Intra Organisational Information Retrieval System for an Agricultural Research Institute in South Africa

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***Abstract*—**Intra organisational information sharing is a tool that can ensure efficiency within the organization. Benefits of this include amongst others; conservation of vital information, time saving, reduced expenditure, and minimisation of information duplication. We investigate the benefits of intra organisational information sharing as a tool in an organisation. The study characterised, examined and discussed detail information sharing, image annotation, content based image retrieval, as well as semantic tagging and taxonomy. The crucial element of this tool is annotation, and the significant role it plays in the success of intra organisational information sharing. Furthermore; since the users are the outlets of the information that will be fed into the intra organisational information sharing; the study also investigates the manner in which users approach the indexing of information to be shared. We also investigate manners in which the shared information should be described during indexing, and how the description impacts on the ease of other users to access and annotate the information and the contents. The study also investigated existing methods that influence the manner in which users tag and these include; amongst others; model based, descriptive as well as categorised. These are methods that are commonly recommended to ensure simplicityof sharing and retrieving of information by receipt users from the framework created. Methods that are used to retrieve information from the system itself were also investigated. These are tailored into the six design science (DS) steps using programming language and specific design and development methodsts the footnote at the bottom of this column.

***Index Terms*—**Information retrieval, information sharing system, image tagging, organization, agricultural system.

I. Introduction

In the process of the works done at the Agricultural Institute, researchers take a lot of images which are currently not kept in any structured system. The current situation is that, especially when there is a need for an article or publication to be written, personnel from marketing and communications have to send requests from the researchers. This process takes time as some deadlines are tight and are often not met. An online information system is proposed in this paper that would be used to manually or dynamically upload on to the system, and when images are required the system can be searched and the required information can be easily retrieved and used.

According to [3], driven by social interests, values, needs and individual use, to use technology for the common good has risen in the last few decades. Thus an intra-organisational information retrieval system for a specific use would be of a huge improvement to the organisation. In the study by [5] the web 2.0 allows users to share, tag and comment on their pictures, my study is mainly about image annotation which users must be able to use and retrieve any image that would be under a subject of their interest at the particular time.

According to [16] images are annotated with arbitrary key words called tags, thus tags will be used by the framework. According to[9],researchers from different fields such as image processing, pattern recognition, computer vision etc. have joined together to put efforts into understanding the real implications out there in the world in image retrieval. Image retrieval systems worked on text based frame work, then became content based-image retrieval (CBIR). The focus has now shifted to automatic image annotation (AIA). Modern search engines have critical challenges in labelling images precisely due to images being more complex [15]. In this paper I propose the use of the 6 DS steps [10].

As part of the research conducted by the ARC, climate smart agriculture has become a primary focus area. The research is aimed at household, small-scale, resource-poor, emerging as well as commercial farmers. Some of the research requires surveying of farmers where data is collected and some of the data is in the form of images. Other images are captured by researchers during their laboratory experiments as part of proof for the work that has been performed as well as to use during presentations to their peers and clients at scientific meeting. In addition, there are other stakeholders, within the ARC, that capture events and occurrences that are used for marketing the ARC as well as communicate the output of the products to the employees as well as ARC stakeholders and beneficiaries.

However, these images are uploaded, following capturing, manually or dynamically by these researchers. However, the uploading is such that the information becomes personalised in that it is only disposable those within the specific network for a certain time and at times, permanently. This deters information sharing within the organization which could assist and enable the organization to market itself to non-targeted stakeholders. If the images are readily available to the ARC employees, it will positively contribute to the above stated. In an effort to resolve this highlighted problem.

As a contingency plan, ICT has an opportunity to develop an online system where researchers can upload their images on a central database, which will be easily accessible to all ARC employees thus contributing positively to increased marketing and communication of the outputs of the ARC as well serve as a

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platform for potential collaborators. An additional advantage of such a system is that it will ensure that the images are stored and backed-up thus omitting loss of information through equipment malfunctions.

Currently within the ARC, important information is unfortunately scattered in all the campus of the organisation within South Africa. During times when writers, designers, marketing and communications personnel need images for business purposes, users rely on email communication to request as well as receive relevant images to and from researchers.

However, as is customary within the research sphere, researchers are commonly busy either in the laboratory, fields or out of office attending meetings and conferences. This makes the efforts of obtaining the images dragged as the requester has to wait for the researcher to be available to supply the requested images.

As a result of this identified problem of information sharing, a study was undertaken to investigate the possibility of developing a comprehensive framework where users are able to capture, upload their respective images, share as well enable other users to effectively retrieve information and use the images with these being in good publishable quality.

In the absence of structured or formal method of capturing images, and the identified challenges of access and retrieving of images, two questions were asked.

What does the research propose to enable a structured or formal method for capturing image based information?What does the research propose as an approach that enables ease of access, retrieval and sharing of information?

II. Literature Review

A. Introduction

Given the importance of literature review in a research, we present in this section previous studies related to my our research study.

B. Taxonomy

This is a practice and science or technique of classification, according to a pre-determined system, with the resulting catalogue used to provide a conceptual framework for discussion, analysis or information retrieval.

Fig. 1. An example of image that can be uploaded

Figure 1 and figure 2 illustrate the types of images that would be in the database which a user might land up with their search and they will have to be sure or know which exactly they are looking for to select the correct one.

Fig. 2. Another example of image that can be uploaded

When a user searches and the different groups of images in the category they have searched for, then the user is able to select the image the need to use for the specific purpose.

C. Image Tagging / Annotation

Annotation is metadata attached to an image or any other data making reference to specific original data, and allows the data to be found again by browsing or searching. Tagging is mostly used for making findability easy. According to [15] image content is becoming complex and existing methods are becoming less effective and satisfactory performance is hardly achieved. "Tagging is designed to simulate general users tagging behaviour".

A tag is a term assigned to any piece of information in the information system world. Web 2.0 has made the tagging feature very important, and now it is also part of some desktop software (https://en.wikipedia.org/wiki/Tag_(metadata)). According to [5] when it comes to tagging due to diversity of knowledge and cultural background of users, tagging is often subjective and inaccurate, studies reveal that many tags are imprecise and there about 50% tags related to images. According to [5] by learning the tag relevance that can solve image tagging, and many approaches have been proposed to deal with tag relevance problem. Matrix factorisation is one if the proposed mechanisms, tag ranking is used to further exploit pair-wise similarity between tags by random walk to refine ranking score.

In the social media environment images are associated with multi-type object information that makes the tagging task to be more challenging [16].Qian. *et al*. [11] mentions that users in this case it would be the researchers, if they are to upload images themselves they would most likely give images tags according to their own vocabularies to describe the contents of their images. Wang. *et al*. [14] also mentions that the desired data can thus be efficiently retrieved with a text query. In their research they have looked at automatic multimedia tagging which has attracted a great research interest, which is defined as the process that automatically assigns a set of tags to multimedia data without any human interference. Where the techniques used are called assistive tagging as the common principle is allowing computers assist humans in tagging data thus improving tagging quality.

Smith [12] highlighted that there were five reasons why people want to participate in tagging activities. These are: to manage personal information; social bookmarking; collecting and sharing digital objects and improving e-commerce.

The advantages of tagging were shown to:affording many

users find the ease or contentment of tagging; flexibility tagging provided for the users; tagging is seen as a modern form of social interaction. In addition, tags do not put the tagged object into one category thus can mobilise anonymous indexers to help index a huge collection of untraceable photographs.

Several disadvantages of tagging were also noted and these included amongst others:The disorderly manner which tags tend to present themselves; users often do not take their readers into consideration when tagging thus making it difficult for the readers to understand and utilise the tagged images in a constructive manner. Finally,tags were said not necessarily provide sufficient information about the object in terms of events that surround the events as well as the outcomes expected from the object tell something about what the object or what it is about.

The authors of the accepted manuscripts will be given a copyright form and the form should accompany your final submission. A review on image tagging/ annotation including image-level and region-based approaches is done according to [15]. Image-level refers to images that are tagged as a whole, Wang *et al*. [13] proposed that when an image to be tagged a group of identified words are summarised and then these tags are refined with a random with a restart model.

The process of tagging is usually designed to simulate general users tagging behaviour and this is usually solved by data-driven approaches, the tags usually have no explicit limitations.

Region-based image tagging performs aging at a more fine-grained level that has a classification problem. Several region-based annotation methods are built on multiple instance learning [15].The objectives are to assign annotations to the whole image rather than individual region.

There are more major approaches in tagging images according to [16] looks at three of the models: the model-based approach that requires for models to be learned, which are then in turn are used to tag new images according to relevance to each one concept, which the process boils down to learning a mapping between low level visual features and high-level semantic concepts which limits to large-scale dataset.

Input: Query image Iq User Qu;
Output: top-k ranked tags;
Procedure Image Tagging;
1. S= A set visually similar images of Iq;
2. Ranking S according Eqn. (I);
3. Sc=top ranked images of S;
4. Tc = candidate tags associated with images in Sc;
5. Vq= visual words extracted from Iq;
6. Uq=Qu and his friends;
7. Construct graph G=({Tc Vq Uq}, E);
8. Initially rank Tc Vq Uq;
9. Re-rank Tc by the reinforcement model on G;
10. Return top ranked tags

Fig 3. Pseudo code for image tagging as described by [16]

The second is the example-based approached which works with similar visual images and assumes they are assigned with similar stet of tags, visual similarity from content is associated with this approach.

The third approach is personal image tagging; tags are done by the query users however in this approach the use of relating the visuals with tags is rarely considered. Instead relationships are mainly considered and relied on among tags and users. Thus the latter two approaches do not differentiate between tags relation with other object types.

Figure 3 illustrate Image tagging using the reinforcement model, the reinforcing model is used to enhance candidate tags which have strong interrelations with important visual words. Tagging query image relevant tags to the image need to be selected for the users. "The tagging procedure works as following. First, we retrieve a set of images S which are visually similar to the query image (line1), and all the image sin S are ranked by their semantic consistence scores (line2). We select the top ranked images S_c as the neighbours of the query images (line 3), and all the tags associated with the neighbours are extracted to construct the candidate tag set (line4). The bag-of-word model is used to represent the query image, and a set of visual words V_q is extracted (line5). Meanwhile, a set of friend so the query user is retrieved (line6). Then, a relation graph G is constructed with three types of nodes (line7) i.e., visual word nodes, tag nodes, user nodes. Each type of nodes is initially ranked based on their own weights and intra-relations with each other (line 8). Finally, all he nodes are re-ranked using a reinforcement model on the relation graph (line9), and the top ranked tags are returned (line10)." [16].

Assistive tagging is another form of tagging I will be discussing as one of the many elements of tagging. Wang. *et al*. [14] writes that it has been recognised as a challenge the automatic multimedia tagging that lies in the semantic gap, which is a gap between low-level features and tags. By multimedia in my research it will be a focus on images.

Techniques that can provide tags with higher quality than automatic tagging and are able to provide results that are better as computers can correct several mistakes and needs less labour cost. The techniques are categorised into three paradigms:

-*Tagging with data selection and organisation* – This paradigm aims to reduce tagging costs by manually labelling several representatives samples or improving tagging effectively via intelligently organising the to-be-tagged data.

-*Tagging recommendation* – This paradigm suggests a set of candidates to labellers in the tagging process such that users can directly select the correct one from the set of candidates. It can improve both the tagging efficiency and the quality of tags.

-*Tag processing* – This is defined as the process of refining human-provided tags or adding more information to them. For example, many tag refinement methods are proposed for improving the accuracy and completeness of tags, and some other methods analyze the relevance, saliency, and other characteristics of tags [14].

For photos that are usually captured in a continuous same scene, and they would frequently they would share the same tags. This is batch tagging also looked at by [14] and it requires users to organise related photos into a batch in order to facilitate batch tagging.

D. Content-based Image Retrieval

According to [9] image retrieval systems initially worked on text-based framework, then came the content-based image retrieval (CBIR) and recently the focus has moved to automatic image annotation. In CBIR systems visual space visually interprets the image contents for retrieval. The one element that may deteriorate image retrieval is tags that are irrelevant, incomplete, noisy and personalized.

According to [2] "CBIR emerged due to rich information that images hold in a polysemy way making it hard to be justified through words. This method consists of two stages; the indexing of images in the database and the searching phase. There are also two basic approaches to the CBIR problem arising depending to the visual types they employ, they are either global features (GF), like colour, texture, and shape features computed on the image. The other is the local features (LF) which look at spatial extent and are typically salient patches of the image, rich in visual information. Local features approaches provide a slightly better retrieval effectiveness than global features". Bampis *et al*. [2] also mentions that as the images database grows it becomes apparent that efficiency, apart from the effectiveness of a method becomes a matter of great importance.

E. Image Tagging / Annotation

Information system tools designed should help the ARC personnel and they must be able to understand how technology evolves, and the understanding of how the system would be of a huge advantage to use as a repository this would be the best way of storing the precious work the researchers carry out [1]. With the permeation of Web 2.0 there are large online image collection platforms. The ARC may adopt the same methods and create their own intra organisational system that would be used and make other functions effective and more reliable within the organisation. The Web 2.0 websites allows users to share, interact, tag and comment on what they are interested in from the platforms.

The framework for the ARC would only limit interaction to uploading and naming /tagging images in a proper manner where a user would be able to search and retrieve what they are looking for. The images may be uploaded by the owner or they will need to send it through to the system administrator and the uploading can be performed from that view.

III. METHODOLOGY

Design science research approach is adopted for this paper as this method involves construction and evaluation of information systems in IT. Going through the six steps the framework utilises metadata and image annotation (tagging) to retrieve desired images. A system of principles, practices and procedures applied to a specific branch and knowledge is methodology says [10] that would help information system researchers to produce and present high-quality design science research in information system that is accepted as valuable, rigorous and publishable.

A. Design Science's Six age Tagging / Annotation

An information system is developed as a solution to gaps organisations have, "an information system is an applied research discipline in the sense that theory from other disciplines is frequently applied to solve problems at the intersection of information technology and organizations" [10].

-*Problem Identification* – According to [10] in design science, information systems proposed must serve human purposes. At the ARC a need for an information system that would be developed and used to improve the organisations efficiency and reliability when there is a need for a publication or any marketing material required the images can be retrieved from the system. The methodology requires for images to be available that are from the field work from researchers.

Another problem that must also be addressed and its theory be looked at according to [6] is that image retrieval and similarity search in databases especially large ones. Image retrieval aims at finding images in a large scale dataset, using visual similarity. A common approach to accelerate image searching is indexing. Another popular approach to efficient searching of images is performing a linear scan on the dataset.

-*Problem Identification* – The lack of this information system makes information sharing within the ARC less effective, the need of an effective and efficient way of sharing information has triggered the purpose of this research. The problem is that there is all of these images currently and important work a high chance of the work getting lot and misplaced is there, and this would be a huge loss for the ARC as some of the work may never be captured again.

-*Problem Definition* – The objective is to develop an information system for the ARC that would be able to support efficient information sharing for the organisation and to ensure that the process is effective. Data is collected: Images taken from the field where researches work on a daily basis.

-*Program Design and Development*– The information system is designed using the programming language C#, sql database and HTML. The system can be both desktop and an online application that will depend on the needs per user if there is more than one user. Theory on methods that make image retrieval as this affect large scaled dataset ranging from matrix factorisation etc.

-*Demonstration*– This is the most important characteristic of design science as demonstrating effectiveness of the proposed framework happens at this stage. The steps are clearly defined as to what and how the system looks like. In chapter 4 the demonstration is clearly outlined with the screens showing how the system works.

-*Evaluation* – This is the most important stage as the system will be observed and measured as to how well it supports as a solution to the problem identified. Comparing to the objectives as identified at the beginning:Capturing information in a structured manner using the framework; Simplifying information sharing within the ARC; To enable users to find exactly what they are looking for with less searching; A user experience that is closer to human perception; Next section describes all the aspects that have to be looked at to evaluate the system from the managerial level to the users of the system

which would be the employees.

-*Communication* – Several authors have shown the importance of communication to ensure that the information gathered is disseminated to the beneficiaries. Communication should entail a proper breakdown of the information, use of language that is easy to understand by all recipients, a highlight of the identified problem, the activities that were undertaken to resolve the problem, the impact of the activities, as well as the people responsible or the support structure available for the activities in case obstacles occur during implementation of the activities by the recipient. The communication of this information to the recipients will ensure acceptance of the suggested activities without or with little resistance.

IV. System Development And Outputs

A. Programming

The programming language for the online information system used is C#. The C# is a programming language, developed by .NET platform and Microsoft, which is commonly used to develop and implement software application (Nakov *et al*., 2013). The language is said to object-oriented thus for this study, it was perfect since; as mentioned in the research problem; it aims to solve the image sharing problem identified at the ARC. Since it a modern language, it meant the use of the language would ensure that the framework suggested in this study would be current and relevant. Another important feature of the C# language is that it is tailored to restrict access as it is managed by Microsoft. This made the selection of C# language above others, such as Java, easier.

B. Figures and Tables

As shown in the figure below, a user can upload a picture by selecting the Campus and/or the Category. This also helps in grouping the images to their correct placing where a person searching will search by campus or category.An example of different images of wine grape search, a list of all grapes appears, to see each image the user will have to click in the link and the image will be shown as demonstrated on the right side of the screen. When an image is uploaded users are prompted by a message making them aware that the image is uploaded.The pop out that verifies the image has been save successfully to confirm that an image is saved.

Fig. 4. Uploading image unto the database

V. Evaluation

The system is evaluated on the following:
- Structure: Does it make it easy to capture images and store the images in a manner that makes them accessible.
- Does the system enable ease of access (e.g. flexibility of controls?)
- Is the system user friendly?
- What is the level of complexity?
- Cost of acquisition/ development / ownership and operation.

The system is intended to be used to improve the ARCs efficiency and improving methods of obtaining images for publications, articles etc. as that is one of the core elements of the organisation (McNaughton B et al., 2010).

The four perspectives of evaluation for improvement methods have a great chance of being looked at:

"Management Perspective: The executive management in the organisation, to ensure that areas such as financial impact, business impact and the collective user experience are considered properly in the evaluation.

Technology Perspective: that of Information System management and the IT department as a whole. It ensures positive effect on areas such as technological efficiency, and specific IT related costs and budgets.

IT Users Perspective: that of the individuals who need the systems, technology, equipment, products and services of the IT department on a daily basis to support business processes. Users also interact with the IT department via means such as the IT help or Service Desk. This is included to ensure that the effect on areas such as IT service quality, expectations and perceptions are considered as it relates to their work.

IT Employees Perspective: that of the personnel within the IT department, especially operational staff affected by change. This may include first and second level support staff, network administrators, security personnel, database administrators, and application owners, they are the workers who directly deal with the implementation of new processes and changes. This perspective serves as a check on the validity of the IT user perspective and vice versa; these perspectives should be comparable. *"*

Furthermore, McNaughton B et al., (2010) writes in the process level of the evaluation of the information system the three types of metrics are:

Effectiveness: the performance of an attribute relative to a target or standards.

Capability: the shape distribution of performance of the attribute.

Efficiency: the cost of delivering a service, resource usage and time.

VI. Conclusion

In conclusion, an information system has been developed that would help the ARC in improving other work functions and make them efficient. Programing in C# and a sql database with an HTML interface a feasible working system has been developed. Although Matrix factorisation is the best method to be used especially that the ARCs database has potential to grow and become a large scaled repository that will store precious treasure for the ARC, and the IP will be safely stored in a

structured information system. In further studies, the implementation using this method would be used.

REFERENCES

[1] G. Adomavicius, R.J. Kauffman, J.C. Bockstedt and A. Gupta (2008). Making Sense of Technology Trends in The Information Technology Landscape: A Design Science Approach.(*MIS Quaterly Vol. 32 No. 4 pp. 779-809/December 2008)*

[2] L. Bampis, C. Iakovidou, S.A. Chatzichristofis, Y.S. Boutails and A. Amanatiadis. (2015). Real-time indexing for large image databases: Color and edge directivity descriptor on GPU. *Journal of Supercomputing* 71: 909-937. https://doi.org/10.1007/s11227-014-1343-2

[3] J. Gil-Garcia and D. S. Sayogo. (2016). Government inter-organisational information sharing initiatives: Understanding the main determinants of success. *GovernmentInformation Quarterly*, in press https://doi.org/10.1016/j.giq.2016.01.006

[4] A. Iscen, M. Rabbat, T. Furon. *(2015).* Efficient Large-Scale Similarity Search Using Matrix Factorization. *[Research Report] 8820, INRIA; MCGILL UNIVERSITY.*

[5] Z. Li, J. Liu, J. Tang and H. Lu (2014). Projective Matrix Factorization with unified embedding for social image tagging. Computer Vision and Image Understanding 124: 71-78. https://doi.org/10.1016/j.cviu.2014.02.001

[6] B. McNaughton, P. Ray, L. Lewis. (2010). Designing an evaluation framework for IT service management. *Information & Management* 47: 219-225 https://doi.org/10.1016/j.im.2010.02.003

[7] S. Nakov (2013). Fundamentals of computer programming with C#. The Bulgarian C# Programming Book. ISBN 978-954-400-773-7.

[8] S. Pandey (2016). Content based semantics and image retrieval system for semantically categorised hierarchical image databases.

[9] S. Pandey, P. Khanna and H. Yokota. (2016). A semantics and image retrieval system for hierarchical image databases. *Information Processing and Management* 000: 1-21. https://doi.org/10.1016/j.ipm.2015.12.005

[10] K. Peffers, T. Tuunanen, M.A. Rothenberger and S. Chatterjee (2007). A design science research methodology for information systems research. *Journal of Management Information Systems* 24: 45-77 https://doi.org/10.2753/MIS0742-1222240302

[11] X. Qian, X. Liu X, C. Zheng, Y. Du and X. Hou. (2013). Tagging photos using users' vocabularies. *Neurocomputing* 111: 144-153. https://doi.org/10.1016/j.neucom.2012.12.021

[12] G. Smith. (2008). Tagging: People-powered metadata for the social web. Berkeley, CA: New Riders.

[13] C. Wang, L Jing, and J. Zhang. (2006). Image annotation refinement using random walk with restarts, in: ACM Multimedia, pp. 647-650 https://doi.org/10.1145/1180639.1180774

[14] M. Wang, B. Ni, X. Hua, T. Chua. (2012). Assistive Tagging: A survey of multimedia tagging with human-computer joint exploration. ACM Comput Surv. 44,4 Article 25 https://doi.org/10.1145/2333112.2333120

[15] Y. Yang, Z. Huang, Y. Yang, J. Liu, H.T. Shen and J. Luo. (2013). Local image tagging via graph regularized joint group sparsity. *Pattern Recognition* 46: 1358-1368. https://doi.org/10.1016/j.patcog.2012.10.026

[16] X. Zhang, X. Zhao, Z. Li, J. Xia, R. Jain and W. Chao. (2013). Social image tagging using graph-based reinforcement on multi-type interrelated objects. *Signal Processing* 93: 2178-2189. https://doi.org/10.1016/j.sigpro.2012.05.021

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