Searching the EAGLE Epigraphic Material through Image Recognition via a Mobile Device

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Abstract. This demonstration paper describes the mobile application developed by the EAGLE project to increase the use and visibility of its epigraphic material. The EAGLE project (European network of Ancient Greek and Latin Epigraphy) is gathering a comprehensive collection of inscriptions (about 80% of the surviving material) and making it accessible through a user-friendly portal, which supports searching and browsing of the epigraphic material. In order to increase the usefulness and visibility of its content, EAGLE has developed also a mobile application to enable tourists and scholars to obtain detailed information about the inscriptions they are looking at by taking pictures with their smartphones and sending them to the EAGLE portal for recognition. In this demonstration paper we describe the EAGLE mobile application and give an outline of its features and its architecture.

Keywords: mobile application, image recognition, similarity search, epigraphy, Latin and Greek inscriptions

1 The EAGLE Project

One of the main motivations of the project EAGLE (Europeana network of Ancient Greek and Latin Epigraphy [1], a Best Practice Network partially funded by the European Commission) was to collect in a single repository information about the thousands of Greek and Latin inscriptions presently scattered in a number of different institutions (museums and universities) across all Europe. The collected information, about 1,5 million digital objects (texts and images), representing approximately 80% of the total amount of classified inscriptions in the Mediterranean area, is being ingested into Europeana and is also made available to the scholarly community and to the general public, for research and cultural dissemination, through a user-friendly portal supporting advanced query and search capabilities.

In addition to the query capabilities (full text search a la Google, fielded search, faceted search and filtering), the EAGLE portal supports two applications intended to make the fruition of the epigraphic material easier and more useful. A Story Telling application provides tools to assemble epigraphy-based narratives to be made available at the EAGLE portal, intended for the fruition of the epigraphic material by less knowledgeable users or young students. A Flagship Mobile Application (FMA) enables a user

to get information about one visible inscription by taking a picture with a mobile device, and sending it to the EAGLE portal for recognition. This demo will show the EAGLE Flagship Mobile Application (presently implemented on Android) and the next sections will briefly describe the functionality and the architecture of the FMA.

2 The Flagship Mobile Application

The FMA enables a user to get information about one visible inscription by taking a picture with a mobile device, and sending it to the EAGLE portal, specifying the recognition mode. In "Similarity Search Mode" the result is a list of inscriptions (just thumbnails and some summary information) ranked in order of similarity to the image sent to the EAGLE server; by clicking on one of the thumbnails the user will receive all the information associated with that inscription. In "Exact Match Mode" the result is all the information associated with the image, if recognized, or a message saying that the image was not recognized.

The Graphical User Interface (GUI) of the FMA, available on the touch screen of the mobile device gives access to the functions listed below. The user can navigate through the different functions with tabs, and at any moment has access to the initial page.

- Search EAGLE content using image recognition in Similarity Search mode
- Search EAGLE content using image recognition in Exact Match mode
- Search EAGLE content using text search
- Login to the mobile application using an account already existing at the EAGLE portal
- For logged-in users, annotate and save queries and their results
- For logged-in users, annotate and save pictures taken with the mobile device
- For logged-in user, access and review the navigation history.

The mobile application communicates (through the Internet) with the Flagship Mobile Application (FMA) server, which in turn communicates with the EAGLE server using the specific APIs supporting the mobile application. Figure 1 shows the main functionality blocks of the EAGLE portal and the communication APIs between the FMA server and the EAGLE server. Complete details of the architecture and the mobile application can be found in [2].

The Image Recognizer (middle block on the right in the EAGLE server) has three main functions: (i) Image Feature Extractor, (ii) Image Indexer and support of Similarity Search Mode, (iii) Support of Exact Match Mode.

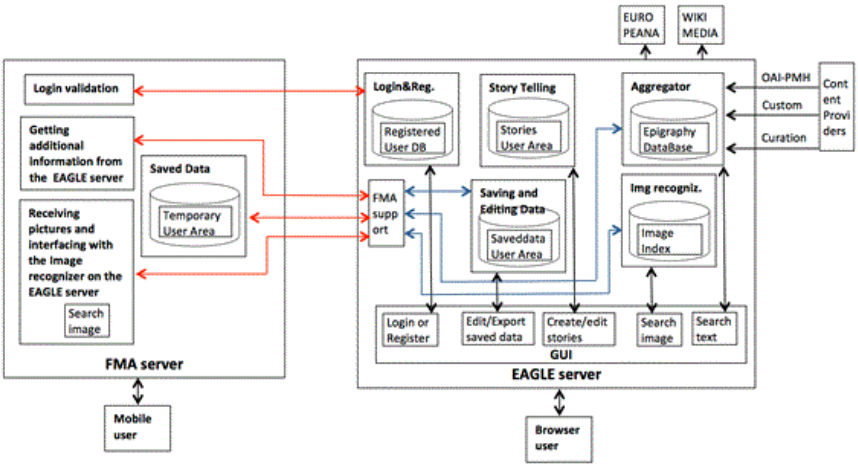

Figure 1 – Basic Architecture of the EAGLE server and the FMA server

2.1 Image Feature Extractor

The Image Feature Extractor analyses the visual content of the EAGLE images and captures certain local visual properties of an image (features). Local features are low level descriptions of Keypoints (or salient points), which are interest points in an image, whose description is invariant to scale and orientation. The result of extraction of visual features is a mathematical description of the image visual content that can be used to compare different images, judge their similarity, and identify common content. The Image Recognizer in EAGLE has a multi-threaded architecture for fast extraction of features and for taking advantage of multicore processors. It has a plug-in architecture, so that it is easy to add or delete the mathematical libraries supporting the many different algorithms for the extraction of local visual features, such as SIFT, SURF, ORB, etc. and their aggregations, such as BoF and VLAD [4].

2.2 Indexer and support of Similarity Search and Exact Match Modes

The Image Indexer leverages the functionality of the Melampo CBIR System. Melampo stands for Multimedia Enhancement for Lucene to Advanced Metric PivOting [3]. It is an open source Content Based Image Retrieval (CBIR) library developed at CNR-ISTI that allows efficient comparison of images by visual similarity through the use of local features.

After the visual feature extraction, the local features are encoded using an approach called “Bag of Features”, where a vocabulary of visual words is created starting from all the local descriptors of the whole dataset. The set of all the local descriptors of all the images is divided into a number of clusters (depending on the algorithms used, this number can go from a few hundreds to tens of thousands) and a textual tag is assigned to each cluster (usually in a random fashion). The set of all the textual tags becomes the

"vocabulary" of visual words related to the whole set of images. At this point each image can be described by a set of "words" in this vocabulary, corresponding to the clusters containing the visual features of the image.

The support of Similarity Search Mode is based on the use of the Lucene search engine. Each image is represented by a set of words (the textual tags of the visual vocabulary), and Lucene builds the index of those words. At query time, the query image is transformed into a set of words, and then Lucene performs a similarity search, returning a list of images ranked according to the similarity with the query image.

The support of Exact Match Mode is based on a set of classifiers, each one recognizing a specific epigraph. The construction of the classifiers is done off-line, selecting from the complete database those epigraphies for which several images are available. The set of images representing the same epigraph is the training set used for building the classifier of that epigraph. At query time, the recognizer performs a similarity search for the image to be recognized and then takes from the result list the first *k* results for which there is also a classifier. The recognizer uses the RANSAC algorithm to perform geometry consistency checks [5] and assign a score to each class. We decided to assign to each class the highest matching score (i.e., percentage of inliers after the RANSAC) between the query image and all the image in the classifier. If the score is above a given threshold, the image is recognized.

3 Results

The Flagship Mobile Application has been tested on a preliminary database of about 17 thousand images for Similarity Search and 70 training sets for Exact Match, using different vocabulary size and visual features representation. Presently, the best results have been obtained using VLAD for visual features aggregations, with a codebook size of 256.

4 Bibliography

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