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Executive Summary

Open Source Image Retrieval – Integration of Developed Tools (OSIRIDE)

according to
CONTRACT Number: 4000112921

Prepared by:
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Doc. Ref: TERRASIGNA-OSIRIDE-ES-01
Issue: No. 1.0

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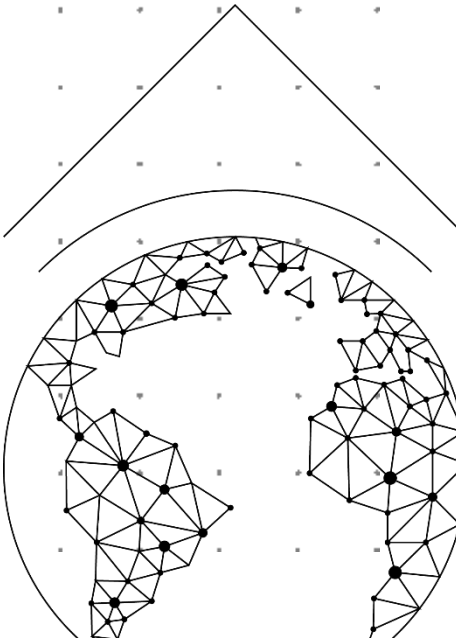

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REVISION HISTORY

Issue	Date	Revised by	Description
2.0	23.09.2015	All	Second edition

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1 INTRODUCTION

The present document represents the executive summary of the project **Open Source Image Retrieval – Integration of Developed Tools (OSIRIDE)**, contract no. 4000112921 within the **General Support Technology Programme (GSTP 6 El. 1)**, presented at the **Final Presentation (FP).**

It includes the following sections:

- Introduction;
- Project objectives;
- Project breakdown structure;
- Project schedule;
- Work performed and results;
- Recommendations and conclusions.

More details about OSIRIDE are presented on the project webpage:
http://wiki.services.eoportal.org/tiki-index.php?page=OSIRIDE

This document is designed for internal use only. In case it is published, an appropriate version will be prepared upon request.

2 PROJECT OBJECTIVES

The main objective of the project is to develop, implement and integrate tools for Earth Observation (EO) Content Based Image Retrieval (CBIR) into a powerful and ready-to-use Open Source platform.

The system addresses not only the ground segment data operators, but specifically also regular and scientific EO services / applications users.

The algorithms for extracting the information and for ranking of the results consider the importance of the correct definition and optimization of features guiding the search for image. Special attention is given to additional sources of information (e.g. gazetteers, taxonomies, etc.), for improved search results.

The following specific objectives were addressed within the OSIRIDE project:

- Analyse, benchmark and prototype advanced technologies for the automatic identification of relevant images - in very huge image archives - based on their semantic content**;**
- Adapt developed technologies to the peculiarity of EO image content and use, in view of the exploitation of past, current and next generation of satellite images and taking into account the possibility to build long time series;
- Implement and integrate developed components into an Open-Source platform to permit users to quickly and effectively exploit and extend CBIR functionalities;
- Select and integrate relevant additional sources of information (e.g. gazetteers, taxonomies, etc.) for their use in the platform, in order to improve system capabilities and usability;
- Demonstrate the implemented platform through specific EO applications (e.g. flooding, forest mapping, etc.).

3 PROJECT BREAKDOWN STRUCTURE

The work Breakdown Structure for the project implementation is summarized below (Figure 1).

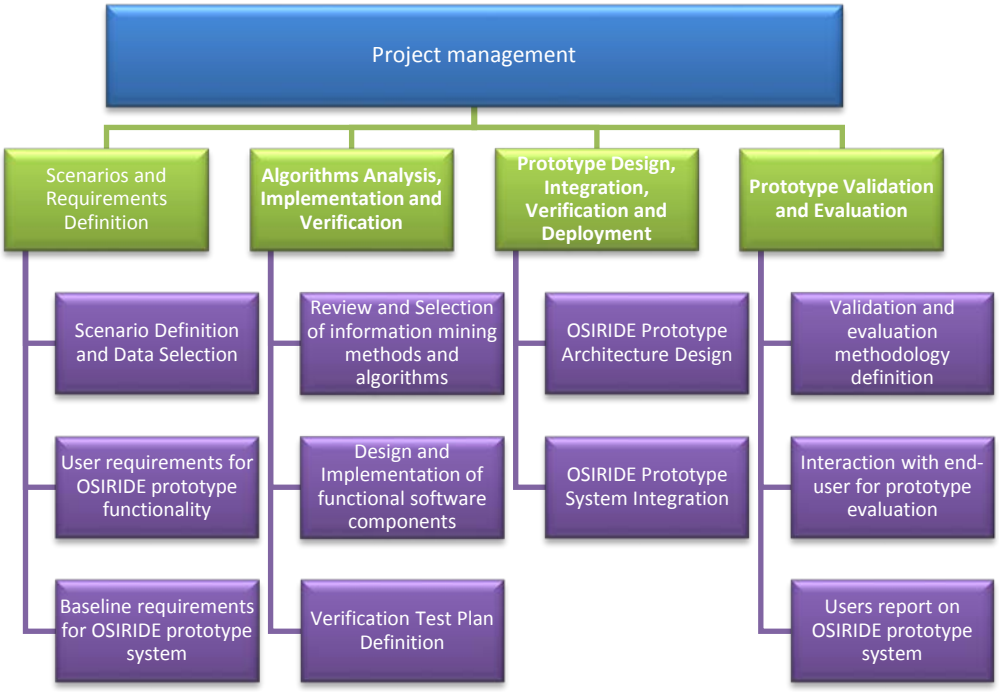

Figure 1 Work Breakdown Structure (WBS)

Task 1: Project Management

- WP 1100 Project Control
- WP 1200 Quality Management
- WP 1300 Project Web Information Management

Task 2: Scenarios and Requirements Definition

- WP 2100 Scenario Definition and Data Selection (I17 - I19 SoW)
- WP 2200 User requirements for OSIRIDE prototype functionality (I20 SoW)
- WP 2300 Baseline requirements for OSIRIDE prototype system (I21 SoW)

Task 3: Algorithms Analysis, Implementation and Verification

- WP 3100 Review and Selection of information mining methods and algorithms (I24 SoW)
- WP 3200 Design and Implementation of functional software components (I25, I26 SoW)
- WP 3300 Verification Test Plan Definition (I27 SoW)

Task 4: Prototype Design, Integration, Verification and Deployment

- WP 4100 OSIRIDE Prototype Architecture Design (I31 - I32 SoW)

- WP 4200 OSIRIDE Prototype System Integration (I33 - I35 SoW)

Task 5: Prototype Validation and Evaluation

- WP 5100 Validation and evaluation methodology definition (I39 - I41 SoW)
- WP 5200 Interaction with end-user for prototype evaluation (I42 - I43 SoW)
- WP 5300 Users report on OSIRIDE prototype system (I44 - I45 SoW)

4 PROJECT SCHEDULE

The schedule of the project is presented hereunder:

	1 Feb '15	2 Mar '15	3 Apr '15	4 May '15	5 June '15	6 July '15	7 Aug '15	8 Sep '15	9 Oct '15	10 Nov '15	11 Dec '15	12 Jan '16	13 Feb '16	14 Mar '16	15 Apr '16	16 May '16	17 June '16	18 July '16
Task 1 Project Management																		
KO Meeting																		
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WP 5300 Users report on OSIRIDE prototype system																		
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Final Presentation																		

Table 1 Bar chart – project planning

5 WORK PERFORMED AND RESULTS

This section presents the work performed and main project results:

- **Use Cases and Scenarios (Technical Note)**. A questionnaire presenting a short description of the proposed concept together with a list of the significant issues regarding the software functionality were sent via e-mail to a list of potential users.

  The potential users are active in domains such as: Space data, Earth and space sciences, Space applications for EO, Geographic Information System (GIS), Navigation, EO image analysis, Geospatial technology, Geodesy, Geomatics, City modeling, Agriculture, Disaster management, Photogrammetry & Remote Sensing for Education and Research.

  The use case scenarios derived from both SoW and end-users questionnaires assessment include two levels for defining use case scenarios:

  • System general use cases - load and ingest in the OSIRIDE repository new data; define the type of process the user is interested in; select from the available archive the data that is relevant for the proposed scenario; after the inspection of quick looks, the user will select one scene and drive the system into the phase of opening a work session and thus a specific interface; choose the search mode; choose the “Threshold Value for the Resemblance Degree”; proceed with the search function; after the inspection of retrieved results, the user may save the results as a semantic class map or may continue with the search process; 9. Compare the semantic class map with Reference data or with a different semantic class map by overlapping or by joining the maps;

  • Applications scenarios - disaster management - flooding assessment; forest mapping; urban mapping; agricultural assessment;

- **User Requirements Document (Requirements Baseline)**. The user requirements for the development of the OSIRIDE prototype include: UR1 - General Requirements (UR1.1 - Conceptual Requirements; UR1.2 – Functionality Requirements; UR1.3 - End-Users Support Requirements); UR2 - Specific Requirements (UR2.1 - Graphical User Interface; UR2.2 - Data Ingestion; UR2.3 - Data selection; UR2.4 – Performance Requirements; UR2.5 – Constraint Requirements);
- **Methods, Algorithms and Tool Technical Note**. As the OSIRIDE project addresses the need to provide access and control to large amounts of data, it enables tools for exploitation and manipulation of hidden information. It proposes an interdisciplinary approach combining specific procedures for specific data processing, learning, query and analysis. The prototype fits the particularities of Earth Observation data and it is able to allow the integration of additional data sources.
- **Software Requirements Specification (Technical Specification)**. The General User Interface guides the user through the entire process, allowing different interactions with the system, like the selection and visualization of the available scenes from the Local Database, or the selection of different functions from the Query Toolbox (e.g. searching, classification or labelling). All the EO scenes are ingested in the Local Database, together with the corresponding descriptors and additional data. A database management system facilitates the access to the data. New data can be added through the Data Ingestion module. The ingestion method is foreseen due to specific issues involving the Feature Extraction. Also, from this module, the system administrator is able to ingest the Additional Sources' data to be used as additional scene selection criteria before performing the content based search.

- **Software Design Document (Design Definition File)**. The system allows user interaction for three activities during the processing chain: 1. Access the database and select a dataset proper to the application scenario; 2. Perform content base image retrieval and knowledge discovery; 3. Exploratory data analytics and interactive and dynamic navigation.
- **Software Reuse File (Design Justification File)**. Several software applications have been reused to develop OSIRIDE prototype (psycopg2; Scikit-image; OpenCV; Numpy; Scipy; matplotlib; Tarfile; Zipfile; Shutil; Pyproj; Logging; scipy.io; Boostrap; Node.js; Open layers; Three.js);
- **Software Validation Plan (Design Justification File)**. An initial approach was determined for software verifications and validations to be performed in order to ensure the compliance of the OSIRIDE prototype with the Software Requirements Specification and the User Requirements.
- **Software Verification Plan (Design Justification File)**. A general procedure was established to prove that every component element is operational and in accordance to the Software Requirements Specification
- **Software Verification and Validation Report (Design Justification File)**. Test cases were performed for verifying the correct implementation and functionality of the software components, and for validating the OSIRIDE prototype.
- **OSIRIDE SW - User Manual**. It describes the basic functionalities of the OSIRIDE system and to guide the user through further employment.
- **Software Package (SP)**. It includes the software modules and installation instructions.

6 RECOMMENDATIONS AND CONCLUSIONS

Based on the validation activities and the evaluations performed by external experts we may conclude that the OSIRIDE prototype is answering to the user requirements, as they were stated in the SoW and URD-RB documents. Nevertheless some suggestions and recommendations were made by ESA personnel and external experts, to improve the prototype and to conduct analysis in the perspective of a follow-up project.

Thus, in order to make it more flexible in setting up the search conditions, make a better use of the active learning module results and support the understanding of the data and the interpretation of the obtained results by the user, the OSIRIDE prototype can be improved during a short prolongation of the project, by adding new functionality extensions like:

- The Search in the Database for a previously trained/learned class;
- The functionality to perform a search across different patch sizes;
- A custom size selection for searching patch;
- Semantic thresholds for searches;
- Improve the process for an automatic ingestion of a larger region from Europe;
- A data analytics module to support the understanding of the data and the interpretation of the obtained results.

One of the most important recommendations for the future development of the OSIRIDE, was related to the development of a module for *CBIR object oriented search*. Such a new feature, will allow the prototype to be more focused on image objects searches and will increase the number of possible prototype users.

OSIRIDE prototype could also be seen in perspective of a possible integration and deployment in a Collaborative Ground Segment infrastructure (e.g. in Romania), to support local/regional users and applications.

In view of this, taking into account the mentioned recommendations, a follow-up of the OSIRIDE project can be envisaged. In order to prepare the prototype for such an integration, new functionalities can be developed, like:

- A module for CBIR object oriented search;
- A web interface for the prototype administration (ingestion, parameters, users, etc.);
- An improved ingestion process and the new extension for “object search” added, to cover the full Europe with Sentinel data;
- Creation of a flexible plug-in system for adding new descriptors;
- Mosaicking of active learning results in complex shapefiles, in order to create regional coverage maps with trained classes (e.g. Forests, Urban areas, etc.)
- Add new descriptors (also for SAR data);
- Make OSIRIDE work as an interface for an operation EO data repository (e.g. SciHub), for selecting of certain images with semantic resemblance of interest elements;
- Improve performances to an operational level.