



MICO Exploitation Plan

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Executive Summary

This document is the deliverable D9.4 exploitation plan of the project Media In Context (MICO). The document delivers the exploitation approach of MICO beyond the project timeline by describing the exploitation and dissemination activities carried out during the project timeline. In the first chapter, an introduction to the MICO project is given by referring to the purpose and the scope of the project, the problem addressed by MICO project and its mission.

The next chapter discusses the multimedia analysis and retrieval market where MICO is positioned as a cross media analysis product. The chapter discusses competitive products in the market and analyses them with reference to their available features, pricing, strengths and weaknesses and their business model. Furthermore, the chapter describes the main results of the project and the target market segments based on the application area for MICO as a cross media analysis platform. MICO is compared to the other products in the market with reference to its competitive advantage.

The third chapter explains the exploitation strategy for MICO as an open source software project and the continuation of commercial exploitation and collaboration support by the MICO Task Force. The chapter also discusses other exploitation strategies such as knowledge exploitation. In the next chapter, the individual exploitation plans by all the MICO partners are discussed. This chapter shows how MICO platform is integrated into the respective MICO partner's product strategies and business models.

The next chapter is about the MICO showcases developed by partners in different application areas. This chapter shows how MICO is used effectively in different use cases to implement effective cross media analysis products and services showing the commercial potential of the MICO platform. The next chapter explains how these use cases and the platform were presented at various industrial events to attract potential clients to the partner use case products and MICO as a platform.

In the final chapter, key performance indicators (KPIs) are defined in different domains of the project to evaluate the success of MICO project. It lists down KPIs in research, open source, technology and industry aspects of MICO project to perform a comprehensive evaluation of MICO's success.

Introduction

Purpose and scope

This document is the deliverable D9.4 - Exploitation Plan for Media In Context (MICO) project. The purpose is to describe the initial exploitation approach of the project, and to establish suitable plans to make MICO a successful and sustainable project beyond its lifetime of 3 years.

Following are the objectives of the document;

- To identify the target market groups.
- To identify the exploitable tangible and intangible results of the project.
- To align the project activities towards exploitation.
- To show commercial business use cases of the MICO project.
- To show how the MICO technology creates a competitive advantage for the participating partners and businesses.
- To define a plan for project sustainability.

In general, this project exploitation plan defines how the project results will be utilized for additional socio-economic development beyond the lifetime of the project.

MICO exploitation plan can be defined as 3 main segments;

- Publishing MICO software and documentation as open source software and open content.
- Exploitation of the MICO technology by non-university partners and their commercial users.
- Contribution to open standards.

Intended Audience

The intended audience of this document include MICO consortium, the MICO community (research, industrial and academic) and the European Commission.

Problem statement

Knowledge has become the most valuable asset in any organization today. Knowledge is extracted mainly from the content accumulated in the organization's repositories, databases and the web. These content include various types of documents including text documents, images, audios and videos. Most of these content are unstructured and it is increasingly becoming difficult to manage unstructured content and analyse them for hidden knowledge. In particular analysing multimedia content and discovering knowledge is becoming one of the biggest challenges to any organization. Mostly this knowledge extraction process requires expert knowledge and manual work to tag each image or video file with additional knowledge as metadata.

The common analysis process to retrieve, analyse and publish metadata in heterogeneous multimedia content can be termed cross media analysis. Cross media analysis products available in the market today come with hefty price tags while still unable to deliver high quality results. This makes it difficult for organizations, especially small and medium-size (SME) enterprises to utilize cross media analysis technologies in their organization's knowledge discovery processes. Additionally the available cross media analysis products typically operate in isolation and don't work together seamlessly, hence they lack the context of the media content which can be derived from surrounding information such as associated text descriptions.

MICO aims to address these problems by providing an open source service platform, that allows to seamlessly analyse media in context and includes various analysis engines for video, images, audio, text, link structure and metadata.

Mission statement

With the rapid development of the internet, social media platforms and media production equipment, the amount of multimedia content being generated in the digital world is increasing exponentially. The sheer growth of multimedia data and the hidden semantics of raw multimedia content makes it hard to retrieve media assets that satisfy certain information needs. Since common methods for analysing textual content can't fulfill multimedia requirements, new multimedia analysis methodology and technologies are required to extract hidden knowledge from multimedia content.

Given the fact, that most of the multimedia content is integrated in so called 'information units' (spatially related or linked bundles of diverse content formats that are combined to illustrate a certain topic, event or fact), the MICO project makes use of all surrounding information to enrich the pure content, align existing and new metadata into a common model and provide access methodologies for the emerging cross-media data.

MICO targets a platform that supports the interaction of various multimedia analysis components in a loosely coupled cluster environment. MICO proposes a concrete set of harmonized models and software services for orchestration of analysis components, representing and publishing of analysis results.

MICO's mission is to provide a common framework to perform cross media information retrieval, analysis and querying to extract hidden knowledge in the multimedia content.

Market Analysis

Market Description

Multimedia analysis and information retrieval have been under research and development stage for more than 20 years [1]. But with the rapid development of the internet technology stack and the fast growing volume of multimedia data, today there is a great need of enterprise grade applications/frameworks to analyse the multimedia data for different business purposes. This section discusses such business domains that multimedia analysis technologies and frameworks have been used.

Mainly, MICO target market includes the multimedia analysis and retrieval industry. Multimedia analysis and retrieval industry comprises of products and services to analyse, extract metadata and retrieve various forms of content such as image, video and audio. Further, they facilitates content personalization and content recommendations.

Multimedia vendors use diverse strategies to stay competitive in the multimedia industry. To enable easy access to multimedia, the proposed solutions are provided in the form of SDKs, web APIs, desktop and mobile apps. Earlier, search solutions were limited to textual content (E.g., web content, textual metadata and plain text) and now there is a significant focus on providing access to other media forms such as image, video and audio.

Due to the recent advancement of various smart media capturing devices and their accelerated use, creating and sharing multimedia has grown significantly [Gartner, Feb, 2016]. Even though most of the information analysis and retrieval solutions focus on textual content, significant amount of content has been created as other media formats such as video and images. According to Invodo, 74% of all Internet traffic will be video by 2017 [2]. For example, YouTube has over a billion users and almost one-third of all people on the internet and everyday people watch hundreds of millions of hours on YouTube and generate billions of views. [3] Further, in Facebook, the number of video posts per user has shot up 75 percent globally and 94 percent in the U.S. over the past year [4]. According to Gizmodo, Facebook photo uploads has gone up to total 300 million per day [5]. Over time, market share of visits in multimedia content heavy social

networking sites such as Facebook and Youtube has gone up.

Multimedia analysis and retrieval solutions are operated mostly as business to business (B2B) marketing. For example, Photofy, uses Google vision API to provide services such as flagging violent and other inappropriate content in the photos to its end users.


Large companies such as Google, Microsoft are focusing on analysing multimedia content [6]
[7]


Highlights of competitor analysis:



- Visual content analysis has taken prominence over other content forms
- Analysis solutions are exposed as REST APIs (eg : Google vision API, Microsoft Computer Vision API)
- Mostly analysis and retrieval solutions (not much recommendations as a service)


Few competitors of the cross-media analysis and retrieval market are discussed based on the evaluation criteria below.

- Available features
- pricing/ offering mechanism (open source or proprietary),
- Supported content formats, Supported languages, OSs
- Application domains
- Strengths and weaknesses of the solution
- Dissemination/ exploitation strategies
- Business model

	<p>OpenIMAJ [8]</p> <p>OpenImaj is an intelligent multimedia analysis solution written in Java. So, it is platform independent. It contains libraries for video processing, keypoint matching and face detection. Some of the Java code examples are given in the website itself for end user to get a quick understanding on functionalities provided by the library.</p>
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	<p>OpenImaj consists of state-of-the-art computer vision algorithms such as SIFT descriptors and salient region detection. Further, it has implemented some advanced data clustering algorithms as well.</p> <p>Some of the algorithms contain Hadoop mapreduce implementations. Supported OSs for OpenImaj are Linux, Windows and Mac. OpenImaj is distributed as an open source solution.</p> <p>The web site contains comprehensive tutorials and API reference to get familiar with the library easily.</p> <p>OpenIMAJ is maintained by a team of academic researchers in University of Southampton.</p>
	<p>IBM multimedia analysis and retrieval system(IMARS) [9] [10]</p> <p>IBM multimedia analysis and retrieval system(IMARS) is a novel visual feature-based machine-learning framework for large-scale semantic modeling and classification of image and video content.</p> <p>IMARS has provided features such as duplicate image identification and removal, clustering similar images, semantic categorization of images, both content based image retrieval and text and metadata based search. The solution is claim to be scalable.</p> <p>IMARS demos are given using well-known image datasets such as ImageNet and PASCAL, so that potential customers can rely on it's accuracy and scalability..</p> <p>IMARS Visual Recognition Service is exposed as free and easy to use rest API. To provide visual recognition tasks, IMARS has partnered with Alchemy vision. Demo is available to try out with</p>

	<p>images they have already provided as well as the custom images we upload. Customer classifier can be created for custom datasets only if valid credentials are provided.</p> <p>Linux and Windows OSs are supported. This tool was developed by the Multimedia Research team at IBM T. J. Watson Research Center.</p>
	<p>Nuix [11]</p> <p>Nuix provides customer solutions for data analysis in a wide range of application or product areas that includes digital investigation, security and intelligence products (cyber threat analysis), enterprise eDiscovery and information governance (information risk assessment, sensitive data finder and content assessment) and litigation services.</p> <p>Application areas of the provided solution is well-explained in their website, categorized as product, industry and role. This makes decision making easier for potential non-technical customers. Further, how Nuix can help solve analysis problems in recent incidents are mentioned. (E.g., How Nuix helped to uncover facts from Panama papers?) Trainings and webinars are available for Nuix software end users (E.g., Nuix eDiscovery service, Nuix investigation training), so that it is easier for new users to adopt for the system.</p>
	<p>MICC : Media Integration and Communication Center [12]</p> <p>MICC works as an interdisciplinary center for advanced research in the fields of computer vision, multimedia technologies applied to smart environments, natural interaction, Internet Based Applications and collective intelligence.</p>

	<p>One of the project area MICC works on is web media search and retrieval solutions. They have worked on projects such as tagging and retrieval of social media (automatic image annotation), contextual image popularity prediction and adaptive media channels.</p> <p>Areas MICC work on include media security, computer vision (face modeling), smart environments and advanced web applications (panoramic navigation, live cities).</p>
	<p>Loki [13]</p> <p>Loki is a framework to create web-based multimedia search engines, developed by MICC.</p> <p>Features include search, annotation and presentation of multimedia data, synchronized annotation/ speech transcription, frame accurate annotation and search and similar frame suggestion. It uses LIRE, which is a SOLR plugin for content based image retrieval.</p> <p>They have disseminated their research outcome mainly as academic publications. The website also contains comprehensive information about the nature of their research.</p>
 <p>Microsoft</p>	<p>Microsoft Cognitive Services [14]</p> <p>Microsoft cognitive services enables machine based AI/ machine based intelligence. They have provided APIs for vision, speech, language, knowledge and search as features.</p> <p>SDKs are available for Windows, Android, Python. Enabling media analysis and retrieval for mobile applications is a key highlight here. Some of the featured apps are given in the website itself.</p> <p>The possible applications includes image search, dog breed recognition, emojiify faces and face recognition door.</p>



	<p>Their APIs are proprietary (first few transactions are free). Community support is facilitated via MSDN forum, StackOverflow and UserVoice. Comprehensive documentation [15] is available to get familiarize with the APIs. User blog [16] is also available on the provided services.</p>
	<p>I-SEARCH [17]</p> <p>i-Search is an EU funded project which provides unified framework for multimodal content ((text, 2D image, sketch, video, 3D objects, audio and combination of the above) indexing, sharing, search and retrieval.</p> <p>It includes features such as multimedia search and retrieval, relevance feedback, multimodal interaction, personalization and visual analytics.</p> <p>Further, they have introduced a schema to represent the content objects (2D images, video, audio etc.) namely, “Rich Unified Content Description”.</p> <p>Video tutorials [18] are available on music search, furniture search and generic multi-model search.</p> <p>http://www.isearch-project.eu/isearch/new-video-tutorials/</p>
	<p>TinEye [19]</p> <p>TinEye is a continuous and automatic tracking of where a given image appears in the web. It is a reverse image search engine.</p> <p>The solutions are provided as image recognition APIs namely TinEye API, MatchEngine, MobileEngine and MulticolorEngine. Features include duplicate or modified image detection, color search API, mobile image recognition and augmented reality API. All APIs are REST APIs delivered over HTTP in JSON format. TinEye is a proprietary solution.</p>



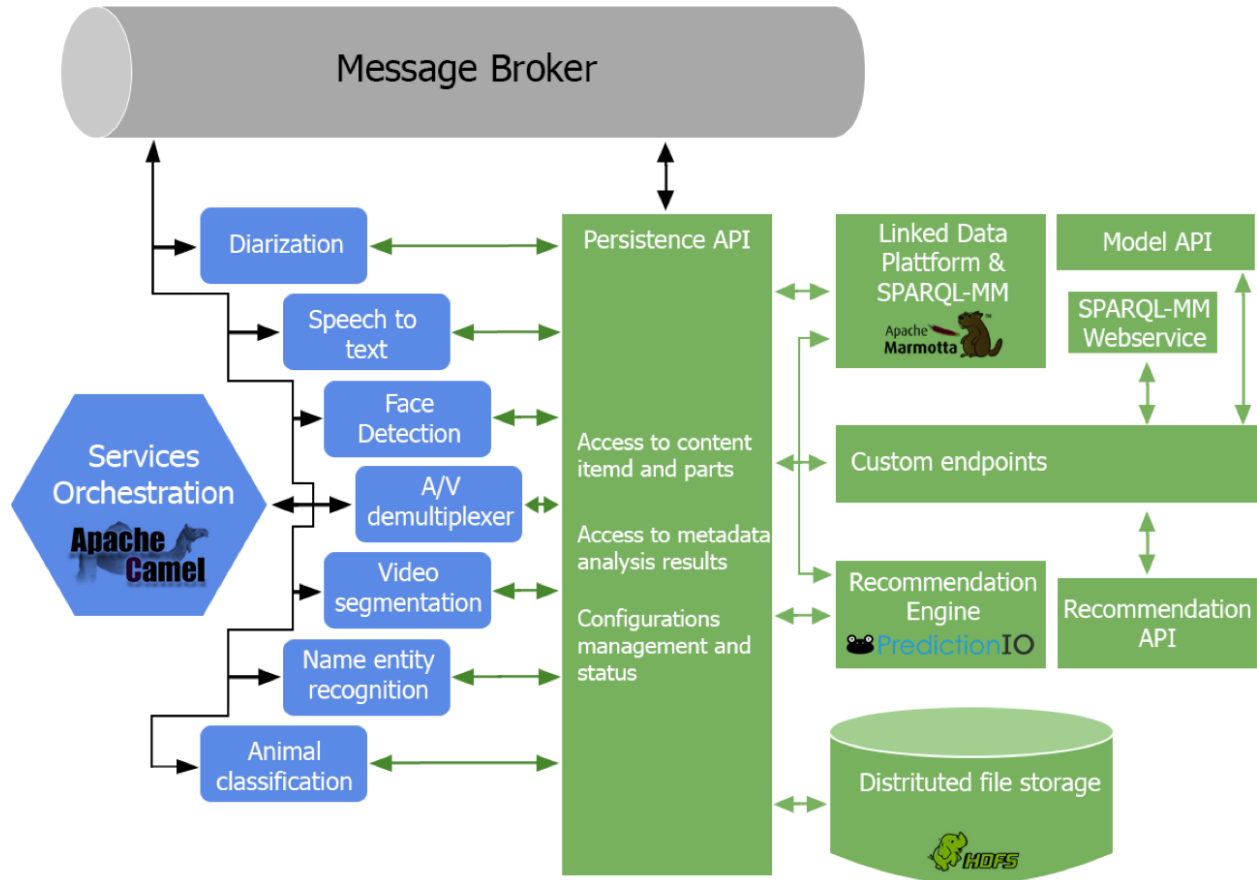
Image Terrier [20]

Image Terrier provides multimedia retrieval using bag of words techniques (content based image retrieval). It is built on top of Terrier text retrieval platform. Here, single pass indexing technique is used in scalable and extensible way. It uses query image to find similar images. Image Terrier is an open source solution. ImageTerrier is available as a modular set of Jars and the source is also available.

Platform Positioning

MICO Platform offering

MICO is an integrated platform for cross-media analysis, metadata publishing, querying and recommendations. Conceptual architecture diagram of MICO framework is given below.



MICO offers both tangible and intangible outcomes that is produced by its partners.

MICO platform offering consist of several assets developed by the partners that can be exploited in different forms including tangible assets such as the MICO platform, MICO extractors, Anno4j library, MICO metadata model, SPARQL-MM and the MICO platform deliverables and intangible assets such as the knowledge and experience gathered during the course of the MICO project.

Tangible results

MICO project's major software results are released under open source licenses. These software results can be considered as the main tangible results of the MICO project. Following section discusses the main software results of the MICO project and their offering model.

MICO platform

The MICO platform is composed of components for extraction, extractor orchestration (MICO broker), data storage / persistence, model and model interaction (MMM/anno4j), querying (SPAQRL/MM) and recommendation. One of the key goals of the platform is to develop a loosely coupled architecture to configure multi-media analysis workflows using separate extractors, address by the following functionalities:

- **Extractors** : The multimedia analysis components in MICO. An extractor produces multimedia analysis annotations of the input content in RDF format, to provide intermediate processing steps for other extractors, or to convert native output to RDF
- **Extractor registration service** : The main goal of the registrations service is support storage and retrieval / discovery of extractor information, focusing especially on the input and output - required data / formats, and provided data / annotations. In addition this service is also responsible for providing the extractors with correct connection parameters (e.g. the storage URI).
- **Data store** : The data store is responsible for persisting the input data provided by the users of the MICO system and to persist and retrieve annotations and the binary data produced by the extractors.
- **Item Injector** : The item injector is responsible for injecting items, e.g. binary data such as a video, an audio file or an image, as well as respective item sets into the system for enhancement.
- **Workflow executor** : The workflow executor is responsible for conducting workflow processing, as requested by the user. It is responsible for triggering the appropriate extractors, providing them with the data they need, following the rules imposed by the workflow planner.
- **Workflow planner** : Is responsible for the creation of a workflow, i.e. the composition of a complex processing chain of registered extractors that aims at a specific user need or use case.

All these components together compose an extensible, scalable MICO platform to perform cross media analysis effectively.

The MICO platform is delivered as an open source project, the only exception being the workflow planner which is deployed as freeware component on the MICO demo servers. The list of platform components and their licenses are listed below.

Component Name	License
Extractor registration service	Apache 2.0
Data store	Apache 2.0
Item injector	Apache 2.0
Workflow executor	Apache 2.0
Workflow planner	Proprietary (FHG): This functionality includes background from FHG, it was not originally planned and is not necessary for using the platform (workflows can also be defined manually); however, FHG provides this as closed-source freeware

MICO extractors

The MICO extractors include animal detection, textual analysis, video quality, temporal, segmentation, automatic speech recognition, speech-music discrimination, face detection, audio tampering detection and further extractors based on showcase requirements.

List of the extractors available with the MICO platform are given below with their licenses.

Audio and Visual Analysis Extractors

Extractor Name	Version	License
Audio Demux	2.2.1	Apache 2.0
Speech to Text (Kaldi)	2.2.0	Apache 2.0
Speech to Text (Bing)	1.1.0	Apache 2.0 (payed service used)
Temporal Video Segmentation	2.2.0	Proprietary (FHG - background)
Speaker diarization	1.3.0	GPL
Audio Editing Detection	2.0.0	Proprietary (FHG - background)
Media Info	2.0.0	Apache 2.0
MediaTags2RDF	1.0.2	Apache 2.0

Image Analysis Extractors

Extractor Name	Version	License
Face Detection	2.1.0	GPL
ObjectDetection2RDF	1.1.3	Apache 2.0
Animal Detection HOG	2.1.1	Apache 2.0
Animal Detection DPM	1.0.2	Apache 2.0
Animal Detection YOLO	1.0.2	Apache 2.0

Text Analysis Extractors

Extractor Name	Version	License
Diarization	1.3.0	GPL
Kaldi-to-RDF	3.1.0	Apache 2.0
Kaldi-to-Text	2.2.0	Apache 2.0
Redlink Text Analysis	3.1.0	Apache 2.0 (paid service used)
OpenNLP NER	1.2.0	Apache 2.0

OpenNLP text class. Sentiment	1.2.0	Apache 2.0
OpenNLP text class. Competence	1.2.0	Apache 2.0
Text Language detection	1.2.0	Apache 2.0

As evident from this list, most of the extractors have been provided under the business-friendly Apache OSS license. This includes all foreground extractors which were prepared and integrated by FHG, the only two exceptions being *Temporal Video Segmentation* and *Audio Editing Detection*, both of which are FHG background.

For proprietary FHG components, FHG offers all MICO partner a free evaluation license for one year beyond the project lifetime. Afterwards, licensing conditions will be agreed on based on the individual needs relevant at that point in time. In general, FHG licensing conditions depend on the specific functionality, and the respective application scenario, but they consist of a moderate fixed annual license fee, plus a variable fee (per-installation, per-volume, etc.) which is recoupable in case of additional R&D contracting. License fees include support / free updates within the licensing period. Fraunhofer IDMT is especially interested in collaboration with SMEs, and we believe that our licensing process and conditions are suited for this purpose.

Anno4j

Anno4j [21] developed by University of Passau is a library to provide programmatic access to the W3C Web Annotation Data Model (formerly known as the W3C Open Annotation Data Model), and the MICO Metadata Model.

Anno4j is contributed to the open source community under Apache License Version 2.0 and the MICO Metadata Model documents under Creative Commons Attribution 3.0 License.

Anno4j is not tightly coupled with MICO use case. It can be used for generic Web Annotations implementations. There are several external european research projects that are using Anno4j for metadata annotation (eg: EExcess [45], LifeWatchGreece [46]). This demonstrates the value of Anno4j as a library for web annotation models.

MICO Metadata Model

Metadata model in MICO project is used to annotate multimedia items to describe the resources and associations between them. It captures content, selection parts of the content and the

contexts. MICO metadata model [22] is based on W3C Web Annotation Data Model. The Web Annotation Data Model specification defines a structured model and mechanisms that enable users to construct and share the annotations interoperable between different hardware and software platforms.

MICO metadata model can be used by potential clients to integrate different new media analysis processes and tools with MICO as extractors. Anno4j provides high-level APIs to inject and query content with the MICO data model.

SPARQL-MM

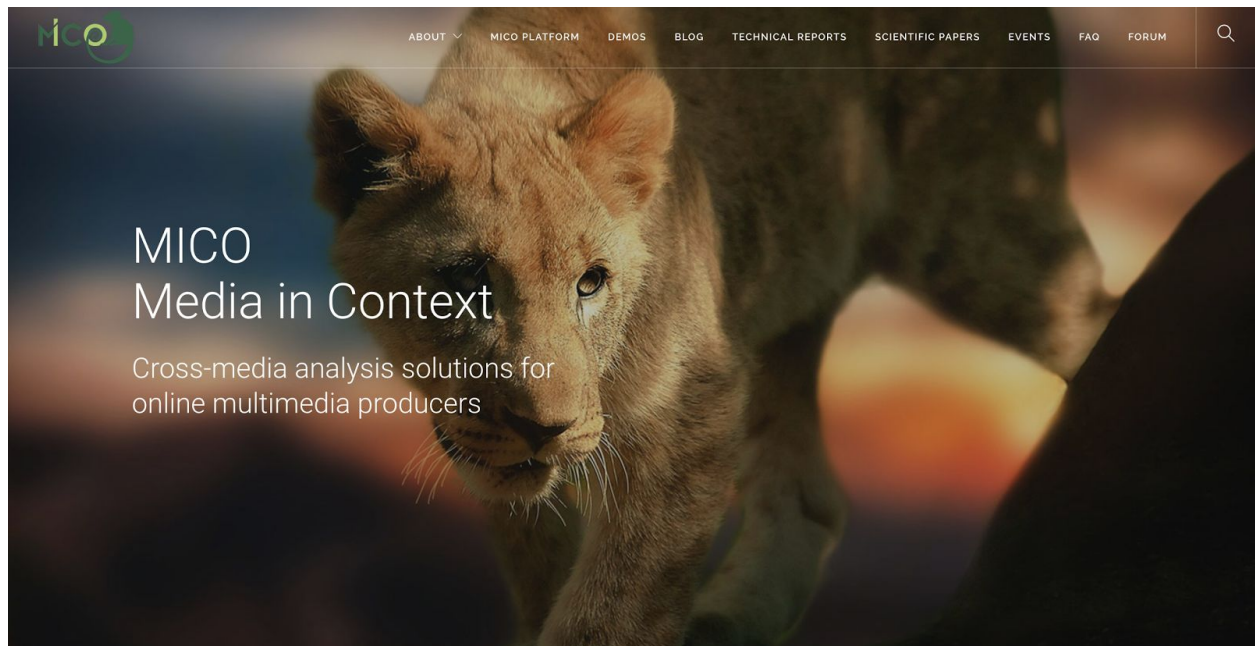
SPARQL-MM [23] is the multimedia extension for SPARQL 1.1, the linked data query language. It is a multimedia-extension for SPARQL 1.1 implemented for Sesame. It aims to bridge the gap between multimedia and the semantic web enabling querying for spatial and temporal object retrieval. By now it supports relation, aggregation and accessor functions for Media Fragments URI 1.0 - and features are constantly extended. SPARQL-MM currently supports complex spatio-temporal fragments, geographical queries by integrating the GeoSPARQL standard from Open Geospatial Consortium to Apache Marmotta, supports media analysis functions and properties and supports image and video fragment presentation.

Currently the implementation is an unofficial extension for Apache Marmotta, developed at GitHub.

MICO Java Client

This open source project provides a set of generic methods to access MICO API. Currently, this provides a set of methods for creating and submitting content items to the MICO platform and also provides a high-level query client interface for querying Marmotta back-end for extracted metadata on content items without having to write SPARQL queries. This project is useful for the developers to access MICO API and perform content injection and query tasks efficiently from a higher level of abstraction. The GitHub project is at [38].

MICO Web Site



MICO web site [52] hosted by project partner Salzburg Research will be the key access point for the public users to all the information about MICO project. It is the main access point for the project documentation and knowledge, all the demos, latest updates from the MICO blog and the MICO forum. MICO web site provides following sections.

- MICO platform documentation [53] : A complete project documentation is available here with an overview of the platform, installation guide and user guide for MICO, developer guide for MICO extractors, software releases and binaries, source code and the software licenses of the project.
- MICO demos [54] : A collection of demos of MICO platform technology and it's usage in research and industry use cases.
- MICO blog [26] : Latest updates from the MICO partners, events and platform development are shared with the public via the MICO blog. The blog entries are organized by different categories allowing the interested parties to filter and browse important posts based on their interests.
- Community Forum [28] : MICO aims to create a user community around media analysis technologies and their use cases. It is also a place for users to ask questions and start

discussions around MICO technology related topics. MICO partners will continue to provide support and guidance on MICO technology to interested users via the MICO forum. More details of the community forum will be discussed in a later chapter.

The web site will be maintained beyond the project timeline and will continue to be the key hub for MICO enthusiasts and partners to continue with the MICO project.

MICO Project Source Code

The source code of the project is currently maintained in bitbucket [43]. The source code will be actively supported by it's original developers for further questions and issues reported on the bitbucket project and discussed over the MICO forum and the MICO open source mailing list.

MICO Open Source Mailing List : mico-public@mico-project.eu

This mailing list hosted by MICO partner Salzburg Research will be the community mailing list for all MICO developers and users. Original developers and project partners of MICO will be actively participating in the mailing list to discuss future activities and developments and to answer questions from new MICO users and interested parties.

Intangible results

Knowledge and experience gained throughout the process and shared via the dissemination activities are the main intangible outcomes produced by MICO. The following can be mentioned under intangible results.

Practical Knowledge

Project deliverables of the MICO project contains the practical knowledge and expertise gained while developing the product

- MICO architecture
- Multimedia analysis techniques
- Evaluation methodology (evaluation for different use cases)
- Legal requirements
- Identify stakeholders

Brand

MICO project brand is an important intangible outcome. Strong brand is capable of creating an image or perception of its product in the minds of the consumers.

Most identifiable element in MICO branding is the MICO logo given below.



Mico is a shortened form for **Media In CO**ntext. MICO also used to describe a small South American monkey (*Mico melanurus*), related to the marmoset. So, a mico (monkey) is also included in the MICO logo design.

MICO publications

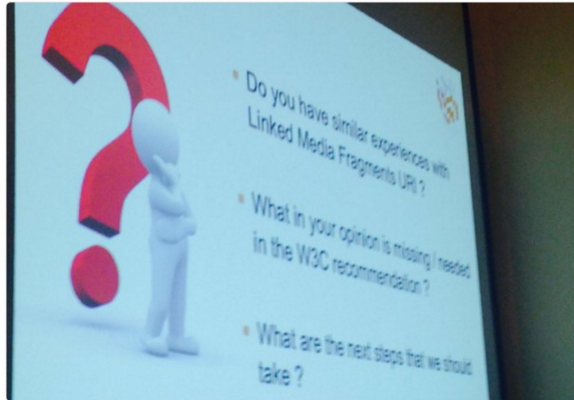
MICO publications provides a rich collection of knowledge acquired throughout the project execution including the following technical publications;

- State of the art in cross media analysis, metadata publishing, multimedia querying and recommendations
- Specifications and models for cross media extraction (extractors and broker), metadata publishing (MICO metadata model using Anno4j), querying and recommendations
- Enabling technology modules
- Use cases requirements analysis (for Zooniverse and InsideOut10)
- MICO system architecture and development guidelines (system architecture, data model, communication and persistence, service orchestration, development infrastructure, development guidelines and best practices)
- Combined use cases: First prototypes (test plan for evaluation)

A detailed list of publications can be found in [24]. Further, knowledge acquired in MICO is disseminated in several scientific conferences [27].

LIME workshop 2016

4th International Workshop on Linked Media was organized by some of the MICO participants to promote the principles of linked media on the web. Researchers specialized on semantic



multimedia and linked data get together to exchange their ideas on impact of the said areas in future web, making the web more usable and understandable. This workshop is co-located with the ESWC 2016 conference held in Heraklion, Greece on May 29 to June 2, 2016. It took place on the 30th of May, 2016. Workshop proceedings are available online at [25].

Target markets and users

The markets for cross-media systems develop at a tremendous rate. In this section, we discuss those that are most relevant for MICO from a business perspective. The markets are segmented by the application areas of MICO framework.

Cross Media Analysis

Out of the three focus areas, cross-media analysis has the broadest market. Much of what was previously written in now communicated through other forms of media, e.g. video, telecoms, and image-based chats, and there is a definite need of an analysis framework that can support and integrate data analysis for many different media. A complete list of markets is not a feasible, so we focus on those that we judge to have greatest potential.

- **Enterprise Knowledge Management**

As mentioned in the introduction, knowledge has become one of the the most valuable business assets. Almost every company has a set of process and tools for sharing and documenting knowledge internally, but with time this tend to lead to a large collection of unstructured data. To organise



and manage the information, platforms such as MICO are needed that can continuously analyse information from many different sources, e.g. issue trackers, digital notification boards, forums, and even email-conversations.

Sensefy by Zaizi is a good example of using MICO cross media analysis capabilities to provide cross media search for enterprise which can be used as a vital component in enterprise knowledge management.

- **Content Publishing**

Digital content publishing is one of the fastest growing professions in Europe. This category includes, photographs, film makers, creative writers, game developers, etc. The value and shelf-life of their output is largely decided by the associated metadata. If the content they produce is tagged with descriptive information, then it is easier to match it against customer needs and hence monetize it. At the same time, manual annotation is very labour intensive, and also a repetitive task that appeals to few. For this reason, automatic metadata extraction and annotation is expected to have a great positive impact for this group. The annotation model of MICO can be exploited by content producers to publish their multimedia content into the Linked Open Data cloud.

Following potential clients were approached with MICO technology as a suggestion for their content publishing requirements during the project timeline.

- Greenpeace (Italy)
- Greenpeace International (Switzerland)
- Shoof (Egypt)
- Digital360 Network (Italy)
- MadaMasr (Egypt)

News Media organizations reached by MICO are listed below.

- Financial Times
- Press Association
- Handelsblatt
- The Guardian News & Media

- **Content Authentication**

Multimedia content is vulnerable to security attacks where third parties try to intercept or destroy the content for various purposes. (E.g., man in the middle attack) Accordingly content authentication is required to verify the integrity or credibility of the information. Content authentication is important in domains such as legal, digital forensics and e-commerce.



Digital content mostly consists of text, audio, image and video. For text, syntactic, semantic and structural approaches are used for watermarking and authentication. Digital signature based methods and watermark based methods are used for video and image content authentication.

MICO can be used as a common platform to support text, image and video processing techniques for content authentication in a seamless manner for a given scenario. The AudioTrust+ project by Fraunhofer is an example showcase of MICO for a content authentication application, currently focusing on audio, but extensible to other media.

- **Adult Content Control**

Due to the sheer number of content available in the form of movies, short films, documentaries and images it has been difficult for legal authorities to filter out inappropriate content that contains nudity, offensive language and violence. Further, it is challenging for parents/ guardians and educators to filter out appropriate content for children without fully watching them. MICO can be used as a solution to automate the process.



Nudity detection and violence detection can be achieved using image processing (single frame processing/ visual features) and action recognition (multi frame processing/ spatiotemporal features processing). Offensive language can be detected using audio and text processing techniques. The extracted metadata on different content forms are stored as MICO metadata model.

- **Trademark Infringement**

Trademark is a sign or logo which uniquely identifies a particular product or service from others.

Trademark infringement is violation of the rights of a trademark to confuse or mislead the regular customers by the un-authorized persons. This is mostly done by the competitors of a particular product. One such scenario is where a particular trademark (e.g., logo) or a similar logo is misused in different multimedia forms such as images and videos.



Due to the large number of available multimedia content items, it is difficult or nearly impossible for humans to manually verify them for any scenarios where trademark infringement has been caused. This is where automated multimedia content analysis platform such as MICO can help. MICO can be used as a platform to implement the different object identification algorithms to identify places where a particular logo occurs in images and videos.

- **Television Billboard Advertising Coverage**

Television billboards are a popular way of digital advertising. Billboard advertisements are broadcasted few times (E.g., in the beginning, end or middle) in a television programs such as sports programs for a given duration. The idea is to use these advertisements as way of strategically marketing the sponsors by displaying their branding material such as



company logos or slogans. Usually, sponsors spend large amount of money on this type of branding activities. Yet there is no convenient way for them to verify if their branding materials were displayed in the television programs as they have been told.

MICO can shed some light to address this issue by using extractors that focuses on object detection and recognition techniques to detect if there company logo is displayed in a given program such as cricket match and the duration it was displayed (E.g., was it visible 3 times during the program for 0.5 seconds or less).

Cross Media Querying

- **Knowledge management and Publication**

The markets for cross-media querying is similar to those for cross-media analysis. Again, enterprise knowledge management is very relevant. Take for instance a consultancy firm that receives a request for a particular competence profile, or a property developer that enters upon a new project. In both cases, it is useful to query a knowledge bank of structured data, such as that provided through MICO through its triple storage. Another relevant market is Publishing. Here, updated information is the principal raw material. By allowing journalists to search their media archives with e.g. SparQL, new possibilities for near real-time publishing open up.



- **Content Archival**

Information that is old and no longer required to access frequently, need to be archived in long term storage, so that they can be retained later.

Possibly, archived items such as documents, reports and records may be useful in future. Some organisations have digital content archival policy, which focuses on managing archives according to a given set of rules or review process. Usually during the content reviewing process, rules are applied to a given type or category of content, so that they are archived by a defined date or duration. Manually categorising the content would be a tedious task for humans and mostly if categorisation is done by different people, it may not be consistent across the system.



MICO can be used as a common platform to automate the above scenario by applying clustering techniques to identify similar content (in form of image, video and audio) that belongs to same category. Once the content is automatically categorised, rules can be applied for the required categories to be archived in a given date.

- **Popular People Identification**

In schools, students are supposed to write essays on different topics and one such frequent topic is popular figures. Conventionally, students used to find information for these essays by reading paper based books and newspapers. However, currently vast amount of knowledge essential for that type of essays are contained in online multimedia content forms such as images and videos. Yet, if this



information is not adequately labeled with the clues on the embedded content, it is hard to find important information by going through all the available content. Multimedia content analysis platform such as MICO can assist users to automatically label the data.

So, the idea is to use video key frame extraction and face recognition techniques to identify people in multimedia content. For example, images and videos that is available in the internet where Barack Obama is featuring will be labeled with his name. Then when there is a requirement to write an essay on presidents of United States of America, students can easily retrieve the right information they need without much hassle.

Cross Media Recommendation

- **Broadcasting**

The broadcasting industry is an important market or cross media recommendations. The shift from traditional TV to on-demand streaming means that broadcasting companies have to find novel ways to expose their viewers to new content.



Whereas with traditional tv, viewers simply

followed the daily program, but in the current situation, it is more difficult to entice them to watch shows and programs that they have not seen before. Recommendation systems are an increasingly more common alternative, but these need to be very accurate, or else the viewer soon starts to ignore them. With MICO, an unbounded number of data sources can be

combined to point users to relevant content, and because of the way data is stored, it is even possible to recommend parts of a video or an image.

- **Online Retail**

Another interesting market for cross-media recommendation is online retail. As content marketing becomes an established sales channel, methods are needed to keep users interested and guide them between promotional assets. As online retailers typically have very tight margins, open source solutions such as MICO are attractive and we expect a fast technological uptake in this segment.



Competitive advantage and initial SWOT Analysis

Competitive advantage of MICO

- A platform to compose different multimedia analysis methods on different types of content in a single product
- Store extracted metadata related to content in an open graph structure / Common metadata format which can be exchanged with other open platforms
- Support for extension to new content types and new multimedia analysis methodologies - custom extractors

Initial SWOT analysis

Strengths

- Providing a platform to analyse any media type in a collective manner (support for any media type)
- Free and open source licence - cost effective and transparent
- Convenient access for developers to use and extend (APIs)
- Use of reliable, scalable, cutting edge technologies for development
- Ability to store extracted metadata in a well defined open standard
- Applications on real world use cases

Weaknesses

- Not having sufficient number of built-in extractors
- Low brand reputation
- Brand is easily confused with MICO bathroom fittings and MICO hydraulic components, controls and brake systems (branding issues)
- Stability of the used open source projects (consistent community support)
- Dependency on proprietary software for some extractors - however, this can also be considered an opportunity in the sense of creating an ecosystem with commercial vendors, and it seems the only realistic approach considering the scope of possible extraction functionalities

Opportunities

- Increase of multimedia usage (creation and sharing)
- Rapid technical advancements of multimedia devices (smartphones, tablets)
- Recent interest of the research community to come up with different novel multimedia analysis methods
- Increased Availability of free and open source solutions for multimedia content analysis (for single content type)

Threats

- Major companies such as Google, Facebook, Microsoft are conducting similar research with better (large and diverse) datasets
- Most of the multimedia extraction methods still do not have sufficient accuracy to be used in real world environment
- Reluctance of end users to adapt to new technologies
- Security concerns of the content during multimedia analysis

Value Proposition and expected impact

Differentiation

These are the key differentiation aspects of MICO as a multimedia analysis framework, compared to other multimedia analysis solutions.

- Cross-media extraction: Providing the collective approach to analyse different media types with different analysis techniques applied using a pipeline approach. The extensibility of the extractor framework makes the MICO platform an ideal solution to orchestrate custom analysis workflows of multimedia resources.
- Cross-media metadata publishing: MICO metadata model is a uniform way for representing and exchanging (extracted) metadata of multimedia content.
- Cross-media querying: Enables querying across multimedia data. The query language extension SPARQL-MM is introduced to provide spatio temporal filter and aggregation functions to handle media resources and fragments using Media Fragments URI specification. Therefore MICO provides a rich query model to perform cross media analysis tasks. Java RDF library Anno4J is introduced in MICO Metadata model to easily cope with annotations and querying making it easier for the developers.
- Cross-media recommendation: A recommendation engine in MICO is developed using collaborative filtering based machine learning to recommend similar multimedia content to users in the Zooniverse use case. This use case shows the power of MICO platform to provide specific cross media recommendations.

When considering the overall functions of the MICO framework and its extensibility, it can be considered as a strong contender in the the cross media analysis product market. Further, the open source and business friendly software licensing model of the MICO framework becomes a key factor which differentiates MICO from the rest of the contenders in the market, as a cost effective solution for SMEs in the multimedia publishing domain to implement their multimedia analysis solutions.

Expected impact

Global impact

In this digital age, MICO helps to cope with the tremendous growth of digital content by extracting actionable knowledge and hidden insights from the available information using MICO extractors, MICO cross media metadata publishing and querying. The platform is targeted mainly at the SMEs working with multimedia content to get more value from their content and content based solutions. Currently several global SMEs who are also MICO partners (Zaizi, InsideOut10, CodeMill) are actively using MICO technology in their commercial products for cross media analysis purposes. Their usage in the products will be discussed in detail under the individual exploitation plans chapter.

Impact on scientific research/ contribution for scientific community

MICO Broker/ MICO platform provide a common framework for researchers to experiment with new custom analysis techniques and algorithms in different combinations. Several such scientific experiments have been carried out and published under MICO research work.

"Europe"2020"Strategy"

Europe has technology lead on the semantic technologies. MICO focuses on maintaining and strengthening the European leadership in fields of information extraction, multimedia databases, semantic web and linked data.

Contribution to open source community

There are several significant open source contributions done during the project timeline in addition to the MICO platform project and the open source extractors. These include the following;

- SPARQL-MM
- Anno4j
- MICO Java Client

Further, MICO exploits the work done in open source projects such as Apache Stanbol, Apache Marmotta in their multimedia analysis and metadata publishing procedures, thus increasing the usage of those projects.

Benefits for target users

For European end users:

- Improved knowledge on multimedia analysis, metadata publishing and querying
- Novel platform for learning and collaboration
- Improved methods for effectively retrieve multimedia content
- Effective ways to preserve relationships between different multimedia content

For multimedia content producers:

- Technologies to effectively analyse and organize multimedia content
- Promote multimedia content usage

Exploitation strategy for MICO

We focus on 2 key exploitation strategies for MICO.

1. Offering a software bundle of MICO platform with key functionalities as open source software with a strong community support
2. Exploit and support commercial and research opportunities with interested SMEs and potential clients for MICO

Business impact drivers

Short term and long term factors that have an impact in the effectiveness of the exploitation strategy are stated below.

In the short term

- Technology readiness of the solution - criteria to evaluate the readiness of the solution for customers
- Approach for dissemination and exploitation activities
- Participation of target users and key providers/ players in different activities of the project

In the long term

- Participation by MICO partners beyond the timeline
- Open source community
- Substantial number of extractors for specific business cases (eg: face detection, animal detection, NLP extractors)

Sustainability

The sustainability of the project beyond the project duration is expected to be managed by the MICO partners. MICO as an open source software project will be actively supported by all it's partners who worked on respective work packages and the developers of the components will continue to support and contribute to the platform source code.

The continuity of the commercial exploitations and customizations of MICO technology for particular business needs will be managed by 'MICO Task Force' a joint venture which will be formulated by the MICO partners. Details are given below.

MICO Task Force

MICO Task Force will be a joint venture, a legally non-binding entity formed by the MICO partners to continue the coordination of open source and commercial relationships with MICO users and potential clients. MICO framework is currently used in several commercial use cases by MICO partners including Smart Video Nordic AB, InsideOut10, Zaizi Ltd. At the events and workshops conducted during the project timeline, there have been many potential clients and interested parties to collaborate with MICO. These relationships and collaboration efforts need to be supported and improved beyond the project timeline for the project sustainability.

The goal of MICO Task Force is to develop the business value of MICO as a platform and continue the marketing and presales activities for MICO platform. MICO Task Force will continue to provide commercial support and necessary collaboration efforts for upto one year after the MICO timeline.

One important element of this strategy is an *open business* approach. All core functionalities of the platform (and many extractors) have been provided under a business-friendly Apache open source license, but the addition of proprietary components e.g. as extractors is explicitly allowed and encouraged: This approach ensures that partners and prospective MICO users share a common platform and code base, while keeping the door open for many commercial exploitation opportunities.

Following members from the MICO partners will be joining the MICO Task Force. The team will convene to discuss the current developments and future plans on a monthly basis via Skype.

- John Pereira (SRFG - Redlink GmbH)
- Patrick Aichroth (FHG)
- Chris Lintott (UOXF)
- Johanna Björklund (UMU - Codemill)
- Dileepa Jayakody (ZA)
- Andrea Volpini (IO10)
- Emanuel Berndl (UP)

MICO Open Source Support services

The source code of the project will be maintained and continued in a public repository at bitbucket [43]. The developer and user support for the public will be available through the community mailing list (office@mico-project.eu) and the MICO forum (<http://www.mico-project.eu/community-forum/>). A comprehensive documentation is also available on the MICO web site for the new users to get started with.

Financial sustainability

Different types of costs are involved to ensure the smooth continuation of MICO thus providing the sustainability of the project. MICO cost structure is given below.

1. Operational cost (hosting the web site and other online material, maintenance and support activities, security features)
2. Service upgrade cost
3. Staff cost
4. Management cost
5. Sales and marketing cost

Based on the interest to adopt MICO technology in the business model of the MICO partners, the above costs will be shared among the partners. Salzburg Research will manage the operation costs for maintaining the web site and other online material. Staff and management costs will be managed by the individual partners internally. Sales and marketing costs for MICO will be covered by the use case partners based on their marketing strategies for the products using MICO technology.

Acceptance

Acceptance of the solution by both internal and external stakeholders is an important factor when it comes to sustainability of the MICO solution. As the framework and many extractors are available as open source, the pricing mechanism of the solutions will depend on the consultancy and the proprietary and custom extractors required to cater for the respective business use case of the client. Acceptance of the internal stakeholders might depend on the perceived profitability of the solution after covering up the costs initially invested on the product.

Branding considerations : Trademarks

When it comes to branding, trademarks play an important role in exclusively identifying the provided product or service. We will be looking into Community trademark (CTM) which offers protection throughout the EU. Registration for the CTM can be filed with the Office for Harmonization in the Internal Market (OHIM).

Novelty search on the selected trademark can be done using the search facilities provided by European Union Intellectual Property Office (EUIPO)'s database on Office for Harmonization in the Internal Market (OHIM) [47].

When filing an application for CTM, the relevant classes for the product or services should be identified using a standard classification mechanism. The Nice Classification is a system of classifying goods and services for European Union (EU) trademark applications. It consists of 45 classes. The Nice Classification assigns goods to classes 1 to 34, and services to classes 35 to 45. The identified NICE class for MICO is 42.

42. Scientific and technological services and research and design relating thereto; industrial analysis and research services; design and development of computer hardware and software.

The relevant sub areas for MICO under class 42 is given below.

- Design and development of multimedia products
- Design of software for multimedia data storing and recalling
- Development of software for multimedia data storing and recalling
- Design of software for processing and distribution of multimedia content

Application fee to apply online for CTM is €850 for one class. If application is submitted using a paper form, the fee of €1000 will be applied.

Secondary exploitation strategies

This section discusses the secondary exploitation lines of the project. Different partners play different roles in the project. Accordingly, they can plan for individual exploitation plans that relate to their particular role. Secondary exploitation strategies primarily focus on MICO

knowledge exploitation through publications and dissemination activities to broaden the MICO community.

Knowledge exploitation

Following section contains the dissemination activities such as conferences, workshops and forums where MICO was presented. The knowledge and experience shared through these activities help to increase the user community for MICO project and also to find collaboration opportunities with other technology providers and business opportunities.

Publications

Title	Conference / Journal
Towards a Commons RDF library	ApacheCon Europe, Budapest, Hungary, 2014
Manage Linked Media with Apache Marmotta	ApacheCon Europe, Budapest, Hungary, 2014
Apache Marmotta	ApacheCon Europe, Budapest, Hungary, 2014
Squeebi	The 13th International Semantic Web Conference (ISWC), Developers' workshop, Trentino, Italy, 2014
Sesame Vocab Builder	The 13th International Semantic Web Conference (ISWC), Developers' workshop, Trentino, Italy, 2014
Towards a Commons RDF Java library	The 13th International Semantic Web Conference (ISWC), Developers' workshop, Trentino, Italy, 2014
Open Data Publishing and Linked Data.	Workshop at the Università degli Studi dell'Aquila, L'Aquila, Italy, 2014
Balloon Synopsis: A jQuery plugin to easily integrate the Semantic Web in a website	The 13th International Semantic Web Conference (ISWC), Developers' workshop, Trentino, Italy, 2014
Interactive Learning of Syntax-based Natural Language Queries	The 5th Swedish Language Technology Conference (SLTC), Uppsala, Sweden, 2014
Automated speech recognition in media asset management	The 5th Swedish Language Technology Conference (SLTC), Uppsala, Sweden, 2014
Balloon Synopsis: A Modern Node-Centric RDF Viewer and Browser for the Web	The 11th European Semantic Web Conference (ESWC), Anissaras, Crete, Greece, 2014

An Open Linked Data Strategy for Tourism	Semantics - Enterprise Linked Data Applications, Leipzig, Germany, 2014
Graph Transformation for Incremental Natural Language Analysis	Theoretical Computer Science, 531:1-25
Extracting the N best trees	The 9th International Conference on Language and Automata Theory and Applications (LATA), Nice, France, 2015
SPARQL-MM - Towards a Semantic Multimedia Retrieval Language	The 3rd International Conference on Linked Media (LIME), Florence, Italy, 2015
MICO - Towards Contextual Media Analysis	The 3rd International Conference on Linked Media (LIME), Florence, Italy, 2015
On Computing Best Trees for Weighted Tree Automata	The 3rd conference on Trends in Tree Automata and Tree Transducers (TTATT), London, UK, 2015
WordLift: Meaningful Navigation Systems and Content Recommendation for News Sites running WordPress	The 12th European Semantic Web Conference (ESWC), Developers' Workshop, Portoroz, Slovenia, 2015
A Platform for Contextual Multimedia Data - Towards a Unified Metadata Model and Querying, v2	The 15th International Conference on Knowledge Technologies and Data-Driven Business (i-KNOW), Graz, Austria, 2015
MICO - Media in Context	IEEE International Conference on Multimedia & Expo Workshops (ICMEW), Torino, Italy, 2015
Efficient Incremental Evaluation of Succinct Regular Expressions	ACM International Conference on Information and Knowledge Management (CIKM), Melbourne, Australia, 2015
This Image Intentionally Left Blank: Mundane Images Increase Citizen Scientist Participation	Conference on Human Computation & Crowdsourcing (HCOMP), San Diego, USA, 2015
WordLift and MICO for Digital Publishers	Roadmapping Workshop on Cross-media Linked Data at the Univesità La Sapienza, Roma, Italy, 2015
A Platform for Contextual Multimedia Data - Towards a Unified Metadata Model and Querying	The 15th International Conference on Knowledge Technologies and Data-Driven Business (i-KNOW), Graz, Austria, 2015

Hotwiring the Crowd	Hotwiring the Transient Universe IV, Santa Barbara, USA, 2015
Grammatical inference of graph transformation rules	The 7th Workshop on Non-Classical Models of Automata and Applications (2015), Porto, Portugal, 2015
Inferring Robot Actions from Verbal Commands Using Shallow Semantic Parsing	The 17th International Conference on Artificial Intelligence (ICAI), Las Vegas, USA, 2015
Formal Models of Graph Transformation in Natural Language Processing	Dagstuhl Seminar 15122, Dagstuhl, Germany, 2015
Predictive Topdown Parsing for Hyperedge Replacement Grammars	8th Intl. Conf. on Graph Transformation (ICGT), L'Aquila, Italy, 2015
Context-Free Tree Grammars are as Powerful as Context-Free Jungle Grammars	Acta Cybernetica 22:373-392
Contextual Hyperedge Replacement	Acta Informatica, 52:497-524
The Output Size Problem for String-to-Tree Transducers	The 3rd conference on Trends in Tree Automata and Tree Transducers (TTATT), London, UK, 2015
Between a Rock and a Hard Place - Efficient Parsing for Hyperedge Replacement DAG Grammars	The 10th International Conference on Language and Automata Theory and Applications (LATA), Prague, Czech Republic, 2016
N-Gram Representations for Comment Filtering	The Annual Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT), Stellenbosch, South Africa, 2016
Idiomatic Persistence and Querying for the W3C Web Annotation Data Model	The 13th European Semantic Web Conference (ESWC), Developers' Workshop, Heraklion, Crete, Greece, 2016
Lifting Media Fragment URIs to the next level	The 13th European Semantic Web Conference (ESWC), 4th International Workshop on Linked Media, Crete, Greece, 2016

The MICO Broker: An Orchestration Framework for Linked Data Extractors.	The 13th European Semantic Web Conference (ESWC), Developers' Workshop, Heraklion, Crete, Greece, 2016
A Workflow for Cross Media Recommendations based on Linked Data Analysis	The 13th European Semantic Web Conference (ESWC), Developers' Workshop, Heraklion, Crete, Greece, 2016
A taxonomy for TA minimisation algorithms	Journal of Universal Computer Science, 22(2) 2016, Graz, Austria
Uniform vs. Nonuniform Membership for Mildly Context-Sensitive Languages: A Brief Survey	Algorithms, 9(2) 2016, MDPI, Basel, Switzerland
Sentiment analysis in a cross media analysis framework	The IEEE International Conference on Big Data Analysis (ICBDA 2016)
Properties of Regular DAG Languages	The 10th International Conference on Language and Automata Theory and Applications (LATA), Prague, Czech Republic, 2016
Approximating Parikh Images for Generating Deterministic Graph Parsers	7th International Workshop on Graph Computation Models (GCM), Vienna, Austria, 2016
EM-Training for Probabilistic Aligned Hypergraph Bimorphisms	Proc. StatFSM 2016: ACL Workshop on statistical NLP and weighted automata, Berlin, Germany, 2016
On the N-best Problem for Hypergraphs	4th International Workshop on Trends in Tree Automata and Tree Transducers, Seoul, South Korea, 2016
Deterministic Stack Transducers	The 21th International Conference on Implementation and Application of Automata, Seoul, South Korea
My Name Is Legion - Estimating Author Counts Based on Stylistic Diversity	European Intelligence and Security Informatics Conference, Uppsala, Sweden, 2016
Anno4j - Idiomatic Access to the W3C Web Annotation Data Model	The 13th European Semantic Web Conference (ESWC), Developers' Workshop, Heraklion, Crete, Greece, 2016

Events

Event	Event type
ApacheCon Europe 2014	Workshop
ISWC 2014	Developers Workshop, Apache Marmotta tutorial
2nd Workshop for Linked Media (ESWC 2014)	Workshop / Invited Talk
Semantics Leipzig	Presentation
The 20th international conference on theory and applications of automata	Main organizers
Swedish language technology conference 2016	Main organizers
Dagstuhl Seminar 15122 Formal Models of Graph Transformation in Natural Language Processing	Main organizers w. Linköping University
Gesellschaft für Informatik: Theorietage 2015	Invited Talk
IBC Conference	Presentation Stand - in connection with Fraunhofer
RiseUP 2015	Presentation Stand - in connection with HelixWare team
Swedish Language Technology Conference	Workshop
International Conference on Innovations in Inforbusiness and Technology	Industry track presentation
4th Workshop for Linked Media (ESWC 2014)	Workshop
SEMANTiCS 2016	Industry track presentation

EDF 2016	Exhibition stall
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Knowledge Transfer

The knowledge gained by MICO stakeholders during MICO project execution can improve the competitiveness of the stakeholders in various ways as listed below.

- The knowledge and experience gained from MICO project can be used in other existing products and services thus increasing the end user experience
- Research collaboration with other partners to improve current products and services
- Conducting training programs on the specialized areas using the knowledge acquired
- Collaborate with universities on academic programs in related research areas

Standardization

The relevant standardization bodies and standardization activities conducted by MICO under each standardization body are described in the table below.

Standardization body	Standardization groups	Technology and MICO contribution	Involved MICO partners
World Wide Web Consortium (W3C)	SPARQL 1.1 Query Language [29]	SPARQL-MM Implementation [30]	Salzburg Research
	Media Fragments URI	Extension of the current version of Media fragments URIs [31] Draft implementation [32]	Salzburg Research

	Web annotation data model [33]	Anno4j Implementation [34] Publication [35]	Salzburg Research
Open Geospatial Consortium (OGC)	GeoSPARQL - A Geographic Query Language for RDF data [36]	Add GeoSPARQL support to KiWi triplestore [37]	Salzburg Research

MICO Community Platform

Effort for a community forum was bifold. Firstly, a section was set up and promoted on the Zooniverse forums. The focus of this section was the combination of machine learning and human effort, as applied to Zooniverse projects. Keeping in mind that this is a specialised topic, we saw a good response to our posts, including people mentioning the MICO platform in other areas of the site.

The second action we took was set up a forum section on the MICO website itself, where users of the platform can come with questions. We have been monitoring this forum and responding to the questions that people posted.

MICO Forum hosted by Zooniverse

Rather than restricting discussion only to specialised forum, we decided to create spaces for discussion of MICO in existing communities. Use case partner Zooniverse has an existing community of researchers building projects which could make use of MICO technologies, and who share an existing forum for talking about relevant issues including computing and machine learning. The forum uses a custom open source framework which makes use of the Zooniverse Talk API (<https://github.com/zooniverse/Talk-Api>) and the Panoptes Front End (<https://github.com/zooniverse/Panoptes-Front-End>) which also hosts Zooniverse projects.


The forum exists as a dedicated section (labelled 'Science') within the top level of the discussion area, which is promoted via regular newsletters to those who have built projects using the Zooniverse tools. Since its launch on the 21st May 2016, the forum has seen moderate activity: there are 8 discussions active with 18 separate participations, most of whom are not otherwise connected to the MICO platform.

Zooniverse Talk
[Zooniverse Talk](#) > [Science](#) > Helping projects like Snapshot Serengeti using machine learning and computer vision
 Search the Zooniverse...

Helping projects like Snapshot Serengeti using machine learning and computer vision
 Moderator Controls
 Unsubscribe You're receiving notifications from this discussion because you've joined it (immediate email)

May 23rd 2016, 1:34 pm

Alex Bowyer
 @alexbfree
 ZOOIVERSE TEAM



An example of an image that a computer vision algorithm would find "hard"

One of the basic premises of projects like [Snapshot Serengeti](#), [Wildcam Gorongosa](#), [Chicago Wildlife Watch](#) and [Snapshot Wisconsin](#) is that when you have a large volume of automatically taken camera trap photos from the wild, finding and identifying the animals in those photos is *really* hard. Darkness, weather, foliage, or other animals can obscure an animal, making it hard to identify. The animal may be in an unusual posture, or partly off camera - its identifying features may not be

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[#blue-ford](#)
[#dunesdikesorchannelstrending11oclo...](#)
[#ford-blue](#)
[#hourglass](#)
[#ngc](#)
[#sadsunday](#)
[#spiral](#)
[#1448](#)
[#1547880](#)
[#1901](#)
[#1913](#)
[#2365](#)
[#2382](#)
[#2398](#)
[#3662](#)
[#744](#)

1 Active Participants:
[Marten Veldhuis](#)

Projects:

June 13th 2016, 12:40 am

@alexbfree Hi, I was thinking about your "often confused with" feature (which is really useful). If you filtering out those subjects which are really often confused by users, that could help machine learning as they are on the "edge" of classes. But maybe you are already doing that, I don't know, my interest in machine learning is quiet new. and I am afraid, it's not "how machine learning can help Zooniverse" but the opposite 😊 The other interesting thing could be the textual analysis extractor (that [Mico](#) is already planning to add to its Zooniverse pipeline) especially combining (or comparing) somehow with region annotation (<http://cs.stanford.edu/people/karpathy/deepimagesent/>).

Helpful (0) Reply Link Report

This discussion area will be maintained by the Zooniverse team following the end of the MICO project; we expect to promote it during a series of upcoming conferences for project builders, in parallel with offering the MICO platform to the Zooniverse community.

MICO Forum available on the MICO Site

Whereas the forum on the Zooniverse site was setup to promote the use of the MICO platform across Zooniverse projects, a different forum was installed on the MICO website in order to provide a space for users of the platform to ask for help installing, running and extending the MICO platform itself.

Continued moderation of this forum after the end of the MICO project will be provided by partners of the MICO project based on topic relevance. Motivation to continue the support and moderation of the MICO Forum is based on the assumption that a commercial interest will be the result of the community support. This is usually quickly evaluated based on the description of the use case.

Welcome to the MICO Community Forum. Here you can ask the MICO team questions that have not been answered in our [Frequently Asked Questions \(FAQ\)](#).

Please login to discuss.

The screenshot displays a list of forum posts. Each post includes a user profile picture, the title of the question, the time it was posted, the category it belongs to, the user's name, and the number of replies and likes. The posts are as follows:

- Cross Media Search With MICO**: posted 27 days ago in *Use Case Partner* by *Dileepa Jayakody*. 0 replies, 0 likes.
- Animal and object recognition**: posted 2 months ago in *Extractors* by *Annica Lindstrom*. 1 reply, 0 likes.
- What are your face detectors?**: posted 2 months ago in *Extractors* by *Emil Lundh*. 1 reply, 0 likes.
- IBC 2016 i Amsterdam**: posted 2 months ago in *Extractors* by *Johanna Bjorklund*. 1 reply, 0 likes.
- Named Entity Recognition**: posted 2 months ago in *Extractors* by *Johanna Bjorklund*. 2 replies, 0 likes.
- Welcome**: posted 7 months ago in *General* by *Werner Moser*. 0 replies, 0 likes.

Frequently Asked Questions

A space for common questions was also set up. Questions that pop up often on the forums will be extracted to this page. Anticipated issues have been added in advance.

Welcome to the MICO Frequently Asked Questions (FAQs). If you have a question or issue that is not answered below or not to your satisfaction then send a message to office@mico-project.eu

1. General

- What will MICO focus on?
- Who is behind MICO?

2. Join MICO

- How can I get involved in MICO?

3. MICO Platform

- What can I do with the MICO Platform?

4. MICO Extractors

- What is a MICO extractor?

5. Install and run MICO

- How to install the MICO Platform

MICO Glossary

- What are MICO Showcases?
- What are MICO Technology Enablers?
- What are MICO User Stories?

Individual exploitation plans

This section provides the MICO partners' individual exploitation plans. Organisations are sorted per role, considering three major roles: industrial partners, academic and research partners.

Each plan consists of four sections: a description of the organisation's business model, the relevance of the project MICO for the organisation (the motivation for participation or the expected benefits from the project), an overview of the provided tools and their licenses, and a short description of the individual exploitation plan along the project execution.

Industrial Partners

Zaizi Ltd



Organizational business model

Zaizi Ltd. is a UK based open source software consulting company founded in 2007. Zaizi design, implement and support solutions for people and content centric business processes. Being a platinum partner of Alfresco, the open source content management platform, Zaizi's technology focus is open standards and APIs to integrate and produce smart and secure digital content solutions to their clients.

Zaizi's solutions range from the basic-storing, digitising and digitally managing content to designing workflow, easy records management and secure internal and external collaboration with hybrid cloud. The company offers a social intranet solution designed to promote participation, improve interaction and encourage knowledge sharing. And in Sensefy, Zaizi is developing a sophisticated, open source enterprise semantic search solution.

MICO relevance in the current business model of the organization

Zaizi caters for enterprise clients to effectively manage their digital content and business activity workflows. Enterprise search and content enrichment have become a key business domains for Zaizi today. Sensefy is the main product developed by Zaizi in this domain. Currently Sensefy provides semantic search features for text content. Integrating MICO will enable Sensefy to add cross media semantic search features that will largely benefit Sensefy as a search platform. Further, multimedia content analysis capabilities will greatly enhance content management solutions offered by Zaizi using Alfresco.

Licensing arrangements

The main contribution from Zaizi to MICO platform will be a MICO connector for open source content ingestion framework Apache ManifoldCF. This will be contributed to ManifoldCF community under Apache 2.0 license which is the same license used for the MICO platform.

Exploitation Plan

MICO technology allows users to annotate multimedia content with additional semantic information and get cross media analysis results for their content. This will be vital for media content producers and content managers in the enterprises to have their unstructured multimedia content managed properly. A key requirement in content management will be finding the required content and extracting the required knowledge for business needs in the enterprise.

“Sensefy”, the enterprise search framework developed by Zaizi can exploit the technology in MICO effectively to provide cross media search features to enterprise users. As the key exploitation goal, Zaizi aims to integrate MICO platform with Sensefy to provide enterprise search across all media content. This will enhance the effectiveness of the Sensefy product as an enterprise search framework with semantic search features across any media type. One of the goals here is to have a significant impact on the domain of enterprise content management in particular, in the SME sector of the domain by allowing the enterprise content managers to use advance cross media analysis and search features using an affordable, easily configurable framework such as MICO.

Zaizi will mainly target on 2 user groups for MICO exploitation and dissemination. The enterprise users and the technology developers. Zaizi aims to provide following facilities to the target user groups.

Enterprise Users

- Utilize MICO as a commercial service
- Introduce cross media search to enterprise search users
- Introduce cross media analysis features for content recommendation and content classification
- Deploy an online demo of the cross media search reference implementation with MICO

Technology Developers

- Develop easy to use MICO java client for developer communities to exploit
- Develop a MICO connector to open source document ingestion framework : Apache ManifoldCF; this will extend the MICO user community further with the user base in Apache software foundation.
- Document MICO integration process as tutorials and sample code segments for developer communities to exploit
- Dissemination of MICO usage scenarios in enterprise content management domain as blog posts

Insideout10 S.r.l.



Organizational business model

InsideOut10:

- develops technological and communication solutions with a focus on *CMS, Online Video, Semantic Technologies, Digital Intelligence and Communication*
- has a mixed portfolio of multinational groups (e.g. Enel, TotalErg, A1 Telekom Austria, RealNetworks) and News&Media enterprises (e.g. Greenpeace News, Caltagirone Editore)
- has over 15 years of R&D experience, collaborating with universities and organizations such as CNR and University of L'Aquila
- owns 80% of *Insideout.Today*, an Egyptian company specialized in online audio-video and social marketing - clients: Ooredoo Tunisie, Ooredoo Algérie, FastTelco Kuwait
- owns 20.24% of *Redlink GmbH*, a startup created with the team working at the Salzburg Research Institute in 2013 to leverage 8+ years of R&D in semantic technologies and linked data
- has developed two solutions targeting the news and media sector as well as the broadcasting industry:
 - [WordLift](#) [40]: a plugin for WordPress that brings the power of Artificial Intelligence to help journalists produce richer content and organize it around their audience.
 - [HelixWare](#) [41]: is an online-video platform for best in-class, multi-screen, live & on-demand streaming

MICO relevance in the current business model of the organization

Insideout10 provides support for news and media organizations, enterprises and public organizations to effectively manage their digital content and publishing workflows.

WordLift targets smart content publishing and linked data needs of content owners and focuses on the news and media sector where data can generate an immediate economical value for its users.

Insideout10 main focus with WordLift is to bridge the semantic gap in today's digital networks, offering an easy-to-use semantic annotation tool that targets journalists, bloggers and editorial

teams, helping them to reach their readership by unlocking the value of open data. Insideout10 helps journalists connect and share experiences with their readers as well as structuring knowledge in machine-readable form.

With HelixWare Insideout10 helps publishers distribute and monetize media content. Also in the case of HelixWare there is a plugin for WordPress that integrates the video publishing workflow with the content management.

MICO brings both to WordLift and to HelixWare the capabilities that are needed to provide an integrated service for cross-media content analysis, metadata tagging and recommendation.

Licensing arrangements

Insideout10 contributes the code of the WordPress plugin for HelixWare and WordLift as open source under the GPL 2.0 license on the WordPress repository. A dedicated MICO gateway has been also contributed as open source to help other developers in the WordPress eco-system re-use the technologies of MICO.

Exploitation Plan

With the rapid growth of multimedia content on the Web and in corporate intranets, discovering hidden semantics in raw multimedia content is becoming one of the biggest challenges for products such as WordLift and HelixWare.

It becomes of crucial importance for content owners, journalists, content managers and marketers to get full control of the metadata being published online and to reduce the complexity of content management and marketing operations.

Insideout10 focuses on two users groups:

- **Enterprise users** using HelixWare or WordLift on the Internet and in their corporate intranets
- **Bloggers, journalists and content producers** using WordLift on their website



Codemill AB

Organizational business model

Codemill AB is a product-development partner specialising in digital video. The company services customers in Broadcasting, Publishing and Online retail worldwide. A typical project consists in developing custom media-asset management system, based on a combination of open-source and proprietary libraries. Advanced data analytics is usually a key component. Codemill was founded in 2008 and now employs 35 MSc's in Computer Science and Interaction design.

Expected benefits

A substantial part of our development effort goes into integrating software components for video analysis and processing. Many of the associated tasks are solved in the MICO platform, e.g. there is a unified framework for representing and storing extracted metadata, there is a broker and message bus to control the processing pipeline, and several key libraries such as Kaldi and OpenNLP have been integrated. With time, the number of available OS extractors is likely to increase further, due to contributions from the Apache Stanbol community.

By using MICO, we expect to reduce development costs and project risks, as well as offer our customers a broader set of methods for video analytics.

Tools and licenses

Codemill are positive to the business friendly licence chosen for MICO, and are active contributors to a range of OS projects, e.g. mpeg. If MICO becomes part of our standard toolbox, then we will become active contributors to there as well.

Individual exploitation plan

Once the MICO platform has reached its final form, Codemill will (resources permitting) conduct an internal evaluation of the system. If this is successful, we will consider MICO as a useful component in our coming projects, and try to build a commercial solution on top of it, as soon as

we find a relevant use case. The relevant KPI's are on the one hand the amount of development hours needed, the cost of licensing, and on the other, the uptime, throughput, and annotation performance.

Smart Video Nordic AB

Organisational business model

Smart Video Nordic AB is an affiliated company to Codemill AB, founded in 2015 to develop and



market the adtech software Smart Video. Smart Video leverages MICO to support in-video purchases and automatically match editorial videos with appropriate ads. The primary market segments are brands, that want to turn existing marketing videos into sales videos, and publishers that want to monetize editorial content. The company currently employs a team of 5 engineers and 2 full-time sales people. Early customers are Rapunzel of Sweden and Komatsu Forest.

During late 2016 / early 2017, SV is conducting an A-round and looks to raise Euro 1 million for continued product development and sales.

Expected benefits

The creation of Smart Video was largely inspired by the MICO concept, and we see the MICO platform as a cornerstone of our developing architecture. The main benefits are the rapidity with which new extractors and workflows can be integrated and configured, and the native support for RDF metadata storage and search. We hope to see a community of industrial partners forming around the SV platform, to ensure its continued maintenance and development.

Exploitation plan

In 2017 Q1, Smart Video will continue the evaluation of the MICO platform begun in 2016 Q4. If the outcome of this evaluation is, as we expect, positive, we will instigate or join continued development on the core platform to address issues outside the scope of the present project. These are principally hygiene factors, such as security, stability, and scalability, that are less interesting from an R&D point of view, but are needed for production.

Research Organisation partners



Salzburg Research

- The department Knowledge and Media Technologies will close end of 2016
- MICO knowledge moved to spin-out Redlink GmbH
- Redlink GmbH supports Open Source projects Apache Stanbol and Apache Marmotta
 - A major business field is information discovery with clients such as Red Bull Mediahouse and Karajan Institute.
 - Setup collaboration partnership with InsideOut10
 - Setup collaboration partnership with Fraunhofer - MM extractors
 - Investigate opportunities with CodeMill

Redlink Cross-media Search Extensions

The Redlink document search¹ is specialized for dealing with documents such as business correspondence, technical documentation and also archival material, which have been scanned in and OCR'ed. The search functionality of Redlink search relies on an NLP processing pipeline including keyword extraction, named entity recognition, entity identification and linking (e.g. mentions of department, employees, projects ...), classification and more.

¹ <http://dokumentensuche.redlink.co>

The capabilities of the Redlink search rely on the correct extraction of the text, so the quality of OCR / ICR is central for scanned documents. Documents can be fully handwritten or have handwritten parts (e.g. annotations), (low quality) machine prints (including typewriter and prints of early dot matrix printers). Text formats and volumes range from single handwritten phrases on musical scores to layouted address information to long text in archival documents such as letters, register documents.

Redlink wants to support this with more cross-media extraction technology:

1. **Speech Music discrimination:** This allows to segment audio material based on whether it contains music, speech, music and speech combined, or silence. This is useful e.g. for royalty reporting purposes, but also to support content browsing and to improve subsequent analysis processes.
2. **Music annotation and similarity:** These components allow for an automatic extraction of metadata from music, e.g. tempo, mood, genre, and instrumentation, and support the analysis of musical similarity.
3. **Improve OCR extraction:** Reduce state-of-art open source OCR recognition failures by 50% to improve findability for documents on a page / paragraph / line level. Archived construction plans or medical charts with machine written names and address boxes need to be linked to legal entities or departments with a precision of 99,9%. The location of the respective “text boxes” is known in advance for each type of documents. The challenge here is to achieve this high precision despite a poor printing quality of the address parts of these documents due to the use of ink-jet printers or address stamps. The used language is standard german.
4. **Improve extraction of handwritten annotations on musical scores:** These notes are single phrases, which do not follow an exact horizontal orientation. As we cannot do this now with standard OCR software, a precision of more than 90% would be a metric to satisfy our clients. In addition to recognize such texts it is necessary to distinguish such occurrences from machine written texts on the same paper - so “adagio” could be a conductor's note or the composers intentional text. An optional requirement is to distinguish between different authors of such notes. The language used are domain terms as well as German, English or French.

It is a mandatory requirement for the Redlink use cases to get the current software as open source libraries before project start and to get the Alpha version of API compliant software no later than April 2017 of the project so that Redlink to has another 2 months of integration into the standard product to be available from June 2017 onwards to create showcases for our clients and to validate the improved cross-media extraction.

This early prototyping is also necessary to describe and validate commercial and technical risks which we face in integrating the software into our standard product. This includes the following questions:

- How many use cases can be covered without specifically training and learning a model?
- Our clients are typically in the KMU sector, so they do not have the computational resources available, which usually are needed for deep learning systems. At the same time, they will not provide documents in the cloud because of their business security restrictions.



Fraunhofer IDMT

General business model and exploitation interests

Fraunhofer IDMT's preferred business model and cooperation forms are:

- direct technology marketing of research results via licensing of software components and patents to commercial customers for integration, or indirect technology marketing via integration partners
- contractual R&D or subcontracting for requirement analysis and system design, prototype development, evaluation, and consulting
- collaborative and joint R&D in the aforementioned domains

We address R&D from an application perspective, and have a funding model that depends on a mix of public projects and industrial projects. This typically puts us in a "technology transfer and moderation" role between universities and industrial partners, and requires us to continuously refine the "appropriate mix" of research and scientific exploitation versus prototype development and commercial exploitation, a mix which differs among topics and over time.

We are interested in and depend on using and extending our technological know-how, contributing to beyond-state-of-the-art activities, and we have a strong interest in long-term cooperation with partners.

Exploitation perspective on MICO

Fraunhofer IDMT's primary R&D domains are in A/V extractor development and adaptation, and related security and privacy challenges. From its start, MICO has been a special project for us, because since many years, it is clear that many if not most practical applications including A/V analysis imply a need for multi-modal, fairly complex analysis workflows which often include the need for textual analysis. However, despite the fact that this is clear since long, there were no convincing solutions for the respective technological challenges, which include extractor integration, orchestration, and media-aware querying.

Similar projects in the past did not succeed, mostly due to one simple reason: Lack of investment from industrial partners, due to a classic free-rider situation: Everyone was waiting for others to make an initial investment (from which everyone would then benefit). On the other hand, public funding within this domain was also not easy to get. And finally, for the few occasions where public funding was available, the lack of agreeing on a balanced approach including an open-source core that allowed proprietary extensions prevented the long-term cooperation that would have been necessary to address this complex technology domain.

Because of this, we have always seen MICO as a great opportunity for long-term cooperations within this domain, and we knew that, beyond extractor development and adaptation, significant contributions from our side to the MICO open-source core platform would be necessary. Due to various reasons, this contribution turned out to be much bigger than originally planned, including also extractor orchestration (broker) and workflow management, and the C++ API for the platform, but we have not regretted to make this investment, and plan to continue work on what has been initialized with MICO beyond the project lifetime.

Finally, while also not originally planned, the personnel shifts within WP5 caused that Fraunhofer IDMT took over parts of the cross-media recommendation framework, which means

that a comparatively new but very promising research domain within our institute could be established.

Exploitable project outcomes / assets

Exploitable project outcomes and assets include:

1. first and foremost, a platform for multimodal analysis and search that can be used to integrate new extractors, which can be used for demonstration purposes, but also as a basis for commercial exploitation: Being an integrated prototype, it will of course be necessary to introduce substantial improvements, especially regarding stability, scalability, and content security in many cases. However, such adaptations are always necessary, and the platform is modular enough to allow for a respective flexibility in order to do that, and represents a substantial improvement over the status quo before the project.
2. broker and workflow management can be separated into two domains: On one hand, the broker, which is part of the core platform, necessary to orchestrate and execute workflows. On the other hand, workflow creation and management "extras" (workflow creation GUI etc.) from WP2, which have not originally planned for in the project and are provided with a freemium business model approach: The current version is provided as freeware, but future extensions may include commercial extensions, adapted and licensed for specific client needs.
3. as for the core platform, several of the new extractors developed by Fraunhofer IDMT in the project are provided as OSS, while other components have always been (and stay) proprietary components. For us, MICO did not lead to new extractors that could be exploited commercially, but after all, as outlined above, the goal was about providing a multi-modal analysis and search infrastructure, which simplifies the integration and exploitation of existing Fraunhofer IDMT background components, which is a satisfying goal by itself.
4. Fraunhofer IDMT build up and extended knowhow regarding related requirements, the overall architecture and platform, extractor integration (especially in the domain of integrating native C/C++ extractors, which is key for us), extractor orchestration and last but not least cross-media recommendation combining collaborative filtering and content-based approaches, which is a very promising field that we have already started to exploit in other projects.

Beyond the aforementioned results, MICO has also been an exercise in demonstrating internally at FHG that "a peaceful coexistence" of OSS and CSS approaches is possible.

Now, the goal is to exploit and extend the results of the project over the next years. We intend to make the following R&D offers to parties interested in MICO and MICO-related topics:

- multi-modal workflow creation and execution and broker usage
- Broker use and extension for specific customer needs
- own (FHG) extractor development, integration and licensing
- 3rd party extractor evaluation and integration
- recommender design, development/extension and evaluation
- platform support and extension regarding e.g. security aspects
- general technical consulting related to MICO topics

Apart from our individual interest, we are also optimistic that at least some of the partners will engage in a long-term cooperation in order to do this. The challenge, of course, will be to find further funding opportunities with industrial partners for concrete applications of the platform, ideally combined with publicly funded activities that allow to "complete" the more research-oriented adjacent challenges.

Exploitation activities

There have been numerous activities where exploitation of MICO results has been prepared and promoted, including many "normal" exploitation activities by Fraunhofer IDMT related to extractor development, where we spread the word about the MICO vision and platform. This includes:

- the poster presentation for MICO at ICME 2015, which beyond the scientific aspects included talks with potential industrial clients, including BBC and Disney
- several FHG-internal presentations on MICO, e.g. at "TechDays" in 2015 and 2016
- an informal presentation at NAB in March 2016 in Las Vegas, which included talks with RTBF, PerfectMemory, Apple and netflix representatives
- a MICO demo and presentation at IBC in September 2016 in Amsterdam, which included talks with Pro7Sat1, RTL, RBB, HR, arvato, memnon and EBU (see also <http://www.mico-project.eu/micoibc2016/>)

- a presentation at the Workshop for Digital Broadcasting in Erfurt, September 2016, which included an interesting discussion about possible cooperation with the NRK (see also <http://www.mico-project.eu/micowsdb2016/>)
- a plenary talk at the FIAT-IFTA conference in Warsaw in October 2016, where the topic of multi-modal analysis and MICO as project was presented, among other topics, resulting in talks with SRG, RAI, and other A/V Archives.

Beyond that, there have been activities related to bilateral cooperation among partners and partner spin-offs, including InsideOut10, Redlink, and Codemill, and investigations regarding further funding opportunities within H2020.

Zooniverse



Business model

Zooniverse is a research organisation which builds and hosts citizen science projects which allow volunteers to participate in data analysis across a wide range of disciplines. We rely on a variety of grant funding to build and maintain the platform, and seek to attract the broadest possible coalition of researchers who make use of our open source tools.

Expected benefits

One of our main resources is the time volunteers spend on our various projects. By using the MICO platform, we expect to simultaneously increase the amount of time volunteers spend on our site, as well as make use of their time more efficiently.

Using MICO recommendations we can suggest interesting things elsewhere on our site, which will keep volunteers engaged for longer. We can also use the recommendations to inform what we know about data that hasn't been fully classified yet, which means we can adjust probabilities (even if the MICO platform recommendations aren't a 100% reliable) so that we can retire subjects sooner.

Both of these benefits will ultimately mean citizen science projects will get through their datasets quicker, which in turn strengthens our position as the leading citizen science platform.

Tools and licenses

All recent Zooniverse code is publicly available under FOSS licenses. Whenever possible, we develop stand-alone libraries that others can reuse, and we contribute to other projects when they miss features we need. Zooniverse is maintaining a Ruby library for accessing the MICO Platform API under the Apache 2.0 license.

Individual exploitation plan

Technologies which aid classification efficiency are made available through the Zooniverse on a project by project basis. We will conduct an internal validation of the technology in its final form during the last quarter of 2016, using Snapshot Serengeti as a test case (See Deliverables D7.3.2). Assuming this validation shows that the cost of broadening the implementation of MICO to further projects is reasonable, these results will be shared initially our community of project builders. We focus particularly on ecology projects which are similar in nature to Snapshot Serengeti, as these projects produce large datasets which are particularly susceptible to improvement via the extractors which we have available.

Development of the Zooniverse platform to take advantage of technologies which enable classification efficiencies is currently supported by a grant (in Oxford) from the Science and Technology Facilities Council and in the US (Minnesota) by a grant from the National Science Foundation. This support will allow us to maintain institutional knowledge of the MICO platform for at least the next two years, and we will actively seek funding for further collaboration with several MICO partners.

Exploitation activities

MICO will be included in upcoming presentations to academic audiences who might use Zooniverse including:

- The Mammal Society (London): Annual meeting on studying mammal behaviour and distribution.

- dotAstronomy 2017 (Baltimore): This is the premiere conference for astrophysical research on the web.
- ESTRO (European Society for Radiotherapy & Oncology) 2017 (Vienna): An interdisciplinary conference for cancer treatment.

These more formal presentations coexist alongside informal presentations; we highlight in particular discussion of MICO at the recent Zooniverse Team Meeting in September 2016.

Academic partners

Umeå University

Business model

Umeå University (UMU) with its 36,700 students and over 4,200 employees is one of Sweden's largest providers of education, offering an attractive range of courses and programme. The university conducts research in many areas and disciplines, and is represented in the MICO project by the research group for the foundations of language processing. The group studies the theoretical and practical aspects of representing languages on computers. Its work spans from the theoretical analysis of formal languages as a theoretical basis for XML and linguistic applications to the practical implementation and evaluation of natural language interfaces.



Expected benefits

UMU benefits from the project both in the short term and in the long term. The initial reason why the UMU team chose to participate, was to learn more about multimodal data analysis, in particular the role of language analysis in a cross-media context. UMU also gains experience from enterprise-scale software development and practical aspects of data science. For UMU, MICO bridges the gap from theoretical research to practical application, provides inspiration to guide future efforts, and a useful testbed for evaluating new algorithms.

UMU will continue to work on the MICO platform after the official close of the project. The platform is equipped with a nice set of open source extractors, and can easily be extended to set up new experiments. Through the project, UMU learnt much about open source dissemination, and we will continue to contribute in this fashion.

Tools and licenses

The UMU team contributed to the LT extractors, and to a lesser degree to the broker. All of these components, with the exception of the Red Link software, are either already available or will be made available as open source.

Individual exploitation plan

For UMU, the central exploitable assets are (i) conference and journal publications, (ii) testbeds and data sets, and (iii) input to thesis projects and courses. The project also builds competence in the individual participating researchers, though this is more difficult to measure.

Conferences and journals

The main KPI is publications, and in this aspect the MICO project has been very rewarding. In addition to the previously reported publications, we aim for the following outputs during the final year of the project.

- International Conference on Implementation and Application of Automata
- Weighted Automata - Trends and Applications
- Interspeech
- European Intelligence and Security Informatics Conference
- Conference on data mining 1
- Conference on data mining 2
- Conference on Speech Recognition

Software and data sets

We continue to build on the MICO platform and evaluate new information-mining algorithms by implementing them as extractors in the framework. The datasets made available by Zooniverse is a valuable base for continued research.

Thesis projects

During the scope of the project, approx. 10 students will have written their Master theses on a MICO-related topic, and Yonas Demeke will present his licentiate in 2017 (and later PhD thesis).

Course work

Due to its modularity and flexibility, the MICO platform is useful for programming assignments, and is will likely be included in the department's new course of cross-media language analysis.

Outreach activities

- i. CodeMill, SME, system demo and engagement as exploitation partner, March 2015
- ii. Smart Video, SME, system demo and training, December 2015
- iii. Delbar, SME, system demo, May 2016
- iv. Vidispine, SME, system presentation, September 2016
- v. BBC R&D, project presentation, February 2014

University of Passau



Organization business model

Since opening its doors to the public in 1978, the University of Passau has quickly developed into a first address in German academia. Some 12,000 students and doctoral researchers from more than 90 countries are enrolled at the University of Passau.

The main focus of the participating chair of Professor Kosch is research and teaching related to Multimedia, Distributed, and Pervasive Secure Systems. Professor Kosch and his staff actively contribute to the ongoing W3C and MPEG standardisation efforts in the areas of metadata standardisation, efficient metadata encoding, adaptation of multimedia content, and web annotations.

MICO relevance in the current business model of the organization

As the University of Passau is a research institute, a commercial transfer or a business model in the context of the MICO project is not applicable. The use of the MICO platform for the University of Passau could be found in non-commercial exploitations like bachelor, master and PhD theses.

Licensing arrangements

The main contribution of the University of Passau to the MICO platform is Anno4j, a library to provide programmatic access to the W3C Web Annotation Data Model (formerly known as the

W3C Open Annotation Data Model), and the MICO Metadata Model. Anno4j is contributed to the open source community under Apache License Version 2.0 and the MICO Metadata Model documents under Creative Commons Attribution 3.0 License.

Exploitation Plan

In general, the University of Passau exploits project results in follow-up projects, bachelor, master, and PhD theses. Central exploitable assets are conference and journal publications. Commercial activities are not planned. Furthermore, the University of Passau focuses on research results and partial technical aspects. In the case of the MICO project, the University of Passau currently plans follow-up projects in the context of multimedia annotations and therefore will reuse project results like the MICO Metadata Model and the Anno4j library as implementation of the W3C Web Annotation Data Model specification.

Developer Community Engagement

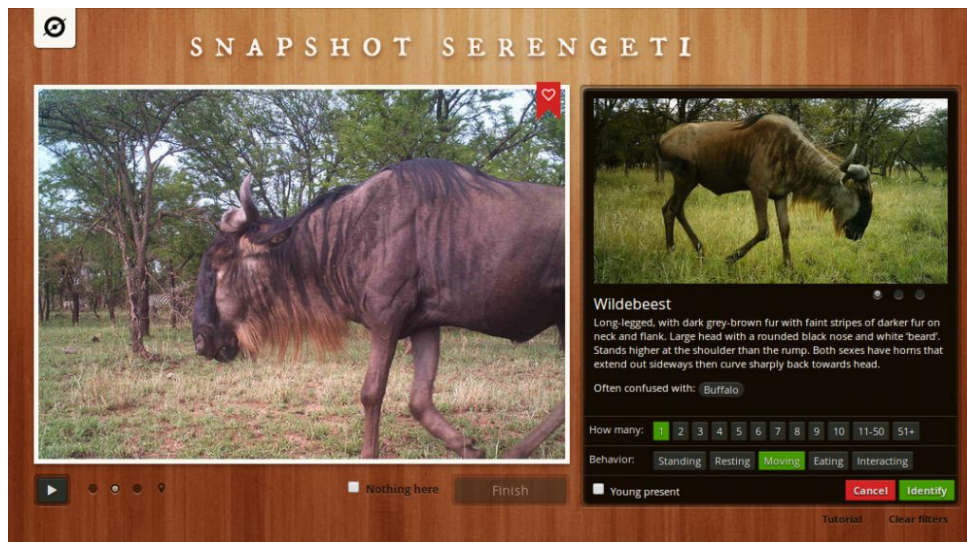
Current exploitation activities of the University of Passau also involve direct contact with developer communities. The W3C Web Annotation Working Group (see <https://www.w3.org/annotation/>) is aware of the Anno4j library and has enlisted it as reference implementation of their Web Annotation Data Model (see <https://www.w3.org/annotation/wiki/Implementations>). The WP3 staff has joined the Web Annotation Working Group's official public email discussion, in order to be part of the group's topics and be informed at first hand of upcoming changes.

MICO Showcases

This chapter discusses the various showcase applications developed in different domains by the MICO partners using MICO technology.

Zooniverse Serengeti Showcase

In order to test the MICO platform's abilities at detection of species and blank images through image analysis, and at sentiment analysis and Named Entity Recognition through textual analysis of discussion posts, Zooniverse built a showcase application. The application presents a number of tools for filtering down on certain sets of Snapshot Serengeti images. These filtered results can then be further explored by filtering according to what the MICO platform found. A specific image can be clicked to examine the MICO platform's findings; the results are shown on two tabs. The "Visual Analysis" tab shows highlighted regions that were detected by MICO – you can hover over these to link the data with the image regions. The "Text Analysis" tab shows discussion posts made by users about this image, along with any detected Entities and sentiment. Alongside both tabs, the crowd opinions for that image are shown so that quality can be examined.



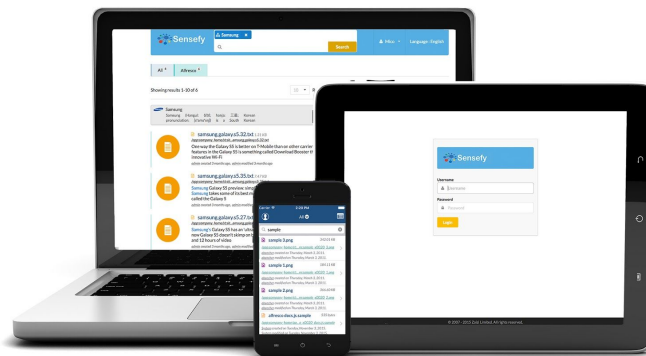
Cross Media Enterprise Search Showcase

With the increasing amount of multimedia content in organizations, it is increasingly becoming difficult to find certain media files for specific information needs. Current enterprise search solutions provide advance search features such as semantic search, navigated search for text based content. But for multimedia content, the same features are not provided in general due to lack of common models to perform semantic analysis in multimedia content. Zaizi aims to solve this problem of lack of cross media search features in enterprise search solutions.

The enterprise cross media search and recommendation use-case by Zaizi, aim to provide the end user the ability to perform a federated and semantic search across different media from heterogenous content repositories in the enterprise context.

The cross-media analysis, querying and recommendation functionalities provided by MICO adds context to media files to enable semantic search work seamlessly across all media in the enterprise (text, images, videos). This will unveil the hidden semantics in raw multimedia files to allow enterprise search users to get contextually relevant search results and related content recommendations across all media files in the enterprise content repositories.

Sensefy DEMO



Sensefy is the cross media semantic search framework developed by Zaizi. The product is focused on providing an intelligent search across all types of content in an enterprise at the user's fingertips. Integration of MICO with Sensefy enables powerful cross media search feature of the product. Sensefy can be useful for many industries such as the media & publishing, advertising, finance, law and medical sectors which require making sense of a lot of unstructured content (including text, video and audio) and finding the required documents efficiently.

Sensefy live demo can be accessed at [44].

- Username : mico
- Password : mico

For more details about Sensefy, please visit the Sensefy portfolio on MICO website here [39]. The screencast available there explains the intelligent cross media search features available in the product.

Potential clients

Sensefy product has been demonstrated as an intelligent federated enterprise search solution to several local potential clients including Hemas Holdings PLC. Further, several interested parties have inquired about Sensefy product during the demonstrations done at EDF 2016 and Semantics 2016 conferences.

Greenpeace News Showcase

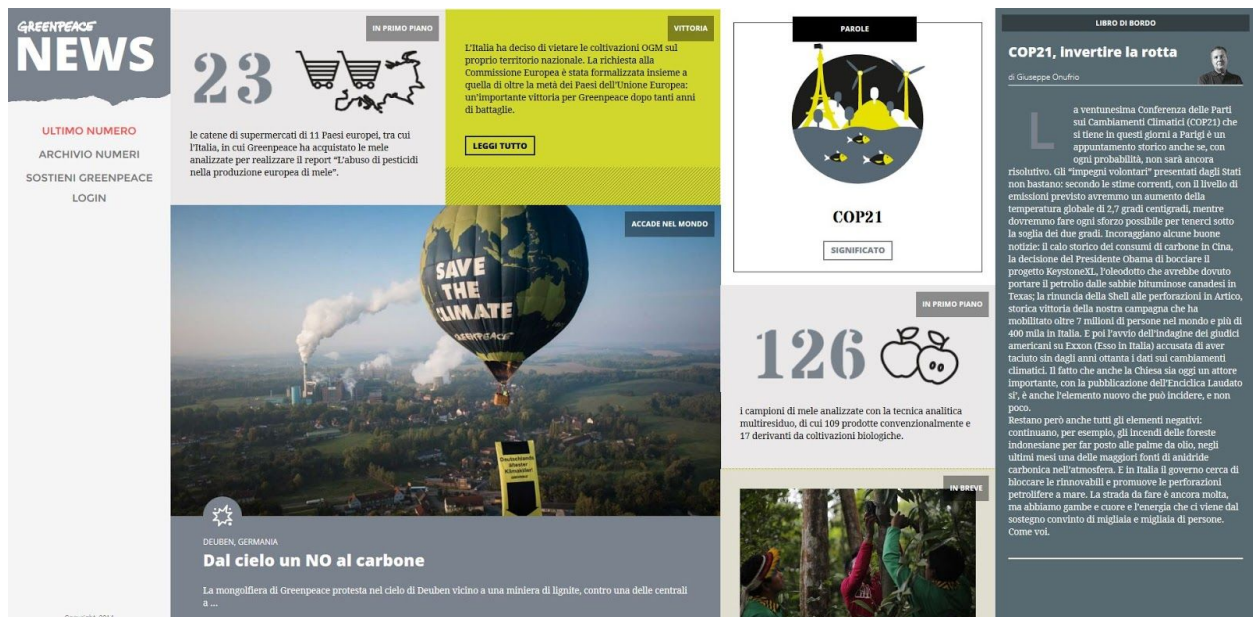
The massive amount of content being produced inside and outside the newsroom needs to be organized and curated to meet the evolving demands of the audience. Wordlift, HelixWare and MICO help journalists produce richer content and organize it around their audience.

The cross-media analysis, querying and recommendation functionalities provided by MICO play a crucial role for both readers and content creators. Integrating existing publishing workflows

and applications with MICO technology models extend readers dwell time with repurposing matching content and reduce the complexity of content management operations.

In other words MICO helps reducing the time spent by online editors for bolstering their media contents by creating a context, detecting quality issues for online videos and supporting the interlinking between different media assets whether in textual or visual form.

The News Showcase has been implemented with the support of Greenpeace Italy's editorial team for their news outlet Greenpeace Magazine [42].

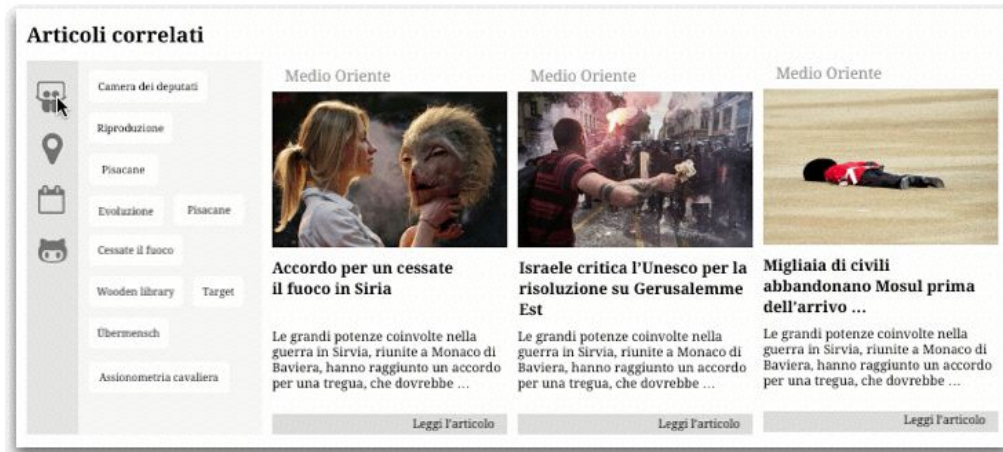


WordLift DEMO

WordLift is a semantic editor for WordPress to help writing, organizing, tagging and sharing content online. WordLift is designed for bloggers, journalists and content creators to inspire and make writing more productive.

WordLift adds semantic annotation and combines information publicly available as linked open data to support the editorial workflow by suggesting relevant information, images and links.

The integration with MICO enables powerful content analysis and cross media recommendations using the navigator and the faceted search widget: these modules are designed to help readers discover relevant content on the Greenpeace magazine.



The demo is live and accessible at the URL: magazine.greenpeace.it.

HelixWare DEMO

- HelixWare [41] is a next generation video hosting platform for digital media delivery to multiple screens, multiple devices and multiple formats.
- HelixWare has been designed to support web publishers in crafting online contents and share experiences with their readers.
- HelixWare comes with a WordPress plugin that integrates video hosting services within the publishing workflow of the CMS. Using the plugin the editor doesn't need to move away from the CMS interface.
- The demo of the front-end is live and accessible at the URL: test.helixware.tv [51].



The editors load the video in the WordPress media library, the video is ingested and encoded via HelixWare and set to MICO for the analysis. The chain being implemented in MICO uses the extractor for temporal video segmentation. HelixWare derives the information on the chapters of the video with a query to MICO executed via Anno4j and displays the segments as chapter markers within the timeslider of the player. As seen in [51] these markers work particularly well for long form videos, to segment it into discreet sections that the user can access with a single click.

Potential clients

WordLift and HelixWare target a large customer base of WordPress users. While there are over 60 million websites using WordPress. As our products require a paid membership, we restrict this market only to the websites that are monetizing their content and are therefore willing to pay for a service to optimize their business. We estimated this group as 5% of the total. This analysis leaves us with a potential market size of over 3 million websites worldwide that can benefit from this technologies.

Future integration plans

In the near future additional HelixWare and WordLift use cases are going to be addressed by exploiting other extractors of the MICO platform - e.g. keyword extraction, and audio-visual quality control.

Smart Video Showcase

Smart Video [50] was founded in 2015 as an affiliated company of Codemill AB. Smart video offers an adtech platform that increases online sales by supporting in-video purchases, programmatic video advertising, and automatically matching editorial video with relevant ads. The target audience is initially larger brands, publishers, and broadcasters, but the company expects to be able to service also smaller companies with restrained budgets in a few years' time. Smart Video has gained commercial traction and count Rapunzel of Sweden [48] and Komatsu Forest [49] among its first customers. The company is currently doing an A-round and are soliciting upwards of 500 000 Euro for continued development and marketing.

The MICO cross-media analysis is a key technological enabler for Smart Video. The overhead introduced by integrating the platform rather than calling extractors directly is motivated by the number and variety of extractos needed. In the data analysis, Smart Video uses both visual and audio analysis, and supports several languages and video formats. Smart Video is also benefitted by the well-designed metadata model and the ability to combine data modalities in the search and recommendation phase.



AudioTrust+ Showcase

The AudioTrust+ project was presented during the IBC 2016 at the MICO booth, as one of the new platform showcases.

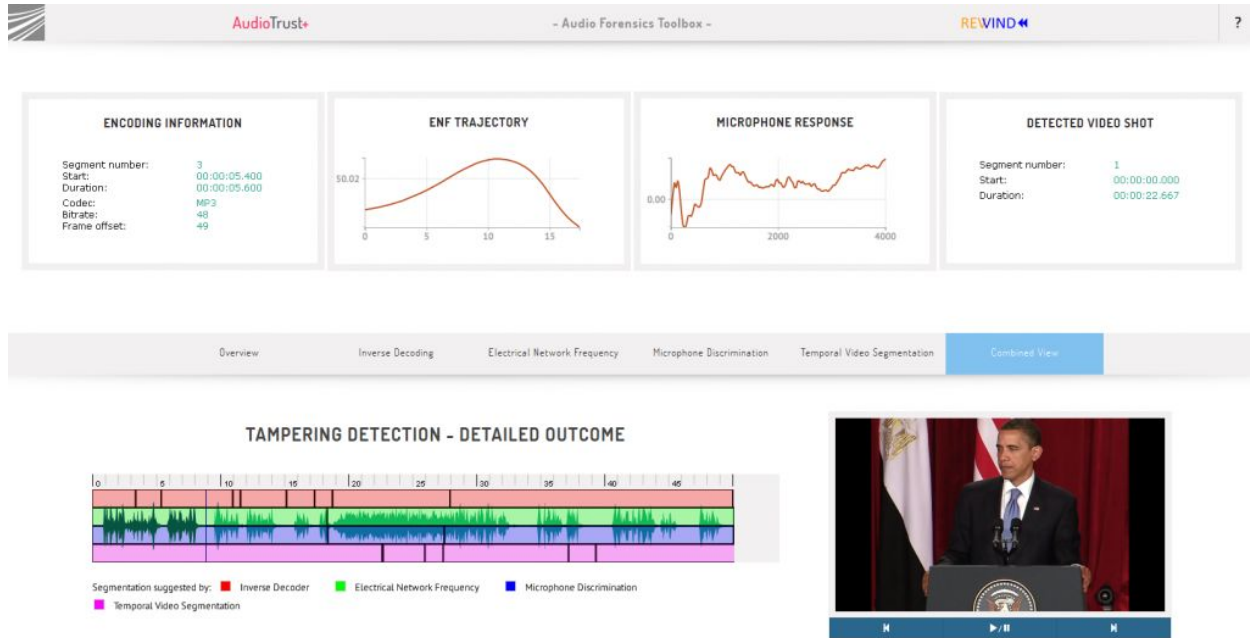
The goal of the AudioTrust+ project is to develop next-generation audio forensics components, which can be used for manipulation detection, quality assessment, content provenance analysis and data integrity assessment.

AudioTrust+ algorithms are very heterogeneous in terms of input/output formats, development language and sometimes also regarding hardware requirements, e.g. the need for a dedicated GPU. And a core element of the project is to exploit synergies among the heterogeneous algorithms developed by combining them into multi-modal workflows. Therefore, MICO platform was a natural choice to address the need for AudioTrust+ component integration, by means of:

1. The MICO Metadata Model, i.e., an easily-extensible RDF-based ontology for cross-media publishing
2. The MICO platform, i.e., a set of services that allows distributed analysis of multimedia content, secure storage, and RDF-based metadata publishing and querying
3. The MICO extractor C++ API and Java API, i.e., cross programming language APIs for the integration of customized services for media analysis

Multi-modal Tampering Detection demo

For IBC 2016, we integrated in the MICO platform three AudioTrust+ components for audio tampering detection developed in C++, that currently serve as a basis for a web-based integrated demo



We did not want to modify their APIs and hence decided to encapsulate them separately, in three different MICO C++ extractors. In order to transform their XML output into RDF, we decided to rely on a separate Java extractor component - following the "annotation helper" paradigm used to create the existing MICO pipelines -, which is only responsible for parsing the XML output, and writing the RDF annotations.

The great benefit deriving from the MICO platform for the showcase, in addition to the distributed processing and automatic content and metadata management, is related to the aggregation of the results coming from heterogeneous extractors. While in the demo web application the aggregation can be done only visually, by looking for corresponding segment boundaries in the "detailed outcome" window, thanks to the good usability of the MICO metadata model, we were able to obtain an aggregated, homogenous outcome where the identification of points where several components detected the presence of a tampering can be easily automated.

As an example, in the following table we highlighted the rows corresponding to such points:

Source Detector	Inconsistent Feature	Detection Timestamp
StableToneAnalysis	Phase	00:00:02.99
InverseDecoding	FrameOffset	00:00:03.40
StableToneAnalysis	Frequency	00:00:05.31
InverseDecoding	FrameOffset	00:00:05.40
InverseDecoding	FrameOffset	00:00:11.00
InverseDecoding	FrameOffset	00:00:11.80
StableToneAnalysis	Frequency	00:00:13.28
InverseDecoding	FrameOffset	00:00:15.20
StableToneAnalysis	Phase	00:00:15.27
InverseDecoding	FrameOffset	00:00:17.40
MicrophoneDiscrimination	CorrelationCoefficient	00:00:18.75
InverseDecoding	FrameOffset	00:00:18.80
StableToneAnalysis	Phase	00:00:22.57
StableToneAnalysis	Frequency	00:00:23.90
InverseDecoding	FrameOffset	00:00:28.00
MicrophoneDiscrimination	CorrelationCoefficient	00:00:29.50

StableToneAnalysis	Frequency	00:00:29.54
StableToneAnalysis	Phase	00:00:39.17
MicrophoneDiscrimination	CorrelationCoefficient	00:00:50.11

Future integration plans

In the near future additional AudioTrust+ use cases are going to be addressed by exploiting the potential of the MICO platform - e.g. audio phylogeny, and audio visual segment matching: These approaches have many synergies and could hence greatly benefit from a multi-modal analysis platform such as the one proposed by the MICO project.

Targeted Business Value

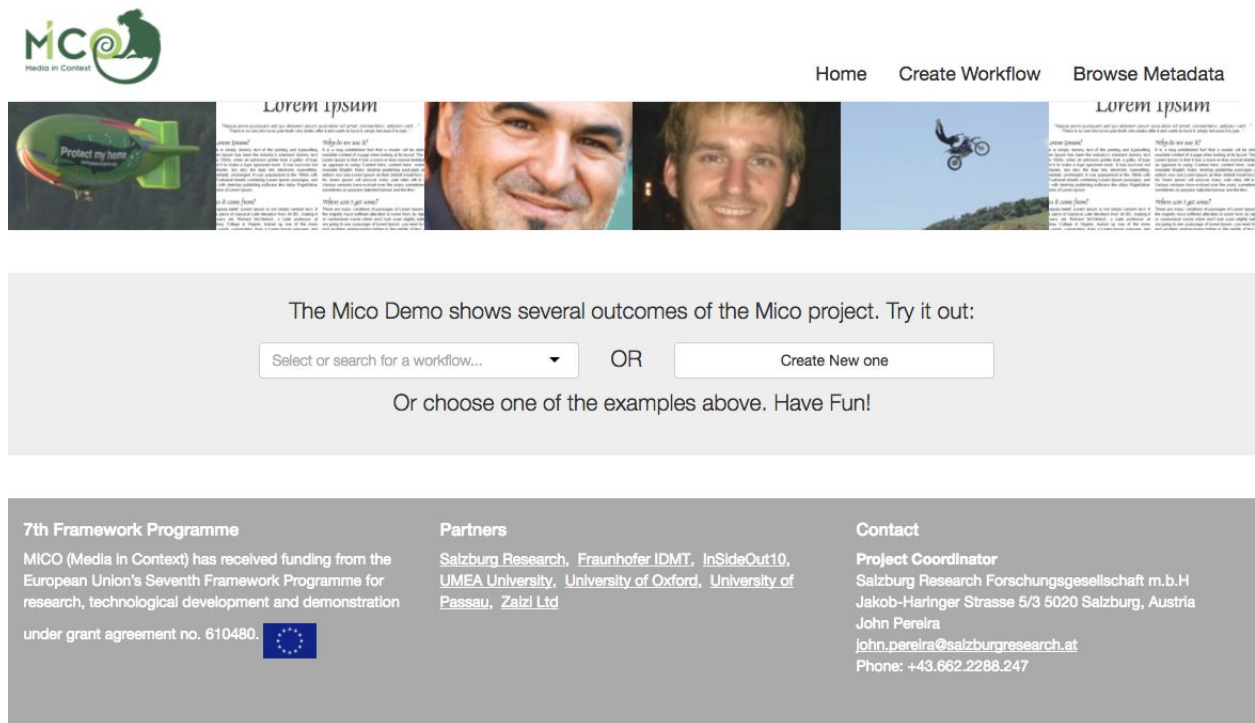
We believe that from a business perspective, the use of editing detection and future integration of segment matching and phylogeny into the MICO platform would provide substantial business value, especially for A/V archive users: It would allow them to have metadata tracking (automatic propagation of metadata for fully or partially reused content within a system) and repository cleanup (detection and removal of redundancies) on top of multi-modal automatic annotation, creating an attractive package. FHG is very interested in continuing work in this domain. However, additional investments / follow-up projects will be necessary to achieve that goal.

MICO Platform Showcase

In this demo you can create/select and test analysis pipelines You can select sample media assets or upload custom media files including image, video, audio and text. When analysis is done, you can watch the results on type specific result pages or get deeper into the generated metadata via using generic annotation views and/or issue SPARQL queries. The demo is purely frontend based and uses the standard MICO platform services. It is designed to demonstrate MICO technology in web-friendly way. Hint: The demo is a (as the name says) a demonstrator and thus not exhaustively tested with the big set of all existing browsers. It works best with Chrome browser.

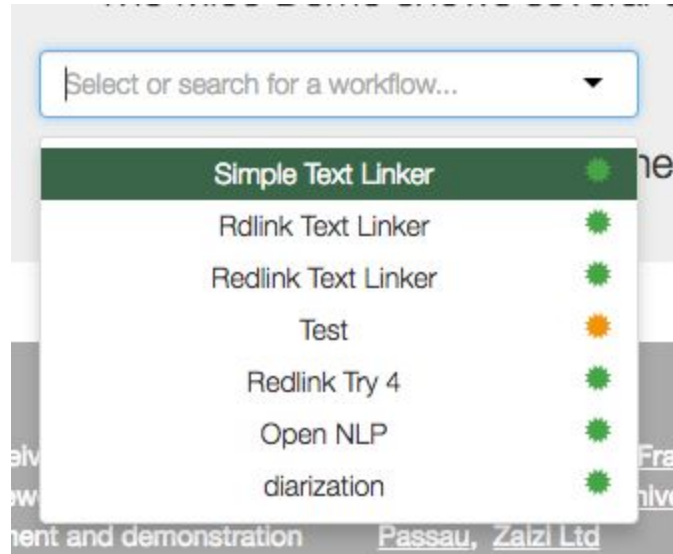
Main Page

The central page of the demo includes links to main demo parts on the top. A list of various prepared demo assets (including images, video, text and audio samples) give users an easy entrypoint without the hurdle of a private asset upload. A click on the demo thumbnails redirects to the regarding result presentation immediately. In the center of the page the users can select from various predefined workflows. Additionally they can create a new one (which leads them to the workflow management section).



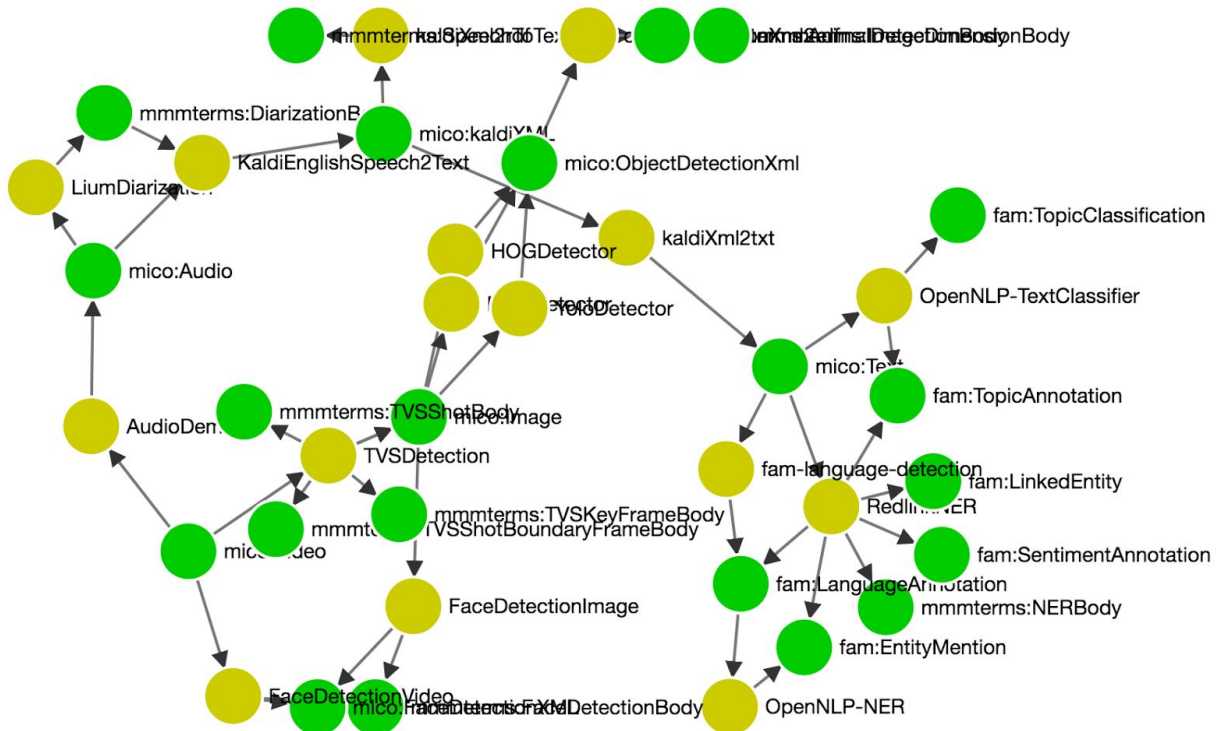
Workflow Selection

The selection of a workflow defines, which data can be ingested by the user. In the public demo, several workflows including image, video, text and audio processing are predefined. The current status of workflow is indicated by a color schema, whereby green denotes *okay*, orange denotes *temporarily unavailable*, and red means *broken*. The workflow status is depended on status of the applied extractor components.

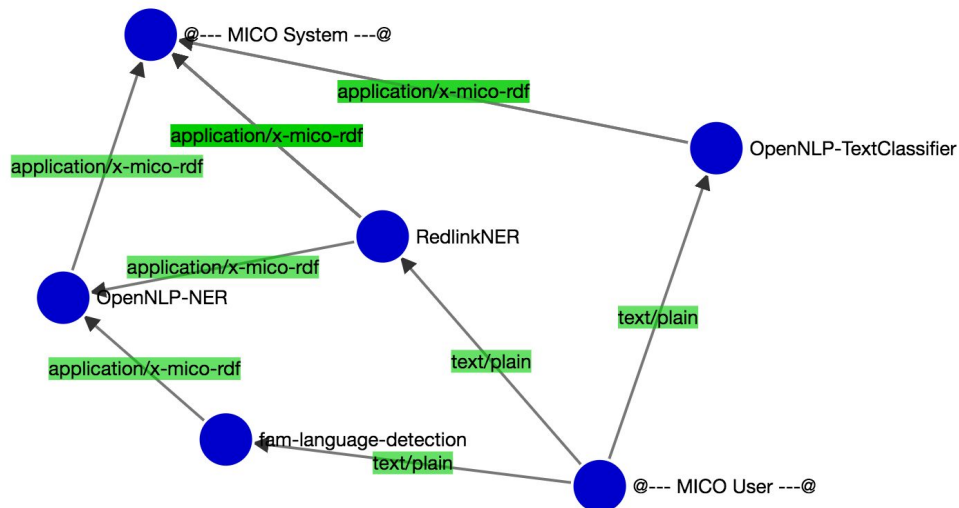


Workflow Creation

The demo allows the maintenance of existing and the creation of new workflows. Thereby the demo integrates the Workflow Management App, which is build on top of a Spring Application that provides Restful a set of task specific web services. The UI gives users an overview of all extractors and its interplay by a dependency graph visualization.



The workflow creation is enabled by a straightforward extractor selection process (by selecting and unselecting extractor components). Analogous to the extractor overview, the created workflows are visualized as a graph, which allows a) a what you see is what you get (WYSIWYG) experience during the creation process and b) a immediate overview on input and output values and assets.

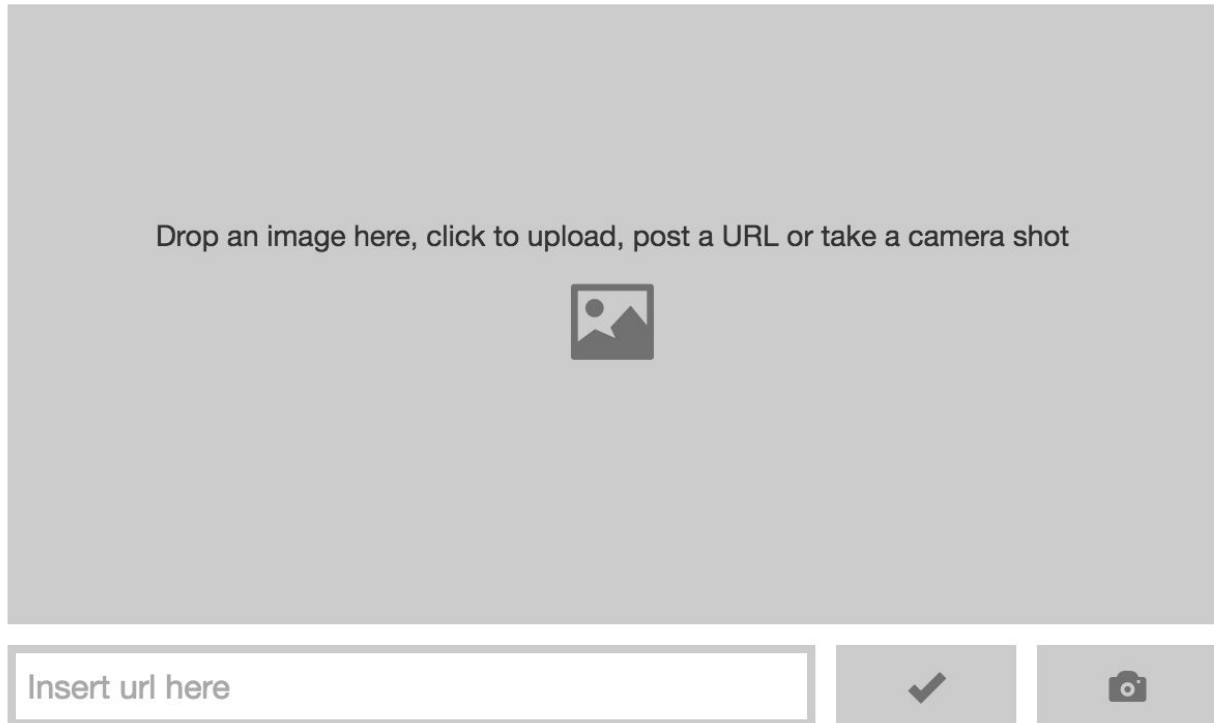


Data Ingest

The ingestion UI is aligned with the selected workflow. Thus, there currently exist 5 different ingest UIs:

- The **Image Ingest** allows to push images to the system by providing an URL, by drag and drop desktop images, by common file system selection and by using an onboard webcam to take a picture.
- The **Text Ingest** allows drag and drop, file select and input by using a textarea.
- The **Video/Audio Ingest** provides drag and drop and file select. To overcome the issue that audio and video processing may take a while (depending on asset size) the UI also enables process notification by email.
- As MICO workflows support multi asset as well as multi content type processing a **Mixed Ingest UI** allows the upload of multiple files within one step

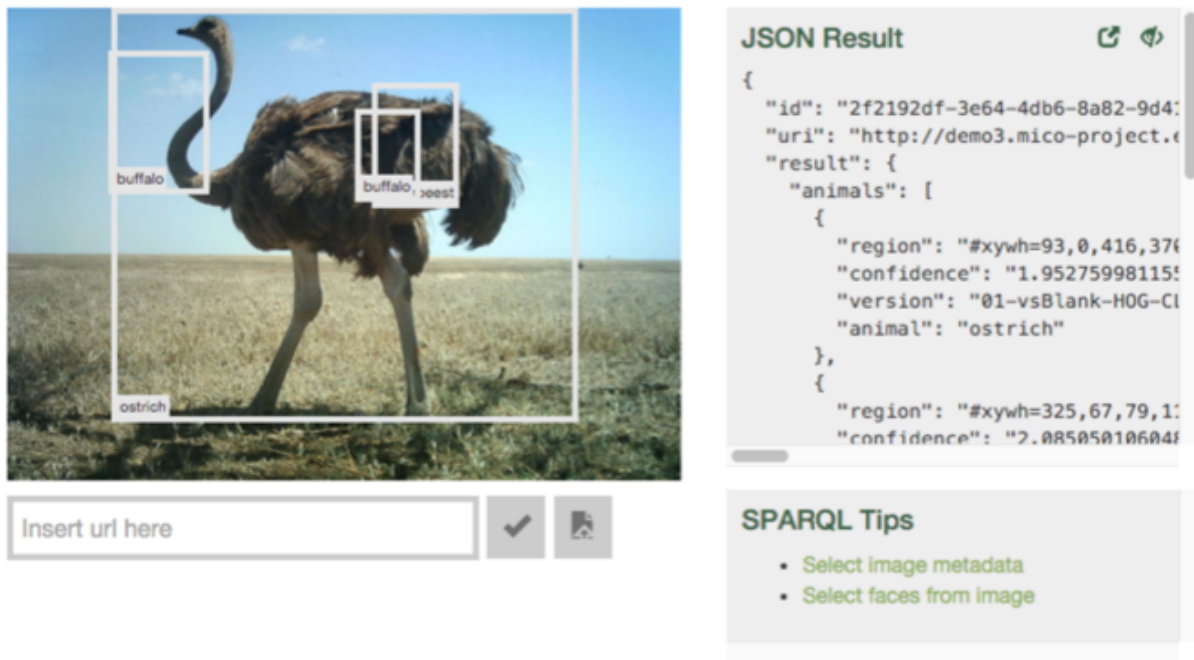
In order to get an impression of the ingest UI we added a screenshot of the of the Image Ingest Interface.



Result Display

MICO produces a bunch of metadata and assets during workflow execution. To enable users, which are not yet familiar with RDF and MICO specific ontologies to get an overview on the results that have been created, the demo supports the display of several result types in a well known manner. Such displays are for example:

- Image Media Fragments are displayed as rectangular shapes
- Video Fragments are displayed via keyframes
- Recognized Entities in text are displayed by as colorization and popups
- Video subtitles are displayed under the regarding video and are aligned to the current video timestamp
- Recognized Entities are displayed together with metadata within type specific information boxes



The screenshot displays a web interface for image recognition. On the left, an image of an ostrich in a field is shown with bounding boxes and labels: 'buffalo' on the neck, 'ostrich' on the body, and another 'buffalo' label on the head. Below the image is a text input field labeled 'Insert url here' with a checkmark and a refresh icon. On the right, a 'JSON Result' panel shows the following data:

```

{
  "id": "2f2192df-3e64-4db6-8a82-9d4:",
  "uri": "http://demo3.mico-project.c",
  "result": {
    "animals": [
      {
        "region": "#xywh=93,0,416,376",
        "confidence": "1.952759981159",
        "version": "01-vsBlank-HOG-CL",
        "animal": "ostrich"
      },
      {
        "region": "#xywh=325,67,79,1:",
        "confidence": "2.085050106048"
      }
    ]
  }
}

```

Below the JSON result is a 'SPARQL Tips' panel with the following suggestions:

- Select image metadata
- Select faces from image

The list of type specific displays is not fixed and may be adapted and extended with new extractor types.

SPARQL Endpoint

SPARQL is a powerful query language with a syntax that is aligned to common query languages like SQL. Nevertheless, SPARQL query building can be a complex task because the language is not yet widely used and deals a lot with URLs, which can be confusing to new users. In order to lower the barrier for SPARQL query writing we developed Squebi², a clean SPARQL UI which supports:

- customization of SPARQL result visualization
- support for SPARQL 1.1 (update and select)
- bookmarkable uris that define queries and the visualization type
- support for SPARQL query editing
 - Auto-creation of URIs prefixes
 - Autocompletion for well known ontologies

The demo integrated Squebi and provides the user additionally with many generic as well as workflow specific examples.

² <https://github.com/tkurz/squebi>

[Get examples!](#)

```
1 SELECT * WHERE {  
2   ?subject ?property ?object  
3 } LIMIT 20
```

➤ Run

[Table](#) [JSON](#) [XML](#)



Rows 1 to 10 of overall 20



subject	property	object
http://demo3.mico-project.eu:8080/marmotta	http://www.w3.org/ns/ldp#contains	http://demo3.mico-project.eu:8080/marmotta/3dd2da82-7e84-4e86-8f9b-c29cfa0167d0

Industry events and trade fairs

ICIIT 2016

International Conference on Innovations in Infobusiness and Technology (ICIIT) 2016 was held on 4th March 2016 in Ozo Colombo. The conference was organised by IEEE Student Branch of Informatics Institute of Technology (IIT). The conference was technically sponsored by the E-learning and Technical Communication ACM Professional Chapter – Japan Section.

The theme for the conference is “Emerging Tech Trends for Smart Digital Business”. The keynote speakers, Professor Debopriyo Roy and Professor Keitaro Naruse were from University of Aizu, Japan.

The conference included both industrial and academic presentations. Industrial presentations session was focused on disseminating and exchanging knowledge on ongoing industry research in computing. Leading software companies in Sri Lanka such as Virtusa, Pearson, 99X Technology, Headstart and Informatics International Ltd. presented their research.

From MICO side, Zaizi presented industrial presentations session on “Intelligent Enterprise Cross media Search” which is an use case of MICO platform. Further, we have demonstrated the MICO platform, core technologies used and other use cases as well.



EDF 2016

The European Data Forum (EDF) is one of the key European events for industry professionals, researchers, policy makers, and members of community initiatives to discuss the challenges and opportunities of data-driven innovation in Europe. The Forum aimed address all facets of data-driven innovation: infrastructure, tools, applications (including, new products and services reaching out to multilingual European audiences) as well as societal and economic impact.

EDF 2016 was successfully held on June 29-30th at the Evoluon, Eindhoven in the Netherlands. With this years theme of 'Scaling up the European data economy', the conference had many insightful keynotes and sessions by industry & technology leaders in the European data driven economy.

MICO was a gold sponsor of this year's conference and participated the exhibition at the conference with a MICO booth. Among other EU funded research projects including Big Data Europe, FERARI, LeanBigData, Streamline and Timon, MICO team presented the project, showcasing the platform and the use-cases of the powerful cross media analysis features of MICO.



Semantics 2016

Semantics is an annual conference which is intended to bring together expertise in the field of semantic computing from all over the world to discuss and share knowledge. The 12th conference on semantic systems (SEMANTICS 2016) was held on September 12th-15th at University of Leipzig, Germany. Conference was a very successful event with over 200 participants including researchers, information architects, engineers and students from organisations ranging from NPOs, universities, public administrations to the largest companies in the world attending the conference. Oxford University Press, Springer Nature, Siemens, IBM, Wikidata and Hasso Plattner Institute delivered keynote presentations.

MICO project was one of the gold sponsors for the conference. Zaizi and InsideOut10 were at the conference representing MICO project. In the poster track and the industry track of the conference, Zaizi presented on the topic “Cross Media Concept and Entity Driven Search for Enterprise” in which we introduced “Sensefy” as an open source federated cross media search solution. Andrea Volpini from InsideOut10 presented “Reimagining news blogging with linked data publishing” in which he introduced “WordLift” a semantic plugin for WordPress.



IBC 2016



MICO was presented at IBC 20106 (Sep 9-13) with a demo at the Fraunhofer IDMT booth. Our demo setup included:

- Intro slides, presenting the relevance and challenges of multi-modal, context-aware analysis and semantic search
- Slides and screen-casts for the individual MICO showcases, provided by
 - University of Oxford, on Zooniverse and the Snapshot Serengeti project
 - InSideOut10, with an introduction to Helixware and Shoof
 - Umeå University, presenting the SmartVideo application
 - Fraunhofer IDMT, demonstrating the AudioTrust+ R&D project
- A running instance of the MICO platform equipped with
 - The MICO workflow creation web application
 - A live demo of a MICO workflow execution
 - A few pre-defined MICO workflows
 - A live demo of the AudioTrust+ audio tampering detection workflow and SPARQL query of the MICO metadata model, and of the respective existing AudioTrust+ tampering detection front-end
 - Several live demos of AudioTrust+ use cases that are going to be included into MICO in the near future, including audio segment matching and audio phylogeny:

All these approaches have many synergies and hence can benefit greatly from a multi-modal analysis platforms such as MICO

Considering that the demo was about an integrated prototype from a EU project (while most visitors tend to be focused on ready-to-use-products), we were very happy about 30+ organizations visiting us at the booth, including e.g. A1 (AT), Ericsson (SE), Slovak Film Institute (SK), scisys (DE), O2 (CZ), Ministry for ICT (KR), RTL (DE), Pro7Sat1 (DE), valossa (FI), Beeld & Geluid (NL), netflix (US), arvato (DE), RBB (DE), HR (DE), Memnon (BE), EBU, and many others.

General feedback from visitors

Regarding individual topics, visitors tended to be most interested in

- the overall MICO idea and architecture
- individual extractors
- MICO showcases, especially in AudioTrust+ (Fraunhofer IDMT) and in cloud aspects (InsideOut10)

From discussions at the booth, broadcasters did not yet have solutions in place for multi-/cross-modal and context-aware multimedia analysis, semantic search and recommendation. Many of them, however, were fully aware that this will be a key question, especially for archives, and that they need to make strategic decisions about this in the very near future. Therefore, they were interested in how MICO dealt with the respective technical challenges, and what our position regarding follow-up projects was.

The fact that the MICO platform is an integrated prototype which needs to be significantly extended did not surprise visitors: They did not expect a ready-to-buy product, but were all the more interested in how they could be addressed after the project lifetime. Topics for improvements that came up during discussions included e.g.

- integration of additional "key extractors" for various application domains
- platform stability, scalability, and security aspects
- further integration of user feedback and user interaction

- training of extractors by users
- PaaS aspects (including specific security requirements)
- testing and quantitative evaluation not only of single extractors, but also of integrated workflows

There was positive feedback especially to the following MICO domains:

- Simplified extractor integration and C++ support (those who had experience in this domain were fully aware of the related complexities)
- Complex, dynamic workflow support and related workflow creation; visitors made minor suggestions, and some of them have already been integrated into the app after IBC
- Media-aware querying using SPARQL-MM, almost always combined with the question on how the complexity of SPARQL could be taken away from the user with templates and dedicated API and integrating natural language query approaches
- The MICO metadata model and in general the semantic web based approach, which was welcomed by many visitors, almost always combined with ideas on how scalability issues could be addressed, and a few visitors explaining which Triple Store they have investigated or used for this purpose
- Cross-media recommendation, which was considered the most interesting "enabler" by several of the visitors

The fact that the MICO core is available under a business-friendly Apache license, and that the overall approach is aiming at combining OSS and CSS extractors, was very useful for these discussions.

Feedback regarding extractors and extraction

Almost all visitors were aware of the potential of using automatic extraction (especially those from the archive domain). However, many had only limited practical experience with automatic extraction so far, and in almost all cases, things seem to start with Automatic Speech Recognition (ASR) and Named Entity Recognition (NER). Consequently, questions related to ASR and NER such as the following emerged frequently:

- Which OSS and CSS solutions and services for ASR exist, and how well do they work?
- How well does Kaldi ASR perform? How can it be extended with new language models?

- How can Kaldi ASR be used for keyword search? How can customized NER vocabularies be supported?

After the exhibition, we decided that this should be addressed with an additional ASR / NER report.

Regarding A/V extraction, requests were mostly related to person identification, i.e. face detection / recognition, and speaker discrimination / recognition. Beyond that, there seems to be a general interest to be informed what is technically possible audio and visual analysis possibilities - several visitors claimed that it is very difficult to keep an oversight over this.

When asked about overall needs regarding extraction, not surprisingly, most visitors indicated a strong interest in extractors suitable for the detection of persons, locations, events and objects. Moreover, it seems clear that there are many cases where detection should not only be based on general concepts, but should also support custom vocabularies and user training. This also goes for the detection of semantic concepts - a discussion which almost always included the notion of CNN and deep learning approaches.

Feedback regarding MICO showcases and tools

Finally, there was also a lot of interest in individual showcases, regarding

- The idea of cloud-based extraction as implemented by Insideout10 using Helixware and more general, the idea of cloud-based services based on MICO ideas and the MICO platform. Several visitors indicated that such approaches could be interesting for them, but that security concerns need to be taken care of.
- The idea of how an analysis framework such as MICO can be used in combination with crowdsourcing, which can be nicely illustrated with Snapshot Serengeti from Zooniverse. From the discussions, it was clear that a tight (and customized for specific workflows) integration of automatic annotation and user interaction is important.
- Object detection within SmartVideo, on the idea of using object detection to recognize products in video, and applying key word extraction to find product names and categories. Product and logo recognition was a relevant topic for several visitors.

- The usefulness of Fraunhofer IDMT's AudioTrust+ showcase and related audio forensics extractors for archive, news production and monitoring purposes was discussed with many visitors, regarding:
- Audio tampering detection, which can support decisions regarding the authenticity and reliability of user-generated content, or to annotate undocumented editing steps made during production
- Inverse decoding and double coding detection, which can be used to avoid quality loss due to unintended processing of previously encoded material, or to optimize transcoding
- Microphone classification, which can be used to automatically tag / classify archive material
- Audio and video segment matching from AudioTrust+, which can be used to detect redundant items and segments, track metadata throughout a system, and find items which reuse the same original material, often because they refer to the same event (this is not yet included in the MICO back-end, but planned to be integrated in the future). Such functionalities were considered useful by many visitors, especially those with an archive background.
- Audio phylogeny from AudioTrust+, which can be used to establish the "processing history" for transcoded copies of the same item, and to differentiate between original and derived versions of the same item (this is not yet included in the MICO back-end, but planned to be integrated in the future). This was discussed mostly together with the above, segment matching.

The feedback from visitors confirmed that the intended use cases were relevant - we now need to make sure that the activities in all these domains will be continued.

Summary

In summary, IBC proved to be a fruitful event for MICO and our intentions to follow up on the MICO activities. Beyond the many R&D aspects involved, it also became clear that there is a demand regarding consulting interested organizations in their decisions regarding (multi-modal) automatic metadata extraction and related aspects.

As for general requests regarding the MICO platform, we told all interested visitors that the best time to follow up and to download and try will be in November/December. We promised to provide and update via e-mail by then.

FIAT/IFTA 2016

Fraunhofer IDMT was invited for an archive-technology panel at the FIAT/IFTA World Conference 2016 in Warsaw (Oct 14-15).



The event included many interesting sessions with relevance for automatic metadata extraction and MICO aspects:

On Oct 14, there were interactive sessions on **next-generation MAM**, which highlighted e.g. the need for automatic metadata extraction, semantic search and decentralized infrastructure, and also on **cloud aspects for A/V archives**, in which it became clear that security and data protection issues are key obstacles for A/V archive usage of cloud storage and processing.

Later on the same day, there were several presentations by A/V archives regarding the use of **automatic metadata extraction** which confirmed that major goals of automatic metadata extraction in this domain are the detection of persons, locations, subject, and segments, and

that automatic extraction typically starts with the use of ASR, NER, face and speaker recognition. It also became clear that in order to support concrete archive workflows, it does not suffice to integrate technologies of the shelf, but that the key is to combine different extractors and to complement them with manual annotation to address the (often very specific) requirements of an individual workflow to be supported.

Another presentation demonstrated the use of **statistical analysis to find anomalies in metadata**, to speed up metadata curation and troubleshooting, and to predict effects of changing metadata structures.

On Oct 15, the event included a **panel chaired by the SRG SSR**, which we were invited to. It included discussions on

- the growing importance of recommendation, the need for semantic linking and the possibilities of using MPEG-21 UDI for standardization by *RAI*
- an introduction and demonstration of applying deep learning for visual classification by *4Quant*
- multi-modal annotation and related challenges by *Fraunhofer IDMT*, including a presentation of the MICO project

This panel was especially interesting in that it evolved into a discussion on why such technologies, despite having great potential for A/V archives, are not yet commonly applied within the domain. Judging from this discussion, main obstacles include

- the need to address data protection issues to exploit recommendation based on collaborative filtering
- the need to combine automatic extraction with manual metadata in a reasonable way, customized to the specific needs of a use case
- the challenge that automatic extraction is considered a challenge and even a threat by some archivists, and that its benefits (and limitations, which will always require a "human in the loop") need to be explained better
- the challenge to not to put too high expectations into extraction - for instance, even ASR extractors which are far from working "perfectly" can be used as a support tool to speed up manual annotation, or to support keyword search

- the need to provide extractors with modular, service-based approaches based on OAIS
- the need to allow archivists to train extractors, based on their own data
- the challenge that long-term cooperation in this domain are required, but that startups cannot always provide that long-term perspective
- the challenge that archivists and technologies have different perspectives, and should communicate more, which helps both sides

All in all, it was a very interesting event in which many MICO-related issues came up, which has resulted in several ongoing follow-up discussions with A/V archives.

Impact Key Performance Indicators

The overall scientific and technological objective of the MICO project is to develop models, standards and software tools to jointly analyse, query and retrieve information out of connected and related media objects.

Below are the KPIs defined for MICO project in different impact areas including research, open source/content, technology and industry.

Research KPIs

Impact Metric	Results
Research papers published	49 (see listing on https://docs.google.com/spreadsheets/d/1Sm_oJDZ7SUcGT8qstWVckUIPBbPCy0UviMrr9Ln7EvvY/edit#gid=1529745152 on tab Scientific Output)
Journal articles	5 (same listing)
Research Conferences	44 (same listing)
Research Masters and Phd Theses	<p>PhD theses at UMU:</p> <p>N. Zechner, <i>Text classification</i>, est. May 2017</p> <p>Y. Woldemariam, <i>Architectures for Cross-Media Language Analysis</i>, est. 2018</p> <p>Master theses at UMU:</p> <p>O. Wiklund, Face recognition, 2014</p> <p>P. Larsson, Interactive learning of NL queries, 2014</p> <p>M. Karlsson, Authorship attribution, 2015</p> <p>F. Leiding, Motion tracking, 2015</p>

	<p>F. Modig, Distributed analysis, 2015 D. Karlsson, Sports classification, 2016 S. Ågren, Object tracking, 2016 A. Jonsson, Semantic analysis, 2016</p> <p>PhD theses at SRFG: Siegfried Reich <i>Adapting Semantic Web Information Retrieval to Multimedia</i>, est. March 2017</p> <p>PhD theses at UP: Harald Kosch <i>Adapting Semantic Web Information Retrieval to Multimedia</i>, est. March 2017</p> <p>PhD thesis at FHG: T. Köllmer, <i>Combining CF and Content-Based Recommendation for the Multimedia domain</i>, est. Winter 2018</p> <p>PhD thesis at FHG: L. Cuccovillo, <i>Multi-modal Tampering Detection</i>, est. Winter 2017</p>
<p>Use of MICO technology in research projects</p>	<p>Zooniverse Snapshot Serengeti project uses MICO for recommendations of relevant content to the volunteers</p> <p>UMU use MICO for research on Sentiment analysis</p> <p>FHG uses MICO for AudioTrust+</p>

Open Source/Content KPIs

Impact Metric	Results
New open source projects	<p>Anno4j : https://github.com/anno4j/anno4j (Apache 2 License)</p> <p>MICO Java Client : https://github.com/zaizi/mico-client (Apache 2 License)</p> <p>MICO Platform : https://bitbucket.org/mico-project/platform/ (Apache 2 License)</p> <p>Many MICO extractors are released under open source licenses</p>
Contributions to existing open source projects	<p>Contributions to Apache Marmotta by integrating GeoSPARQL standard from the Open Geospatial Consortium (acknowledged : http://marmotta.apache.org/acknowledgements.html)</p>
Visibility of the project information to the public	<p>MICO site contains all the public information about MICO project : http://www.mico-project.eu</p> <p>A comprehensive documentation of MICO can be seen here :</p>

	http://www.mico-project.eu/pages/documentation/
Community discussions	<p>MICO forum to discuss project related topics : http://www.mico-project.eu/community-forum/</p> <p>MICO FAQ to provide answers to common user questions : http://www.mico-project.eu/pages/faq-2/</p>

Technology KPIs

Impact Metric	Results
WWW Standards and Models	<p>MICO Metadata model</p> <p>SPARQL-MM</p> <p>Media Fragment URI Extension</p>
Ease of Installation	<p>Pre-configured Virtual Machine Image of the MICO platform is available for easy installation</p> <p>An easy to use Installation Guide is available at : http://www.mico-project.eu/pages/documentation/#cat-2</p>

Industrial KPIs

Impact Metric	Results
<p>Use of MICO technology in commercial products</p>	<p>MICO as a framework caters for SMEs in the domains of multimedia and content publishing by offering a cost effective framework for media content analysis. Following are several SMEs who have already integrated MICO in their products.</p> <ul style="list-style-type: none"> ● Zaizi Sensefy Cross Media Search ● CodeMill AB ● Smart Video Nordic AB ● InsideOut10 GreenPeace project ● Fraunhofer AudioTrust+
<p>Related industrial projects</p>	<p>Following are several european projects that use Anno4j project internally for metadata annotation purposes.</p> <p>EExcess [45]: Anno4j is used and extended with a server component.</p> <p>LifeWatchGreece [46] : Anno4j is used to provide an annotation service for annotating morphological characteristics of fish species using the polytraits database.</p>

Conclusions and future work

This deliverable aims to define an exploitation plan for the MICO project with a plan for strategic actions required to deliver a sustainable business strategy for MICO at the end of the project. MICO as a platform is primarily targeted for SMEs in multimedia and content publishing industry as a cost effective solution for their content analysis requirements. This document analyses the target markets and competitive products for MICO, analyses the strengths and weaknesses of MICO in comparison to other products and formulates an offering strategy for MICO for potential commercial exploitations.

The exploitation strategies focus on commercial exploitation opportunities by SMEs who have multimedia and content analysis requirements. The business strategy for MICO relies on the individual exploitation plans of the MICO partners and their common exploitation strategy for MICO as a platform. Several MICO partners being SMEs in the multimedia and content publishing industries including Zaizi, InsideOut10 and CodeMill AB have already incorporated MICO as a component in their commercial product roadmaps. Smart Video Nordic AB is a new startup company which has incorporated MICO in the center of their product strategy, showing the potential of MICO for new spin-offs and SMEs in the multimedia industry.

This deliverable also discusses how MICO has made significant impact on several domains including research, technology and open source software. Many dissemination activities through the forms of blogs, community forums, workshops, events and conferences have been done to take the MICO technology to a wider audience. Therefore as part of the sustainability plan for MICO, the project is expected to be adopted by the audience in these different domains, so that further exploitations can be done in future.

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