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SMART in a Nutshell

The SMART project (www.smartfp7.eu) aims to conceive and implement a scalable open source multimedia search engine that will be able to search information stemming from the physical world, Linked Data and social networks. The SMART framework will enable answering of queries based on the intelligent collection and combination of sensor generated multimedia data.

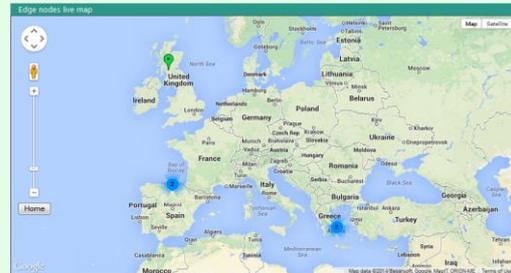
The project is co-funded by the European Commission, under the 7th Framework Program. This newsletter aims at staying in touch with relevant stakeholders and at providing updates about the project developments.

Follow us and join the SMART community!
Twitter: <https://twitter.com/smartfp7>

SMART Deployments

Currently there are 5 active SMART edge nodes providing local information to the search engine. Two are located in Attiki, Greece, two in Santander, Spain and one in Glasgow, UK. They offer different types of metadata:

- Santander, Spain (2 nodes): Non-A/V sensors, Twitter, venues from Foursquare, audio, visual, media clip information, reasoning and agenda metadata feeds
- Athens, Greece: non-A/V sensors metadata feed
- Peania, Greece: visual metadata feed
- Glasgow, UK: visual metadata feeds (two cameras)



SMART Solutions

• Data collection from the city of Santander

The SMART project has deployed audio and video collection equipment at two public locations in the city of Santander, Spain. One set of sensors is located at a main plaza in the center of the city and the other one is near a market square.

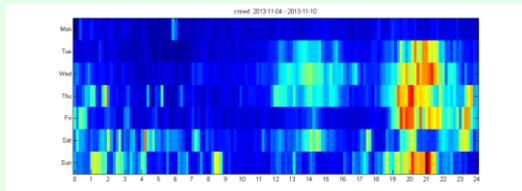
A month of continuous data collection was performed in October and November of 2013. From this month we have collected over 1000 hours of A/V data from those two sites. In addition, parallel data was also collected from social sites. This huge dataset contains mostly normal daily activities and also special events such as demonstrations and musical happenings. The project plans to use this dataset for future algorithmic development and evaluation.

• Audio and Speech Processing

The huge audio data set is a valuable resource for the audio analytics research. Over 10 hours of this dataset we manually annotated with low level events such as traffic noises, crowd noises, music and applause. This is used to further develop and train the audio analytics components. Based on our previous year research, the audio classification is done using spectral features and deep neural networks (DNN) as classifier.

Those algorithms were implemented in and audio analytics module. This module is currently deployed at both sites in the city of Santander. The tool provides real-time audio analytics data to the SMART EdgeNodes.

An example for the analytics abilities is presented in the figure below. This figure shows the weekly pattern of crowd activity in the main square as detected by the audio sensors. Each strip represents a whole day; blue color represents low activity and red high activity. The pattern shows increased activity in the square during the lunch break and at dinner time. On Monday and Thursday this activity was lower because of bad weather.



There is also ongoing work to create a speech sever for SMART. This server would allow to feed the EdgeNodes with voice messages. The server would perform transcription of those messages and allow voice identification for enrolled users.

• **Video Processing**

The SMART video processing involves face tracking for indoors scenes and visual analysis for outdoors. Both processing systems have open source and proprietary to the consortium versions. Although the code for the proprietary versions is not given, they are both detailed in the public Video Signal Processing Prototypes document:

http://www.smartfp7.eu/sites/default/files/field/files/deliverables/D3.2.1_Video_Signal_Processing_Prototypes.pdf

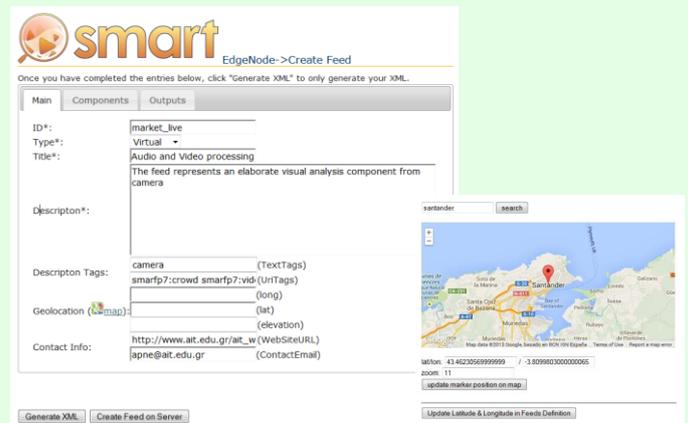
The face tracking system is capable of tracking any number of faces using three measurement cues (face presence, colour matching and foreground existence), all combined in a particle filtering framework. The measurements are not just used for the weith update stage of the particle filters, but also in a measurement-driven version of the object model. The open source version utilizes just colour matching and the typical random walk object model.

The visual analysis system extracts information about the outdoors scene. It calculates the foreground density the colour distribution and the motion patterns in different zones of interest. It also counts objects through gates of interest. In the heart of the system is a proprietary adaptive foreground segmentation algorithm with spatiotemporal adaptation of the learning rate and model merge functionality. The open source version comes with the standard Stauffer adaptive foreground segmentation algorithm, but no difference in the wealth of the extracted metadata.



• **SMART edge node feeds**

The edge node feeds are the streams of local metadata collected by every edge node using its sensors (physical or virtual). These streams are the local information the search engine uses to populate the SMART application with live content from our cities. Edge node managers need to adhere to the feed descriptions they provide for the search engine to be able to utilise the provided metadata. The SMART consortium has provided a tool for the generation of these XML feed descriptions. At the sandbox edge node, the tool is accessible at: <http://dusk.ait.gr/SMART-FP7/CreateFeed/>



The consortium has also provided the latest feed description proposals for a number of metadata streams that cover all needs foreseen up to now in the latest public SMART Distributed Knowledge Base and Open Linked Data Mechanisms document: http://www.smartfp7.eu/sites/default/files/field/files/deliverables/D4.1.1_SMART_Distributed_Knowledge_Base_and_Open_Linked_Data_Mechanisms.pdf

• **Reasoning**

While there is a global event retrieval (which is essentially a type of reasoning) happens at the search layer there also needs to be reasoning at the local level of edge nodes to process first-hand information. The information stemming from local reasoning can then be used for instructing other parts of SMART (e.g. starting to record a particular video feed due to a recognition of a local

camera). It can also enrich the search layer results by offering more information from edge nodes. The local reasoning layer (within the edge node) consists of an Intelligent Fusion Manager (IFM) that is meant to infer high-level information from local low-level information (i.e. formatted sensors data) using pre-configured patterns or by learning patterns using annotated data. The following requirements are considered in the design of the reasoning:

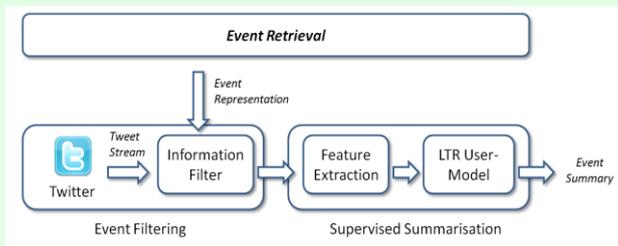
- The recognition patterns must be rule-based to ease their definition by human operators.
- The reasoning must be able to deal with inconsistencies. For example, two sensors may produce inconsistent data.
- The reasoning must be able to deal with incomplete set of data. If a sensor or the transmission of some data is broken then the reasoning process shall be able to move on.

To meet these requirements we have built the IFM around Markov Logic Networks and an existing open-source implementation called Alchemy¹. Since the last newsletter, the IFM has been integrated within the edge node and is now being used to instruct Media Data Manager in the edge nodes to start recording video files corresponding to events.

• **Search Layer**

The SMART Search Layer offers new models for local event retrieval, event filtering & summarisation, and query anticipation.

The local event retrieval model has been enhanced by modelling the location’s background information in order to focus on unusual and interesting events while penalising those events that are frequently recurring or noise-related. While the event retrieval component can provide a real-time stream of events to the user for a location, the high volume of tweets and redundancy contained within this stream can result in information over-load. The event filtering and summarisation component has been developed to tackle this problem of information overload by producing concise and novelty-driven summaries of the events retrieved and by helping end-users to understand the nature of events happening in smart cities.



The Search Layer now also deploys a novel query anticipation model we have developed for venue recommendation. This model leverages the Facebook profile of the users to infer their interests and models the evolution of the venues’ attendance over time. By

¹ <http://alchemy.cs.washington.edu/>

applying state-of-the-art prediction techniques, we can estimate the future attendance of the venues and thus recommend venues that are likely to be well attended (i.e. popular) in the near future. Using this novel model, we developed a demonstration system that was showcased at the DEMOfest 2014 event (see the “SMART in DEMOfest in Aberdeen” section).

The SmartReduce engine is the backbone of the Search Layer. It has been developed in the first year of the project to offer a scalable infrastructure for the indexing and retrieval of large amounts of social and sensor metadata streams. The SmartReduce engine has been enhanced to support the operation of our newly developed retrieval models in an efficient manner. Furthermore, we have developed methods that harness the *Storm reliability API* to ensure a full recovery of SmartReduce when hardware or software failures occur, without any loss of data.

SMART in smart City Expo in Barcelona



SMART was represented at smart City Expo in Barcelona in Nov. 2013. (www.smartcityexpo.com). The SMART project booth was visited by many stakeholders from different countries and various sectors (Public sector and Industry).

SMART 2nd Technical Review



The second technical review of the SMART project was held in palacio de Magdalena in Santander on December 12th 2013. The SMART consortium members had the opportunity to present their work in during the second year. The consortium presented several demonstrations of use cases spanning from individual audio-visual processing components as well as the integrated SMART search engine, SMART cop security use case and live news use case.

The second review of the SMART project was mainly positive and constructive. Among the positive points, the reviewers mostly emphasized on the successful integration of different components in Santander, solid base of the project on Terrier and continuing of improving interesting techniques for processing queries in the Search Layer, and improved dissemination by attending conferences such as SMART cities Expo in Barcelona. Constructive feedback was given for improving the project’s work and final outcomes. More specifically now that the components are integrated annotated data from the real world should be used to validate the results with regards to different components. Building on the reviewers’ comments and recommendations, the SMART

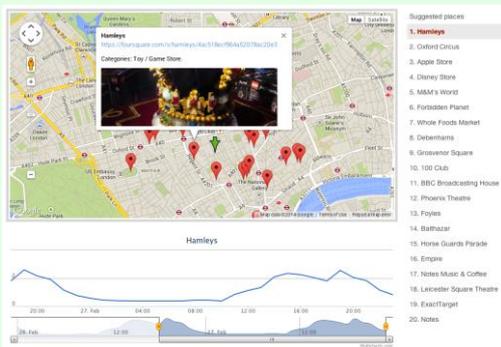
consortium will continue its work in 2014 with a primary focus on open source release, and data annotation.

SMART in DEMOfest in Aberdeen

DEMOfest is an annual SICSA (Scottish Informatics & Computer Science Alliance) event where researchers from all areas of Computing Science in Scotland gather in one space to demonstrate their projects to representatives from industry and other practitioners in the field. The SMART project participated in the DEMOfest North edition that took place in Aberdeen on 11th February 2014, through the presentation and demonstration of a new personalised venue recommendation and anticipation application.

The application recommends venues to visit either to people visiting a new city or to local residents. Suggestions are based on the predicted attendance (i.e. popularity) of venues and on the users' interests derived from their Facebook profile. The demo can be accessed here:

<http://demos.terrier.org/SMART/venuesuggestion/>



SMART at the SICSA Future Cities Workshop

SMART researchers from the University of Glasgow were on-hand at the kick-off workshop of the SICSA's (Scottish Informatics & Computer Science Alliance) Future Cities theme, hosted in Glasgow on 9th January 2014. The vision for the SMART project was presented, as well as current progress (e.g. event retrieval and venue suggestion), and finally a forward-looking position on other possible types of information needs could be tackled within Smart city environments. This workshop is the first of a series of SICSA workshops in Scotland on the topic of Future Cities, bringing together academia, cities authorities and other public agencies.

SMART Upcoming events

1. i-ASC workshop, April 2014

The University of Glasgow has teamed up with researchers in IBM Dublin and the University of Waterloo, Canada to organise a workshop on Information Access in Smart Cities (i-ASC 2014). The workshop will be held in conjunction with the annual European Conference on Information Retrieval (ECIR 2014), which will take

place in Amsterdam on the 13th April 2014. The workshop will be an opportunity for researchers from the information retrieval (IR) community and other related communities, to discuss the emerging research topic of information access in smart cities, identifying its unique challenges, opportunities and future directions. In particular, the workshop aims to cover four main research themes: (i) Acquisition, digestion and mining of the heterogeneous big data streams generated within a city; (ii) Search within smart cities; (iii) Human interaction and context in smart cities; and (iv) Smart city applications. The workshop will have an interactive setting with keynote presentations and breakout sessions to discuss the above topics. Frank Kresin, from the Waag Society, and Dr. Pol Mac Aonghusa, from IBM Dublin, are confirmed keynote speakers at the workshop. For more information about the workshop, please visit: <http://dcs.gla.ac.uk/workshops/iASC2014/>

2. Strategic partnership with UrbanTec Asia, May 2014

In March 2014, Imperial College London (on behalf of SMART consortium) and UrbanTec Asia formed a partnership to promote SMART activities in the upcoming conference in May 2014. Subsequently, Imperial College London is the invited speaker at the UrbanTec Asia conference to present the achievements of the SMART project during the first two years. The following is the description of the conference provided by UrbanTec Asia:

"The UrbanTec Asia Conference @ CIFTIS 2014 will be held at the China National Convention Center from 29-30 May 2014 in Beijing, China. The event is preceded by two editions of UrbanTec China in 2012 and 2013, which were widely recognized by the industry for its international influence, professionalism and authoritativeness. In 2014, the event is renamed as UrbanTec Asia to further its global vision and fortify the high-level platform for "New Concepts and Smart Ideas" to energize the era of new urbanization. As part of the national event China International Fair for Trade in Services, UrbanTec Asia is supported with nationwide partners and international networks."

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