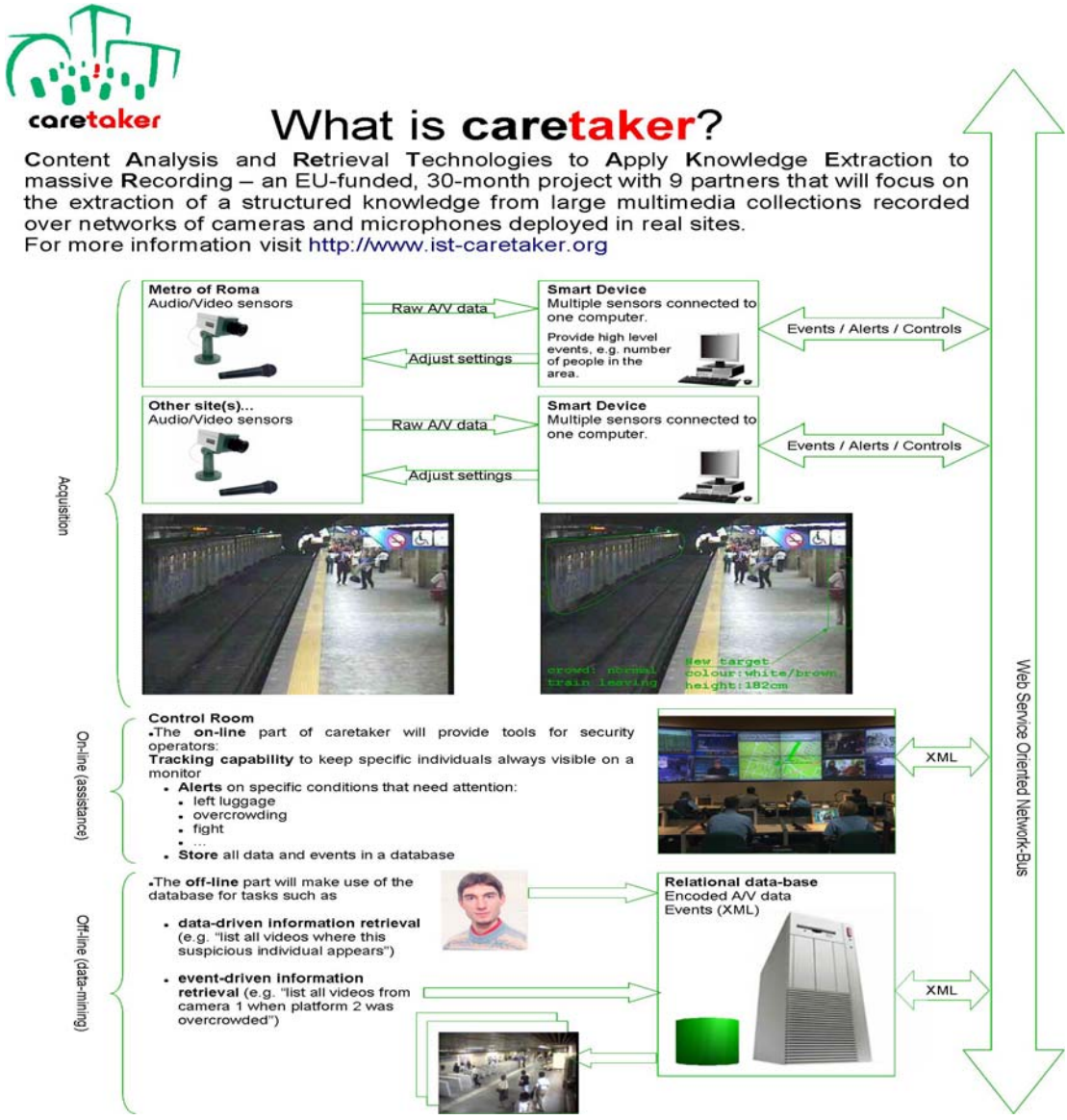
CARETAKER Annual Report (2nd year)

www.ist-caretaker.org

The CARETAKER project aims at studying, developing and assessing multimedia knowledge-based content analysis, knowledge extraction components, and metadata management sub-systems in the context of automated situation awareness, diagnosis and decision support.



The following partners are contributing to CARETAKER project:

Partic. Role*	Partic. no.	Participant name	Participant short name	Country
CO	1	Thales Communications	**TCF**	France
CR	2	Multitel asbl	**MULT**	Belgium
CR	3	Institut National de Recherche en Informatique et en Automatique	**INRIA**	France
CR	4	Kingston University	**KU**	United Kingdom
CR	5	Fondation de l'Institut Dalle Molle d'Intelligence Artificielle	**IDIAP**	Switzerland
CR	6	Agenzia per I Transporti Autoferrotramviari del Commune di Roma SPA	**ATAC**	Italy
CR	7	SOLID Information Technology	**SOLID**	Finland
CR	8	Vysocke Uceni Technicke v Brne (Brno University of Technology)	**BUT**	Czech Republic
CR	9	Gruppo Torinese Trasporti SPA	**GTT**	Italy

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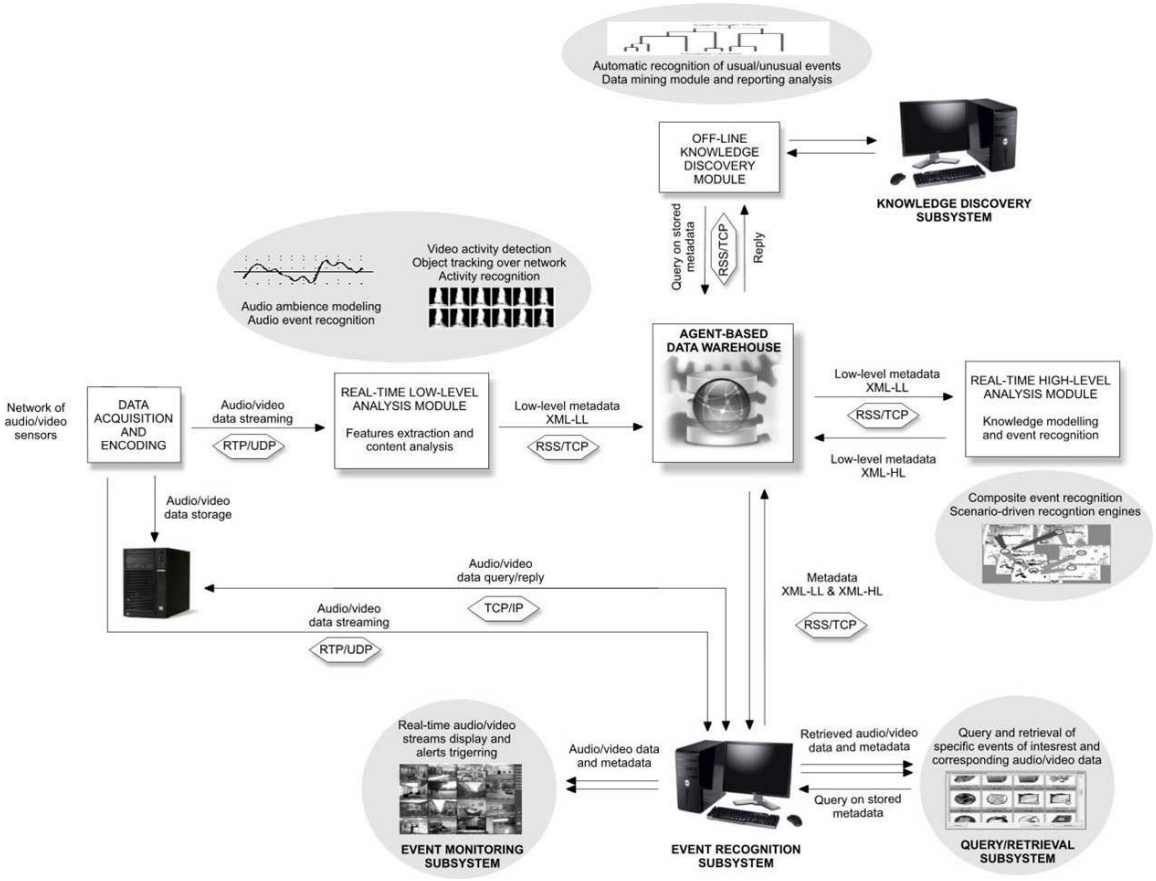
Summary of Activities

Work in the second phase of the project has been concentrated on the real audio video data acquisition, the audio/video event recognition and modelling algorithm development, the knowledge extraction functionalities development and the CARETAKER demonstrator development (subsystems integration).
Work during the next half year will be devoted to finalizing the ongoing work allowing the subsystems integration and also the CARETAKER system evaluation.

Important work area

The work during the second step of the project consisted of finalising the audio/video data collection, developing the first version of the CARETAKER system as well as studying, developing and adapting the algorithmic software bricks.

CARETAKER system



The CARETAKER system and subsystems aim at assessing multimedia knowledge-based content extraction and analysis components in two different ways:

- Online (Event Recognition Subsystem) - through the extraction of structured knowledge from data acquired over a network of camera and microphones (surveillance network of Roma/Torino metros). This is currently achieved thanks to the investigation of techniques for real-time extraction of respectively low- and high- level semantic metadata.
- Offline (Knowledge Discovery Subsystem) - through the relevant exploitation of the extracted information to ease end user operational assignment (metro monitoring by safety/security operators). This is provided through offline processes for extraction of long term patterns of activity, and event-based retrieval functionalities provided in the graphical user interface.

First, raw data coming from the sensors are automatically analysed by a first processing unit responsible for the low-level features extraction. This layer allows the extraction of some primitive characteristics from the audio/video raw data such as ambient sounds, mobile objects, crowd density and object trajectories. The low-level semantic descriptors (metadata) resulting from this analysis are then incorporated into the knowledge management system (data warehouse). A second layer of high-level

analysis then processes the previously computed metadata so as to identify events of interest, such as turnstile jumping and abandoned luggage detection. Resulting high-level metadata is also incorporated in the knowledge management system (data warehouse). At this stage, it is worth noting that one feature of the knowledge management system, in addition to the low-level and high-level metadata storage, is the ability to connect low-level analysis stubs with the high-level ones. Interactions with the knowledge management system are performed through an RSS (Really Simple Syndication) flow where analysis results, queries and replies are all formatted in XML. Concerning the offline part of the architecture, a knowledge discovery module allows the analysis of stored metadata using clustering and data mining techniques. This module aims at identifying general trends in the stored metadata, computing statistics (flow of people, space usage etc.) and exploring the relationship between different types of events.
The main objective of the work related to CARETAKER system-building is to The main objective of work related to CARETAKER system building is to enhance the CARETAKER components resulting from the studies and developments achieved in dedicated work package. In this context, there will be two different emphases (one related to on-line processing, and another linked to off-line analysis). During this period, real time online processing integration, which requires collaboration within the various distributed subsystems, benefited from the work already achieved for the annual review preparation (i.e. demonstration buidling). SolidDB for MySQL support (data base access module) have then been integrated in the metadata management system; the CARETAKER architecture has also been provided with a RSS communication module for algorithmic software bricks and management system interactions. A specific functionality has been developed to access the raw audio/video Data Base on the fly for multiple sensors tracking purposes. Some works have last been carried out to improve the graphical user interface.

Data Collection

Thanks to the data acquisition system developed previously, comprehensive audio and video data sets have been collected in the Roma and Torino Metro sites (June and July 2007). In order to acquire abnormal audio/video events, several scenes have been acted. These data sets have been transmitted to the consortium to finalize the project related processing developments but also to initialize the CARETAKER technologies test and evaluation. To ensure that the critical issue of privacy is respected, the consortium committed itself to using the data for internal research purposes only as requested by Italian and European law.
In order to enhance collaborative work inside the Consortium, some manually annotated files have been shared. These tools will allow the partners involved in audio/video processing to easily compare their results and the proposed approaches.

Audio/Video event recognition

During this second period, involved partners worked on the development of audio/video processing for low-level event recognition. Most of the approaches were under finalization and validation. Audio/video data acquired in Roma and Torino has been used to assess the adequacy and efficacy of the proposed methods in the CARETAKER context.
The Consortium's main contributions to video processing work were focused on the development of algorithms to detect and to track objects in real use case. More precisely, works have been conducted in the following topics: background modelling (in compressed domain, region-based modelling, periodic background and multi-layer

colour/texture based approach), tracking task (enhanced mean-shift algorithm for single-camera and tracking over network, 3D tracking based on Particle Filter for multi camera/person tracking, multi-person tracking using long term analysis), people density estimation...
In audio processing, several approaches have been explored; similarly to visual attention processing used for security audio event detection, a new audio event detection based on "Saliency map" has been developed. A primitive audio event detector/recognizer based on a classification/recognition scheme using neural networks and simple Viterbi decoder has also been proposed, and modified to fit real-time constraints.
In audio as well as in video, the research emphasis has been focused on real data compliancy and adaptation, to ensure the usability and the ad equation of the proposed recognition algorithms. The next main step is thus the evaluation of these techniques in the framework of the CARETAKER demonstrator.

Knowledge modelling and discovery

Knowledge modelling and discovery is an important component of the CARETAKER project, and is very much related to the event recognition issue. Indeed, transforming a set of raw video and audio streams into a form that is appropriate for event recognition and pattern analysis is not trivial given the sequential nature of the raw data, the variable number of objects involved, and the heterogeneity of the data after the low-level data processing (some variable are discrete, some continuous). Several approaches have been proposed to handle this issue. Much work on this component has already been accomplished during the first period. Thanks to end user requirements, specific and appropriate audio/video event and real scenarios have been defined. Based on this list, work during the second period has been more focused on the following key issues:

- Pedestrian trajectories characterisation and clustering,
- Object and event detection by handling uncertainty based on ontologies,
- Monitoring vending machine (machine occupancy and queuing event recognition),
- Left luggage detection,
- Knowledge discovery towards complex event (complex event mining).

There are several applications to the mining of sequential patterns. In CARETAKER, applied to the trajectories of people, it can be used to discover the main trends in the occupancy of the metro station, as well as the main paths taken by people in the metro station. Applied to more complex data, it could be used to recognize typical situations which can lead to dangerous events but also to estimate global trends of specific indices and parameters useful to metro station control and monitoring.

User Involvement, Promotion and Awareness

During this second period, work on the authoring and submission of technical papers by technical partners continued. Following the technical review, the partners were reminded to focus on journal papers, to build publications of greater merit through the collaboration and co-authoring, as well as the consideration of submission to trade publications. These suggestions, especially the first two, have been taken up by the partners. The website was also updated following the suggestions made at the annual review. For the stakeholders forum, it was agreed that the most suitable time and place would be London, in January 2008. The list of Stakeholders has been identified and contacted. Thanks to this second stakeholders forum, CARETAKER project will increase its potential visibility and audience to several public and private companies

involved in audio/video surveillance. The issues in CARETAKER are appealing also to the security/defence domain and urban transport operators, and CARETAKER was presented at several occasions involving this audience (for example during contacts with the CIVITAS initiative and at specific Thales Communications Business Units involved in such a domain).

The CARETAKER project has been introduced in several international scientific conferences such as:

- IEEE CVPR'2007 Conference,
- Visual Surveillance (VS'2007),
- 4th Joint Workshop on Multimodal Interaction and Related Machine Learning Algorithms (MLMI07),
- 8th summer school of the European Masters in Language and Speech (emls2007),
- Johns Hopkins University (JHU) summer workshop 2007,
- Eurocities Knowledge Society Forum 2007.

Papers related to CARETAKER project that were presented in this second period include:

[1] J. Annesley, J. Orwell, A. Colombo, S. Velastin, "An MPEG-7 Standard for Visual Surveillance". in the IEEE International Conference on Advanced Video and Signal based Surveillance (AVSS), Queen Mary University, London, UK, 5-7 September 2007.

[2] A. Colombo, J. Annesley, V. Leung, J. Orwell, S. Velastin, "Consistent detection and identification of individuals in a large camera network" in SPIE Europe Security & Defence & Symposium, Florence, Italy 17-20 September 2007.

[3] A. Colombo, V. Leung, J. Orwell, S.A. Velastin, "Markov Models of Periodically Varying Backgrounds for Change Detection", Visual Information Engineering VIE 2007, London, UK, 25th-27th July 2007.

[4] J.L Patino, H. Benhadda, E. Corvee, F. Bremond and M. Thonnat, "Video-Data modelling and Discovery", International Conference on Visual Information Engineering VIE 2007, London, UK, 25th -27th July 2007

[5] H. Benhadda, J.L Patino, E. Corvee, F. Bremond and M. Thonnat, " Data Mining on large Video Recordings", Veille Stratégique Scientifique et Technologique VSST 2007, Marrakech, Morocco, 21st -25th October 2007

[6] J.L Patino, E. Corvee, F. Bremond and M. Thonnat, "Management of Large Video Re-cordings", Ambient Intelligence Developments AmI.d 2007, Sophia Antipolis, France, 17th -19th September 2007

[7] J.L Patino, E Corvee, F Bremond, M. Thonnat. "Data mining for activity extraction in video data". Submitted to 8èmes journées francophones "Extraction et Gestion des Connaissances". Sophia Antipolis, France, 29th January – 1st February 2008

[8] M. Leny, F. Preteux, D. Nicholson, "de l'estimation de movement pour l'analyse temps reel de videos dans le domaine compressé", GRETSI, Troyes, France, 14th of September 2007

[9] IEEE Signal Processing Society SAFE 2007: Workshop on Signal Processing Applications for Public Security and Forensics, Washington D.C., April 2007 (special session organized by Jan Cernocky)

[10] Radioelektronika 2007, April 2007, Brno (keynote lecture by Jan Cernocky)

[11]F. Grezl, M. Karafiat, S.Kontar and J. Cernocky: Probabilistic and bottle-neck features for LVCSR of meetings, in Proc. ICASSP 2007, Hawaii, April 2007.

[12] V. Beran, A. Herout, M. Hradiš, P. Chmelař, I. Potúček, S. Sumec, P. Zemčík: Video Summarization at Brno University of Technology, In: ACM Multimedia, Augsburg, 2007, s. 4
[13] J. Granát, A. Herout, M. Hradiš, P. Zemčík: Hardware Acceleration of AdaBoost Classifier, In: Workshop on Multimodal Interaction and Related Machine Learning Algorithms (MLMI), Brno, CZ, 2007, s. 1-12
[14] J. Šilhavá, V. Beran, P. Chmelař, A. Herout, M. Hradiš, R. Juránek, P. Zemčík: Platform for Evaluation of Image Classifiers, In: Spring Conference on Computer Graphics, Budmerice, SK, 2007, s. 103-109, ISBN 978-80-223-2292-8
[15] B. Lienard, A. Hubaux, C. Carincotte, X. Desurmont and B. Barrie, "On the Use of Real-Time Agents in Distributed Video Analysis Systems", Real-Time Image Processing 2007, part of the IS&T / SPIE Symposium on Electronic Imaging 2007, 28-30 January 2007, San Jose, CA USA.
[16] J. Yao and J-M. Odobez, "Multi-Layer Background Subtraction Based on Color and Texture", in CVPR-VS, Workshop on Visual Surveillance (VS2007), Minneapolis, USA,
22 June 2007.

Future Work or Exploitation Prospects, as appropriate

Several partners in CARETAKER are involved in closed domains, such as speech recognition, natural language processing and more generally video processing. These domains will be linked together within a common CARETAKER framework, resulting in a system starting from the signal processing, through feature extraction and classifiers, to knowledge representation modules and their software implementations. As a result of the CARETAKER project, a demonstrator based on the previously developed technology will be used to show the results to potential clients. At the end of this second year, the dissemination activity should be based on the real demonstrator platform. The CARETAKER participation to IT-Trans Exhibition (February 2008) will be one of the key points of this activity.

TCF

Among the future expected CARETAKER outcomes, results related to systems and subsystems development will have a key impact on the project. It has been planned to integrate and also upgrade, by the first half of the beginning of next year, the last software bricks allowing us to provide finalized demonstration platform including low level audio/video event detection processing, audio/video meta-data base storage and meta-data analysis. Evaluation of developed algorithms (audio/video low level event detection) will be initialized at the beginning of next year.
A demonstrator based on the previous system will be used after the life of the project in Thales Communications lab and during particular events (internal TCF TechnoDay 2009 by example), allowing us to show the technical results of the project to potential interested internal or external clients. Thales Communications also intends to use some processing modules to develop a particular product offer in cooperation with the corresponding partners in the project. (Audio and video stream packetisation, storage, audio and video analysis etc.).

Solid

SOLID will be working on software integration into the demonstrator but also on general data base access based system capabilities verification. Solid's focus is also to provide data distribution capabilities to enable and validate data storage and data

exchange from detection and analysis servers to end application servers and participate in demonstrator integration work providing data management know-how. Solid Information Technology as data management technology provider will provide for external customers and its technology and alliance partners capabilities related to data management on video and audio content management and content delivery servers with special focus on high volume data and management of data on distributed architectures.

MULT

MULT plans to finalize real time demonstrator components integration including processing bricks and graphical user interface coming from related work package, and metadata management system and communication technologies required in such distributed architecture. In the CARETAKER context, MULT objectives are to realize this know-how and technology transfer to ACIC (MULT spin-off). More precisely, MULT accounts for the audio/video low-level processing algorithms and the knowledge extraction recognizers developed during the project. The experience, results and innovative technologies gained within the project will be exploitable by ACIC. MULT always capitalise on its growing know-how to gain new R&D projects and potentially to build partnerships with other industrial or academic partners. At the end of CARETAKER, MULT thus intends to address FP7 and other programs such as the upcoming ESR (European Security Research).

KU

Kingston University will be working on the integration of the last algorithmic software bricks related to multi camera-tracking object but also on the Graphical User Interface development. KU plans to participate in CARTAKER systems evaluation, and expects to make further contribution to the development of standards for Knowledge Extraction in Surveillance Technology. It also expects to make contributions to the state-of-the-art for automatic surveillance technology.
These contributions will be exploited through licensing or joint ventures with project partners or other existing (or spin-off) parties.

IDIAP

In CARETAKER, IDIAP expects to validate and improve its modelling expertise in multi-object tracking and event recognition, as well as develop new techniques and new tools to facilitate the deployment of automatic surveillance systems. Thanks to CARETAKER results including new algorithm development but also the potential use of the demonstration platform, IDIAP expects to promote automatic surveillance based technologies. As a not-for-profit research institute, IDIAP exploits its expertise through technology transfer contracts and licensing with other existing parties.

BUT

BUT plans to finalize the last algorithms test and integration, and to participate in the evaluation process. BUT's use of CARETAKER's results will be two-fold: as research and educational institution, it will use them as examples for lectures and laboratory exercises for students. BUT however also has a significant activity in cooperation with local and European industry, and it will seek to find such co-operations primarily within the CARETAKER industrial partners.

ATAC

ATAC expects to finalize the CARETAKER system and technologies test and evaluation thanks to the entire consortium. Knowledge gathered from the CARETAKER project will help ATAC to evaluate how to improve security in public

transport through the use of automatic surveillance technology and will also provide inputs for further research.

GTT

In collaboration with ATAC, GTT will also be working on the system and technologies test and evaluation. Due the large amount of potential client visiting the new Torino Metro site, GTT will be able to promote the CARETAKER project. GTT will also be involved in evaluating how to improve the security in public transport thanks to the CARETAKER results.

INRIA

The algorithms developed at INRIA will be improved by using the recently received videos from the ATAC and GTT. Long term trackers or 'global tracker' will be improved to better the quality of the trajectories, to filter out noisy tracks and to maintain temporal coherency of these objects' temporal path in the viewed scenes. The work on the global tracker will be focusing on producing less noisy events, more stable complex events in time and to start defining more complex events to have a great meaning to the user needs. The off line clustering of events will give meaningful evaluation of the obtained trajectories. These algorithms will be integrated to the CARETAKER demonstrator. The expected improvement will then allow the enhancement of the detection of moving objects and to obtain better coherent information out of this motion information. The range of simple events so far recognised will be broadened to allow higher level semantic information to be extracted i.e. knowledge discovery. An off-line analysis of the shape of objects and their trajectories will complement the enhanced information in order to observe frequent patterns or detect infrequent activities (e.g. unusual events).

Further Information

For further information about the project, please consult the following website: www.ist-caretaker.org.
To participate in the Stakeholders events, please contact the coordinator of the project.