood factor. Several Images like Pamban Bridge, Vidhana Souda, Mysore Palace, Francis Xavier Cathedral, Charminar and Rameshwaram Temple were used for Tag Recommendation. The top tags that were relevant are documented in Table II. The results of the tags recommended with respect to the input images are satisfactory and most of the recommended tags are relevant with a high degree of acceptability.

$$\text{Precision} = \frac{No.of\ recommended\ and\ relevant\ Tags}{Total\ No.of\ Tags\ Recommended} \quad (3)$$

$$\text{Recall} = \frac{No.of \;\; recommended \; and \; relevant \; Tags}{Total \;\; No.of \;\; Tags \; that \; are \; relevant} \quad (4)$$

$$\text{Accuracy} = \frac{Precision + Recall}{2} \quad (5)$$

The performance is evaluated using Precision, Recall and Accuracy as metrics. Since the proposed system is a class of Information Retrieval and Recommendation systems, the chosen metrics can be justified to a great extent. Precision is defined as the ratio of the recommended and relevant to the total number of tags recommended. Recall is the ratio of the recommended and relevant tags to the total number of tags that are relevant. Accuracy is defined as the average of the Precision and Recall Measures. Accuracy is the measure that is computed by considering the average of Precision and Recall. Precision, Recall and Accuracy are depicted in equations (2), (3) and (4) respectively.

TABLE III: PERFORMANCE EVALUATION OF THE PROPOSED SYSTEM

Image	Precision	Recall	Accuracy
Pamban Bridge	81.48	84.61	83.05
Vidhana Souda	80	83.33	81.67
Mysore Palace	80	80	80
Francis Xavier Cathedral, Bangalore.	82.5	84.61	83.56
Rameshwaram Temple	81.81	81.81	81.81
Average	**81.16**	**82.87**	**82.02**

It is clear that the proposed SpatioTag System yields an average Precision of 81.16 %, an average recall of 82.87 % and an accuracy of 82.02 %. The Performance Evaluation Measures yielded by SpatioTag is depicted in Table III. In order to compare the proposed SpatioTag recommender, the proposed algorithm was implemented with varied strategies like the Cosine Similarity and Euclidean distance. Table IV illustrates the average performance measures achieved when the NPMI strategy is replaced by Cosine Similarity measure and Euclidean Distance in the SpatioTag Algorithm. Also, the system is evaluated with only text based similarity without image content similarity. Further, the image contents were analyzed and their tags were extracted and integrated into the tag space without incorporating text based similarity. The Evaluation Scores are documented in Table IV.

TABLE IV: PERFORMANCE COMPARISON OF SPATIOTAG SYSTEM

System parameters	Avg. Precision %	Avg. Recall %	Avg. Accuracy %
Using Spatial Information, Text and Image Features using Euclidean Distance	78.2	77.4	77.7
Using Spatial Information, Text and Image Features using Cosine Similarity	80.12	81.78	80.95
For SpatioTag without Text Based Similarity	79.84	81.76	80.8
For SpatioTag without Image Content Similarity	80.12	81.39	80.76
SpatioTag (Spatial Information, Text and Image Content Similarity using NPMI)	81.16	82.87	82.02

6. CONCLUSIONS

An innovative strategy for image tag recommendation that incorporates semantic similarity computation between the text and image content features is proposed. The Image Tagging is based on using spatial information that is either specified explicitly by the user or embedded with image as EXIF metadata is implemented. The tag redundancy in proposed SpatioTag system is eliminated as the semantic gap between the manual tagging and automated tagging is reduced to a large extent. The SpatioTag recommends high quality tags for images uploaded on Online Social Networking sites like Flickr. The tags recommended are of a very high quality, unique with a very high relevance rate. The NPMI strategy that is used for semantic similarity computation yields very good results increasing the overall relevance of tags recommended. The parameters that are considered for computing semantic relevance include the spatial or the geographical information of the image, the textual contents namely the manually defined tags and the actual contents of the image. This is one of

the reasons for a higher relevance rates in the system. The proposed SpatioTag system yields an average precision of 81.16 %, an average recall of 82.87 %. An overall accuracy of 82.02 % is achieved by SpatioTag.

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