Cross Media Aspects in the Areas of Media Monitoring and Content Production

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Abstract

Cross media tools and multi-modal analysis are crucial technologies for automizing media monitoring and advancing content production. We discuss relevant project results from the projects DIRECT-INFO and NM2 where cross media tools and multi-modal analysis were developed and applied.

1. Introduction

Media monitoring, and specifically global advertisement expenditure measurement, is a huge world-wide market. In 2005 the global advertising market was more than 400 billion US $ [Zenith Optimedia, (2006)]. Main goal of media monitoring companies is to calculate advertisement expenditure on all kind of products and deliver to their customers numbers on specific products. Customers of media monitoring companies are executives, policy and decision makers, who are interested to receive data on how much money one company spent on a specific advertisement campaign for one product. Currently most of the work of media monitoring companies is performed manually, resulting in enormous personnel efforts. The introduction of semi-automatic tools requires multi-modal analysis and cross media capability, which makes the task from a technical point of view very challenging. Within DIRECT-INFO project we targeted a specific area of media monitoring, sponsorship tracking, and created a first prototype system for context aware multi-modal analysis with cross media functionality.

NM2 aims at creating a variety of new media genres using all of the facilities of modern broadband communication and interactive terminals. New production tools for the media industry are created within the project that allow the easy production of non-linear broadband media which in turn can be personalised by the Viewers to interact directly with the medium and influence what they see and hear according to their personal preferences.

2. Sponsorship tracking in Direct-Info

DIRECT-INFO primarily targeted the media monitoring sector and specifically the needs of Media Information Firms that capture, monitor, archive, and analyze media information. As a concrete business case the project focused on sport sponsorship monitoring which practically means that a sponsor wants to know how often his brand appears in connection with the sponsored organisation. Knowledge about how often a sponsor is mentioned in connection with the sponsored party is a direct indicator for executive managers to estimate whether to continue sponsorship or invest e.g. in direct advertising activities. The sponsored party can use this information in order to further motivate the sponsor to invest. End-users of DIRECT-INFO are customers of media information companies, respectively top managers, communication managers or PR managers. For this reason an easy to use web based user interface was implemented which promptly presents all the relevant information in a summary page, allowing further “drill down” only if requested.

2.1. Technical overview

Technically the project covers cross media aspects and a multi-modal analysis. Relevant parts of TV streams and electronic press feeds are automatically selected and subsequently monitored to find appearances of the name or logo of a sponsoring company in connection with the sponsored party. For this purpose basic features are fully automatically extracted from TV and press and thereafter fused to semantically meaningful reports. Extracted features include logos, positive & negative mentions of a brand or product, multimodal video segmentation, speech-to-text transcripts, detected topics and genre classification.

From a technical point of view sponsorship tracking is a very complex task. The simple detection of e.g. a brand in one modality (e.g. video) is not sufficient in order to meet the requirements. In praxis a sponsor very often sponsors more than one party hence the context information is needed as well in order to filter relevant appearances.

A multi-modal analysis and fusion, which relates information from different modalities was needed in order to get this context information. Within DIRECT-INFO the multi-modal analysis covers four modalities (video, audio, text and images) and two media

(TV and press) [Rehatschek, H. (2004).] [Kienast, G. Stiegler H., Bailer W., Rehatschek H., Busemann St. Declerck Th. (2005)].

2.2. Workflow of the system

Main project result is a pilot system which has been installed at the premises of partner Nielsen Media Research, Italy. The functionality of the DIRECT-INFO pilot system can be best explained when looking at the workflow which is depicted in Figure 1 and consists of the following main steps

1. Acquisition records video chunks of constant length & Electronic Program guide (EPG) information and notifies the central content analysis controller (CAC) on their availability.
2. Based on EPG information the CAC prepares semantic blocks (represented as MPEG-7 documents) i.e. per sport event, TV show etc.
3. CAC starts an automatic genre classification subsystem on this semantic block in order to get another indicator – next to the EPG information - if the semantic block is relevant for analysis.
4. Based on a condensed result of the genre classification and the EPG information the CAC decides if the corresponding semantic block shall be analyzed or not.
5. If a semantic block is relevant for analysis, the CAC passes the block now according the user defined workflow to the corresponding analysis subsystems
6. After analysis a "Quality Check" is performed by the user (MPEG-7 result editor/viewer). The user can change begin/end of a semantic block and/or modify parameters, go to step 5.
7. After the quality check the results are passed to the fusion component.
8. Fusion component first automatically reduces the different results of the analysis subsystems according to user defined rules. Then based on user interaction the data will be classified.
9. The fused classified semantic blocks are stored in a local database of the fusion component.
10. If a specific customer request comes in the database can be queried via a set-up application for fused classified semantic blocks. Specific customer relevant data will be put together.
11. The delivery / Push system visualizes the output of this set-up application via a web interface and/or immediately alerts (via SMS, MMS or email) the end user in case of important events.

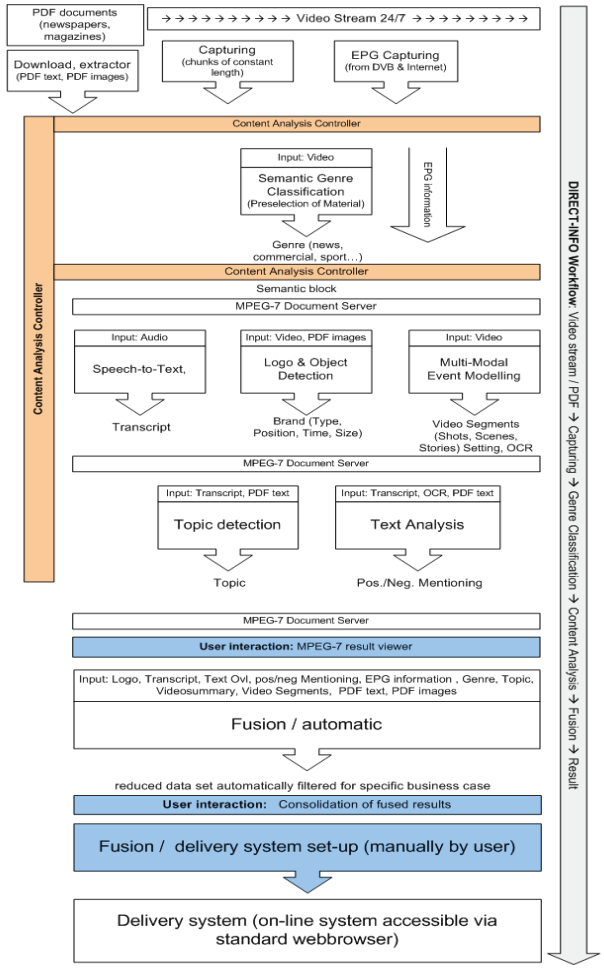

Figure 1: DIRECT-INFO system workflow

Next to the integrated system also standalone components of several meaningful subsystems have been developed. The scientifically most innovative are briefly discussed in the following sections.

2.2.1. Genre classification

This module analyses the video stream in real-time and decides on a shot basis the following semantic genres: commercials, sports, speaker, trailers and comics. The component is based on a generic approach and requires proper training on the genres of interest. As the relatively unreliable single shot classification is not directly used within DIRECT-INFO, the component summarizes the shot information and provides a highly reliable classification of semantic blocks.

The approach is based on low-level feature extraction and their combination in feature vectors that are related to the feature vectors of the training data according to the Bayesian decision theory and a Markov Model [Weiß J., (2005)].

2.2.2. Logo detection

The logo detection module detects visual appearances of logos in the video stream. The task is closely related to detecting known planar objects in still and moving images, with some special requirements. Logos vary in size, can be rotated and are subject to different lightning conditions. The SIFT (scale invariant feature

transformation) algorithm [Lowe, D. 1999], [Lowe, D. 2001] chosen by us is invariant against all these factors. Furthermore logos may be partly occluded or on non rigid surfaces (a player's shirt) so a logo has still to be detected, even if only parts of it are visible/matched. Some logos may appear in any color hence the chosen algorithm does not rely only on color features. The output of this subsystem is a list of logo appearances including time, size and position on the screen. In addition to the original Lowe SIFT we significantly improved the matching part of the algorithm and adapted it especially on video content. In particular we added a tracker [Lucas, B. D., Kanade T. (1981)], [Bouguet, J.-Y. (2000)] in order to improve performance and stability. We currently reach a precision of approx. 35% and a recall of approx. 85%.

2.2.3. Detection of pos./neg./neutr. Mentions

One very important aspect of monitoring is being able to detect positive or negative mentions of a brand. Understandably, the busy executives of a company that pay dear money for sponsorships and advertising are highly interested in receiving such information in a prompt manner. The linguistic and semantic analysis of all textual documents relevant to DIRECT-INFO is delivered by the WebSCHUG system as XML-encoded dependency structures that comply with the MPEG-7 format for textual annotation (the Linguistic Description Scheme) [Kienast, G., András H., Rehatschek H., Busemann St., Declerck Th., Hahn V., Cavet R. (2005).].

The annotation structure has been augmented with a 'polarity' tag. Polarity information is associated with linguistic units (e.g., words). The predicate-argument relations WebSCHUG can analyse allow us to support the more complex linguistic and semantic detection of 'positive' and 'negative' mentions. The WebSCHUG system can be parameterized as to which entities should be assessed. Parameters may include a list of synonyms which supports the inclusion of other brands and other use cases.

The system analyses PDF documents in Italian as well as English plain text, as it could result from ASR or from capturing TV text captures.

2.2.4. MPEG-7 result viewer & editor

The MPEG-7 Result Viewer & Editor is used to visualize analysis results per relevant semantic block (job) of the TV workflow (for the PDF workflow appearances will be directly visualized and checked within the fusion component). The application can be started from the Content Analysis Controller monitoring GUI to perform manual quality checks of the analysis. It consists of independent GUI components (video player, keyframe viewer, timeline view and result editing area) which are synchronized with each other in a common GUI framework. The operator may change in this editor either parameterization of analysis modules and restart the analysis on this semantic block or manually edit specific results in order to get better results of the fusion component.

2.2.5. Semantic data fusion component

Data fusion using different resources is a challenging task. As only high-quality results are acceptable to end-users, DIRECT-INFO opted for an automatic fusion process complemented with a manual assessment and correction phase. Hence quality assurance remains with the human media analyst.

The level of granularity is the *appearance*, representing an occurrence of a logo, a topic or a mention of interest. Fusing appearances requires a homogeneous representation scheme, which is defined using archetypes.

The technology used in the Fusion component is based on the Zope [Zope (2006)] application server, the Plone [Plone (2006)] content management system (CMS), and the Archetypes package that allows the easy definition of new content types for the Plone CMS. This software is in the public domain.

The Fusion Component works on an MPEG-7 document which stores all analysis information of one semantic block. From MPEG-7 content basic appearances per logo, a topic or a mention of interest are derived and stored. Basic appearances and further MPEG-7 information such as EPG data are then used to form complex appearances through a set of fusion rules. These rules are parameterized with respect to sponsor name, company name, or date and time. Results are assessed for correctness by the media analyst through the Facts Assessment Interface and stored in the Zope Object Database. The Setup Application Q/R interface queries and retrieves application-specific appearances according to end-user requirements. The media analyst decides which ones to make available to the end-user and stores them in the database for delivery to the end-user [Declerck, Th., Busemann St., Rehatschek H., Kienast G. (2006)].

3. New media formats in NM2

The State-of-the-Art in media production is the creation of entire finished stories that get delivered through myriads of distribution channels (TV, Internet, DVD, etc) to the end-user. With NM2 media professionals can instead conceive story components that can be used in the production of many different stories (equivalent to the car industry reusing components in different models) and screenwriters are supported to think in "story worlds". It is then up to the end-user to actually create her very own story on-the-fly based on her personal preferences.

In a technological sense innovation in NM2 concerns the development of new frameworks, technologies, tools, methods and architectures for narrative-based annotation (description of content), content recognition and content delivery to support the re-engineering of the production value chain and simultaneously enable the creation of a range of new, profitable, entertaining and engaging media genres with mass-market appeal to Europeans with screen dependent devices such as televisions, computers, games consoles and DVD players.

New tools for personalised, interactive and reconfigurable media productions are created within the project that will be elaborated in seven audio-visual interactive and non-linear productions. The NM2-productions range from news reporting and documentaries through a quality drama serial to an experimental television production about love.

3.1. Production Workflow

The State-of-the-Art production workflow comprises the following phases:

- The **pre-production phase** where preliminary steps before the actual shooting starts are made, followed by
- the **production phase** where shooting takes place, and
- Finally the **post-production phase** where the shot material gets finalized.

Compared to the classical setup introduced above, the NM2-prodcution workflow as depicted in Figure 2 is non-linear and iterative.

The production workflow differs in detail depending on the kind of production (cf. section 3.3, though all three production phases are present in every production.

While the NM2 tools are mainly situated in the post-production phase – where the tools have to integrate with existing post-production tools like existing non-linear editing systems (NLE) – they must also be capable to capture information in the production and pre-production phases due to the fact of the potential non-linearity of NM2-workflow. A very important task is to support NM2-producers in testing and previewing parts of the production to validate the artistic and semantic aspects of the story.

As shown in Figure 3 the NM2 system can be divided into three main areas of functionality:

Production tools support the creators of NM2 productions to produce stories. The production tools cover the ingestion of essence, the manual and automatic description of media items, and the authoring, i.e. the construction of possible stories. These tools integrate seamlessly into the existing production environments.

The **delivery system** presents the output to the end-users. In some NM2-productions customized end-user applications are required, which enable media composition at a user terminal. In some NM2-productions, the end-users are able to interact with the media and also with other consumers within the production in order to exchange comments about the narrative.

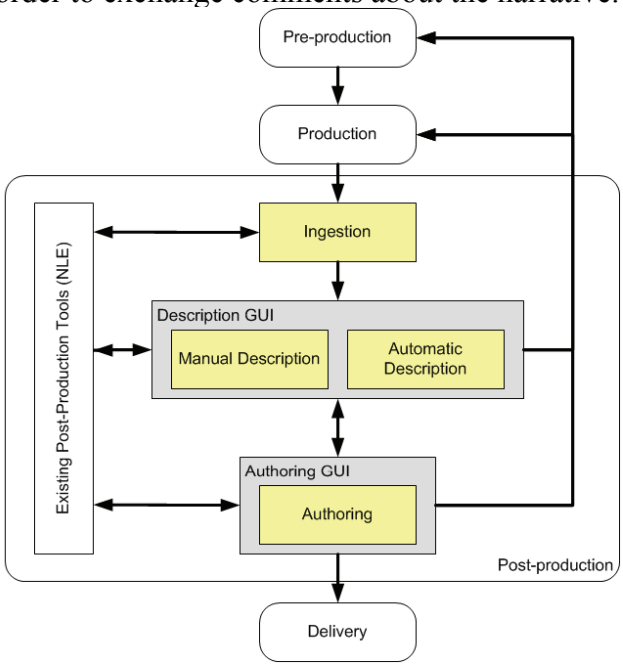

Figure 2: production workflow of NM2

3.2. Architecture

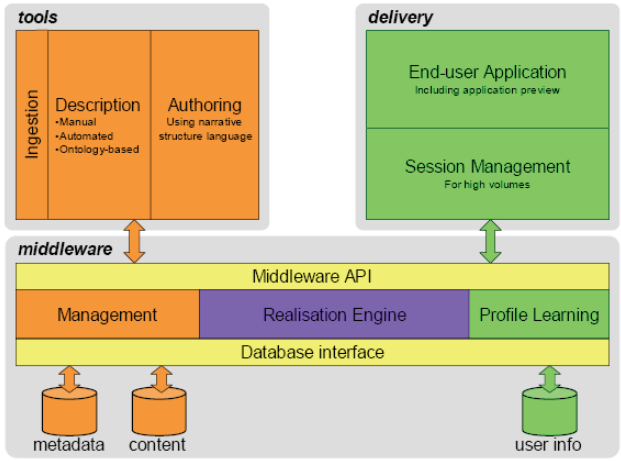

Figure 3: system architecture of NM2 system

This will contrast with the traditional broadcast structure of centralised media generation and delivery in a closed format. The delivery system is set up in a client-server model that is already supported in many popular domestic devices such as PCs, advanced set-top boxes and games consoles.

The **Middleware** mediates between the production tools and the delivery system by managing and interpreting the metadata and content. As such, the Middleware represents a core layer in which shared functionality is implemented. The middleware handles all data management tasks, including database management, automatic assembly of media essence based on metadata, interpretation and recording of user profiles as well as user

interaction. It finally includes the Realisation Engine, which is responsible for dynamically creating a user-specific story, based on a given story world and the interaction of a particular engager. A common API makes all of the above mentioned accessible to all instances of the production tools and delivery system.

3.3. Productions

The media productions are chosen to reflect a range of content genres. They are suited to a range of cross media publishing channels, including, broadcast (television), broadband delivery, and DVD. Each production is mentored by a target professional broadcaster/production company who are assessing the new media experiments:

"Gods In The Sky choice"

An interactive version of an imaginative and thought-provoking set of programmes exploring ancient myths in colourful and imaginative drama, dance and puppet theatre form, with a new astronomical interpretation.

City Symphonies

A new production in a traditional documentary genre. City Symphonies makes use of an old but recently revitalised screen language – montage – which has proved critical to the history of cinema, and is essential to any understanding of the relationship between cinema and the architecture of the city.

MyNews&SportsMyWay

A digital, interactive archive that makes it possible for engagers via broadband to discover, select and recombine news & sports items and stories according to their individual tastes.

Runecast

Runecast is inspired by the time-honoured oral-storytelling, performance-based structures, which contemporary interactive digital media re-enable in new forms. Engagers are enabled to compose their own coherent story constellations of songs, tales and images from mixed audio-visual media.

Gormenghast Explored

A fantastical, allegorical version of Mervyn Peake's great novel, originally produced by BBC Television. The content from the production will be developed to allow the story to be explored through new narrative paths, enabling flexible narrative structures in drama to be explored.

A Golden Age

An ambitious configurable documentary exploring the arts of the Renaissance in England, concentrating on the final two decades of Elizabeth I's rule. The engager determines the aspects of this subject which are of most interest, and the system produces in real-time a version which responds to these preferences.

Accidental Lovers

This production is a participatory black comedy about love for television, mobile phone and Internet using a generative narrative. The engager can affect in real-time the unfolding drama of the unlikely romantic couple, Juulia in her sixties and Roope in his thirties.

3.4. Market

European households are increasingly prepared to receive digital and interactive audio-visual media. At present up to 30 percent of households in the European Union can receive digital television, of which two-thirds receive digital TV via satellite. The next few years will see a substantial increase in digital broadcasting through all networks (DVB-T, DVB-C and DVB-S), but with national differences in the degree of household penetration and in which digital platform dominates the market. Estimations on future penetration vary substantially from 40 percent to 70 percent. Broadband Internet is also taking off rapidly in many European countries.

This distinction between the TV and the PC/Internet environment has consequences for the distribution platforms, devices and users at which the NM2 productions aim. At the same time the distinction between the two worlds seems to become less clear-cut. At present we see increasing convergence between both platforms and increasing possibilities for combining interactivity with attractive and entertaining viewer experiences.

3.5. End-user Devices

In the realm of NM2 end-user devices, we target at three platforms:

- **Barebone PC/Windows Media Centre and TV/Projector**. This is the combination used by most of the home theatre personal computer and media centres nowadays.
- **Game consoles**. This platform refers to the use of any of the most spread "living-room" game consoles available in the market nowadays or in the near future (such as PlayStation 2, XBox, and Nintendo Revolution)
- **Mobile phones**. Currently this platform is for possible spin-off applications, because the main goal of a living-room experience is not reached yet, the upcoming generation of mobile devices at least promises an comparable experience.

3.6. Understanding Visual Content

For non-linear interactive cinematic narrative, it is convenient to work with units, each of which constitutes a "micro-narrative"' contained within a video-clip (defined by its cut-in and cut-out points). This may consist of more than one shot and thus itself contain a number of internal cuts. These units are defined as narrative objects in NM2 and are the building blocks for

the interactive movies. The "glue" that keeps them together is represented by narrative structures using the Narrative Structure Language (NSL) as described below.

In NM2 the narrative objects reify as media objects that have metadata attached on different semantic levels w.r.t. formality and reusability:

- **AAF** (Advanced Authoring Format) [AAF, (2006)] is used to interface with existing NLE-systems and to integrate cutting metadata into the NM2-system.
- **MPEG-7** [MPEG-7, (2006)] is used to capture intrinsic low-level features of the content (colour descriptor, key frame, shot-border, etc.). NM2-tools target at extracting as much as possible automatically from the essence to produce sound MPEG-7 descriptions though some manual post-editing and/or validation is unavoidable in general. The so generated media objects are reusable, i.e. not production-dependent.
- **OWL-DL** [OWL, (2006)] is utilised to define production-specific characteristics for the multimedia objects, to add contextual information and interface to the NSL. Most of the high-level features are derived from MPEG-7 using domain specific mapping from features to semantic entities. A core ontology is defined that formalises all generic concepts and relations. In addition a production-specific ontology (based on the core ontology) is defined per production that describes concepts and relations depending on the domain of the production (news items, historical elements, etc.).

- The **NSL** – developed within NM2 – is a language for expressing non-linear narratives. In NM2 we distinct between specific narratives and global narratives. A specific narrative is a set of representations of media objects arranged into a play-list that is delivered to a NM2 end-user. A specific narrative can be regarded as being rendered as a number of layers playing in parallel, each playing a sequence of media objects. A global narrative contains the same references to media objects, but instead of fixed sequences, it specifies rules that are used to create a specific narrative on-the-fly based on context information. A specific narrative can insofar be regarded as an instantiation of a global narrative. The software that interprets a global narrative, producing a specific narrative, is referred to as the Inference Engine which is part of the above mentioned Realisation Engine (see section 3.2).

4. Conclusions and outlook

4.1. Conclusions DIRECT-INFO project

The main strength of the DIRECT-INFO system is in offering an integrated approach between several analysis components. Other systems on the market focus strictly on a single modality (e.g. brand recognition), whereas DIRECT-INFO provides a unique multi-modal approach which fuses information sources. Besides this the consortium has learned its lessons from the project, as given below.

Efforts for integration - especially for the set-up of a proper infrastructure, firewall configuration for remote access possibility and on-going administration - was higher than expected.

Overall system recall and precision was estimated on a worst case scenario by taking no human interaction into account (which is in praxis not the case) and on a specific use case as follows: rules assigned to a fusion use case: fr1, ..., frn; Subsystems involved in a fusion rule fr: s1(fr), ..., sm(fr);

then F value (fval) for fr = $\prod$ k fval(sk(fr)), $1 \le k \le m$;

F value for fusion use case = $1/n \times \Sigma i \prod k$ fval(sk(fri)), $1 \le k \le m$, $1 \le i \le n$

For Juventus use case: assume we are interested in Tamoil logos, Tamoil logos during topics, and positive mentions of Juventus: Tamoil rule tr. Two subsystems involved (logo recognition, topic detection): fval(lr)= 52%; fval(td) = 72%; fval(tr) = 62%; Rules for pos mentions: fval(pm) = 63,5%; Juventus use case with lr, pm, tr: fval(Juv) = 59,2%

Even though Web Services are commonly seen as easy to use, it has to be stated, that it takes a considerable amount of time to get the necessary know how, even for very experienced programmers. The standardized SOAP protocol supports a broad functionality with numerous options, but not all tools have implemented all of them making interoperability sometimes cumbersome.

It was a good choice to define MPEG-7 as our general metadata exchange format within the system. The disadvantage of an initially higher learning effort is later gained multiple times by avoiding the time consuming phases of definition and continuous extension of a proprietary format.

4.2. Conclusions NM2 project

Currently prototype implementations for all parts of the system (production tools, delivery system, and middleware) exist and are elaborated in a number of productions within NM2.

From a technological point of view a document server is in use that allows transparent and efficient access to MPEG-7-related data either via an RDBMS or (if needed) on a file-system basis. The production information (described on project level) and the set of media object descriptions is managed using a newly

developed OWL Data Store on top of the Jena Framework [Jena, (2006)]. The NM2-system is written largely in C++ and Java – utilising XML-RPC [XML-RPC, (2006)] to ensure interoperability – and partly in Prolog to capture the NSL-rules used by the Inference Engine.

NM2 in the present setup focuses on moving image, but subsequent research projects could apply the methodologies developed in NM2 to produce new cost effective ways of creating multiple versions of content in other media types as well.

4.3. Outlook: MediaCampaign project

Seamlessly with the end of DIRECT-INFO a new R&D project – MediaCampaign - in the area of cross-media analysis is started. MediaCampaign's [Rehatschek, H. (2005)] scope is on discovering, inter-relating and navigating cross-media campaign knowledge. A media campaign is defined as the universe of measures in order to fulfill a specific objective. The project's main goal is to automate to a large degree the detection and tracking of media campaigns on television, Internet and in the press. This will lead to new research results in media monitoring and analysis, and we aim to positively impact the European scientific community.

5. Acknowledgements

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