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DELOS Task 3.7 (and Task 4.5b): MIMA: Multimedia Interfaces for Mobile Applications

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MIMA project

- The project addresses the customization of video stream transmission and display on portable devices.
  - The project scenario is: user is equipped with PDA receiving multimedia information.
  - Field of application: selective transmission of sports and news video.

- Three subsystems:
  - Video annotation and adaptation;
  - Video summarization;
  - User interface.

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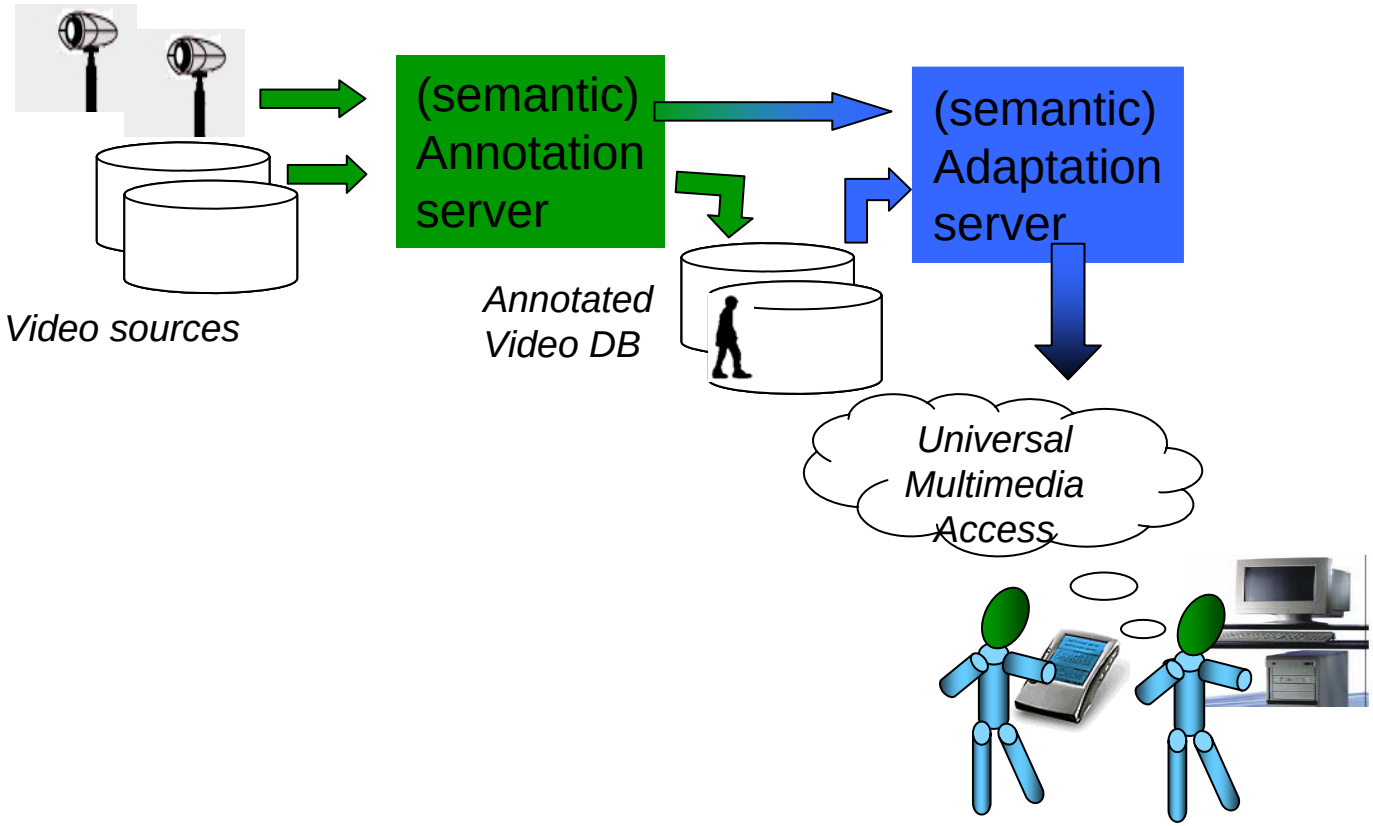
Task objectives

- The main objectives of the Task are:
  - Automatic video annotation:
    - Event and highlight modelling;
    - Extraction of basic video features;
    - Automatic detection of highlights.
  - User-centered design of interfaces for small screen devices:
    - User and device profiling (modelling of user preferences and device characteristics);
    - Design of adaptive interfaces that minimize the user interaction and adapt to user profiles and devices characteristics;
    - Solutions for effective visualization.
  - Define and test indexes of representation quality.

Video analysis and adaptation

- Unified framework for video annotation and adaptation.
- Content-based video adaptation for sport videos.



Video adaptation

- New multimedia standards for video content adaptation:
  - H.264/MPEG-4 AVC (Advanced Video Coding) or MPEG-4 Part-10
  - H.264/MPEG-4 SVC (Scalable Video Coding) – beta release.

- Comparison of the standards with respect to MPEG-4 Part-2.

MPEG-4

proposed S- MPEG-4-SP

Different quality on events of interests

Video adaptation

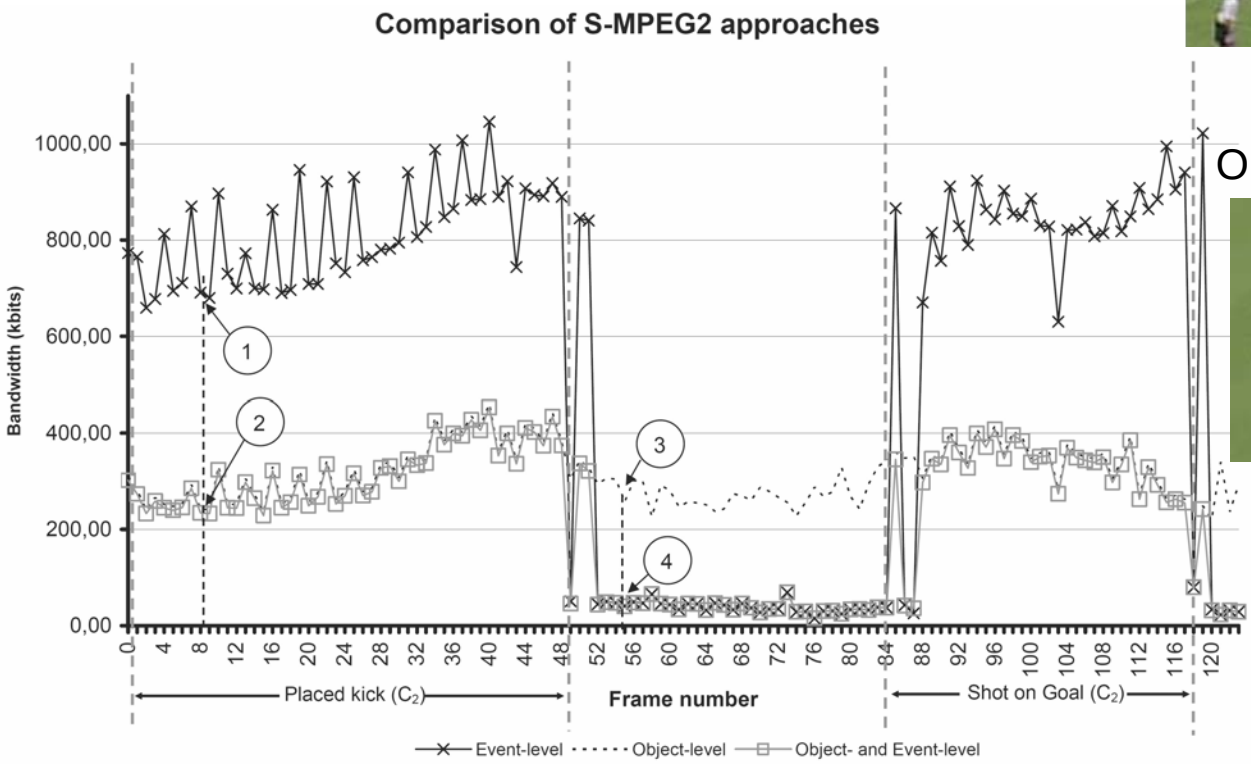
- New adaptation techniques based on MPEG-2 (block-based adaptation) and MPEG-4 (Simple and Core profiles) at event and object level.

Event based (1)

Object + event based (2)

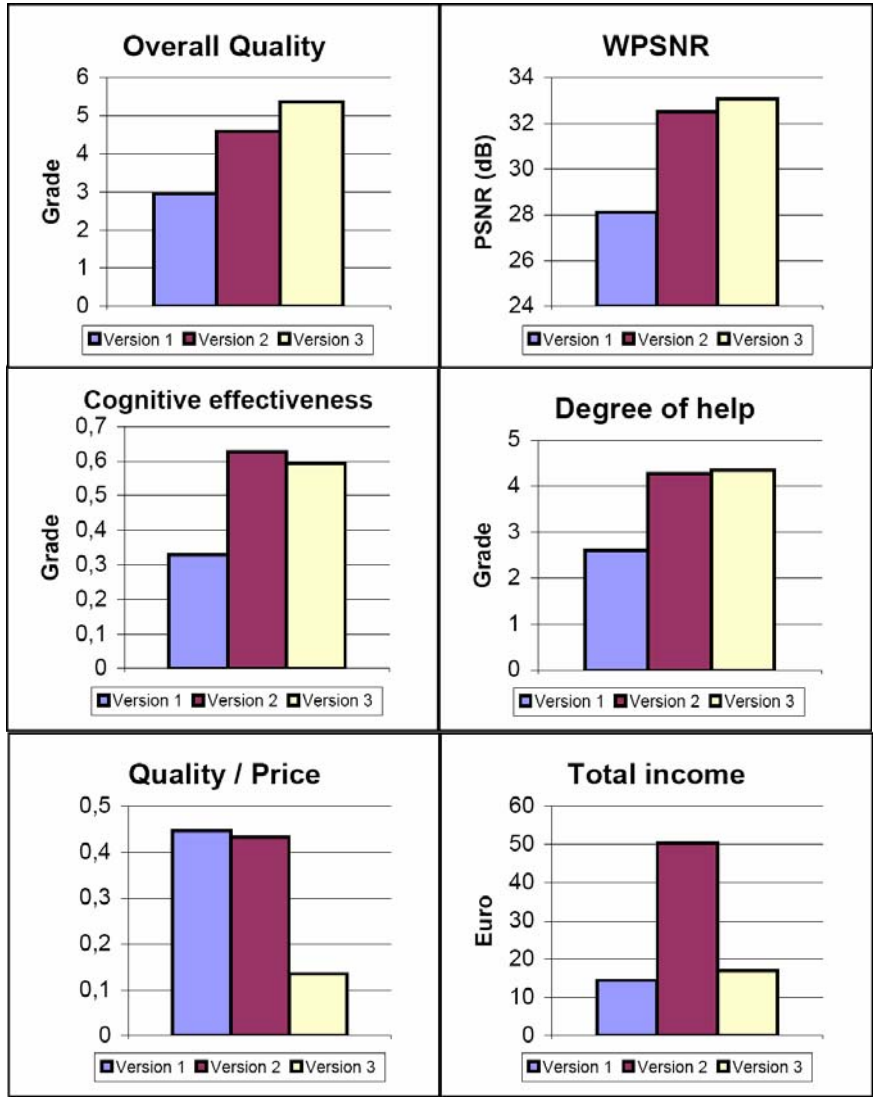
Object based (3)

Object + event based (4)



Video adaptation

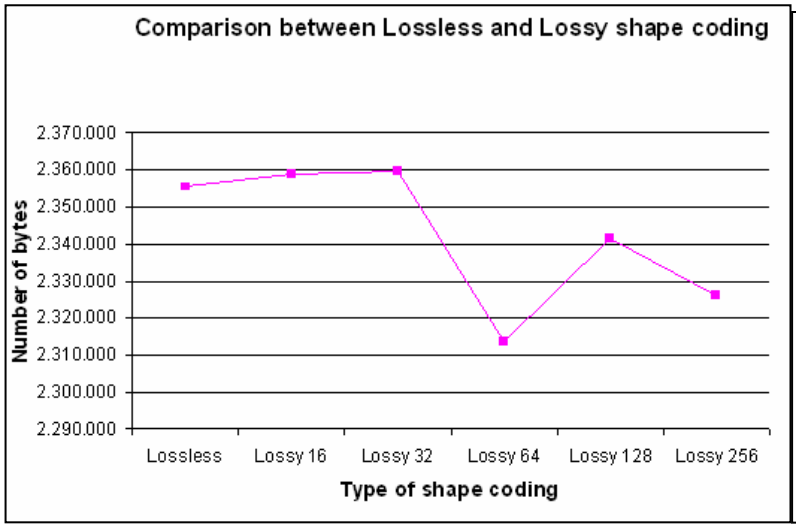
- Usefulness of object coding:
  - Tests on 25 users.
  - Different levels of compression using different approaches (object-based or frame-based selective compression).
  - Qualitative test using a Likert (7-point style) scale.
  - Subjective evaluation on:
    - OVERALL QUALITY
    - COGNITIVE EFFECTIVENESS
    - QUALITY VS. PRICE

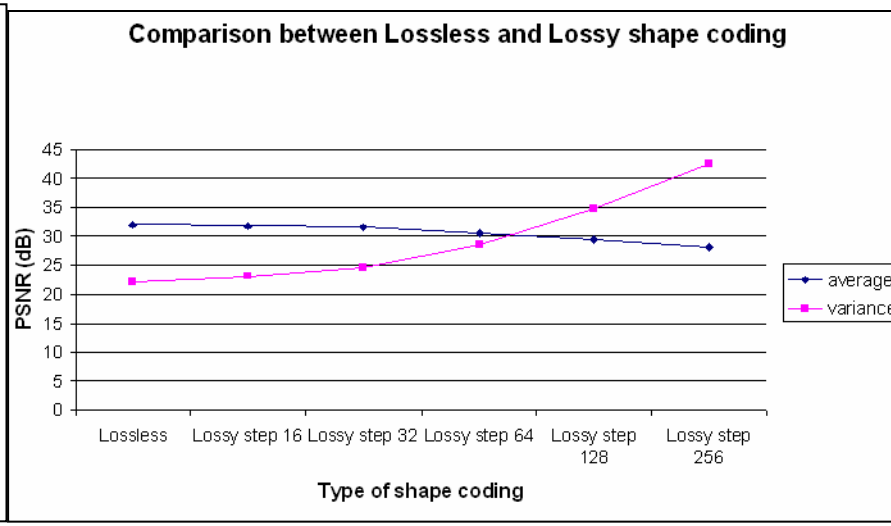


Video adaptation

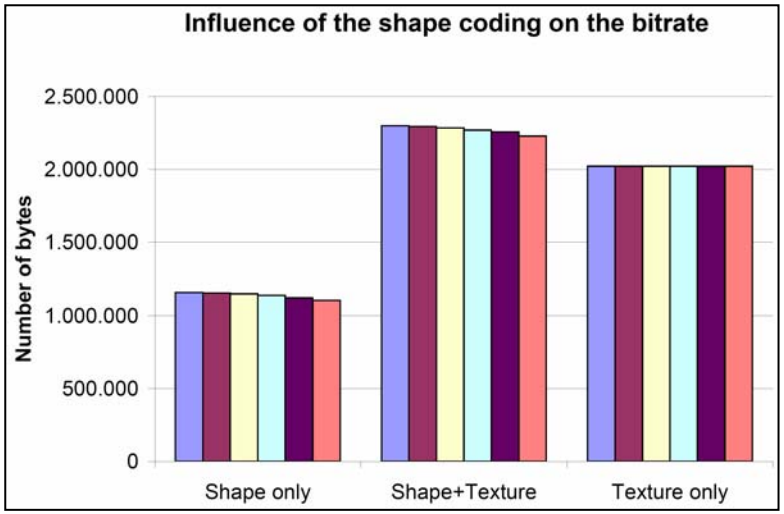
- Usefulness of object coding (quantitative analysis).

Lossless vs. lossy shape coding

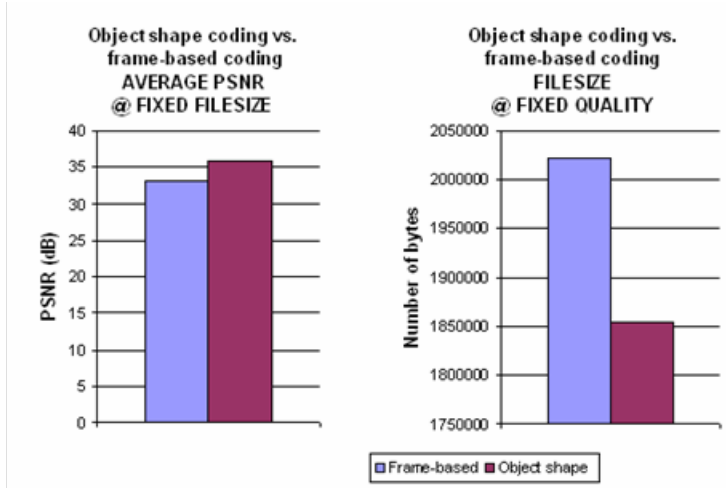




Influence on bitrate

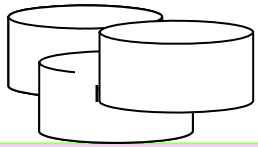


Object vs. frame coding



Performance evaluation

How to evaluate user-centered performance?
PSNR; BR are not enough.



Video sources

Annotation system

Precision / False Alarms

- False detections
- Over-estimation

Recall / Detection Rate

- Miss detections
- Under-estimation

User's Classes of Relevance

Content-based Adaptation system

Non (less) interesting video entities processed as (more) interesting ones

More bandwidth waste than needed
Bit Rate Cost Increase

Interesting video entities processed as non (less) interesting ones

Higher MSE, lower PSNR than needed
Viewing Quality Loss

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Performance evaluation

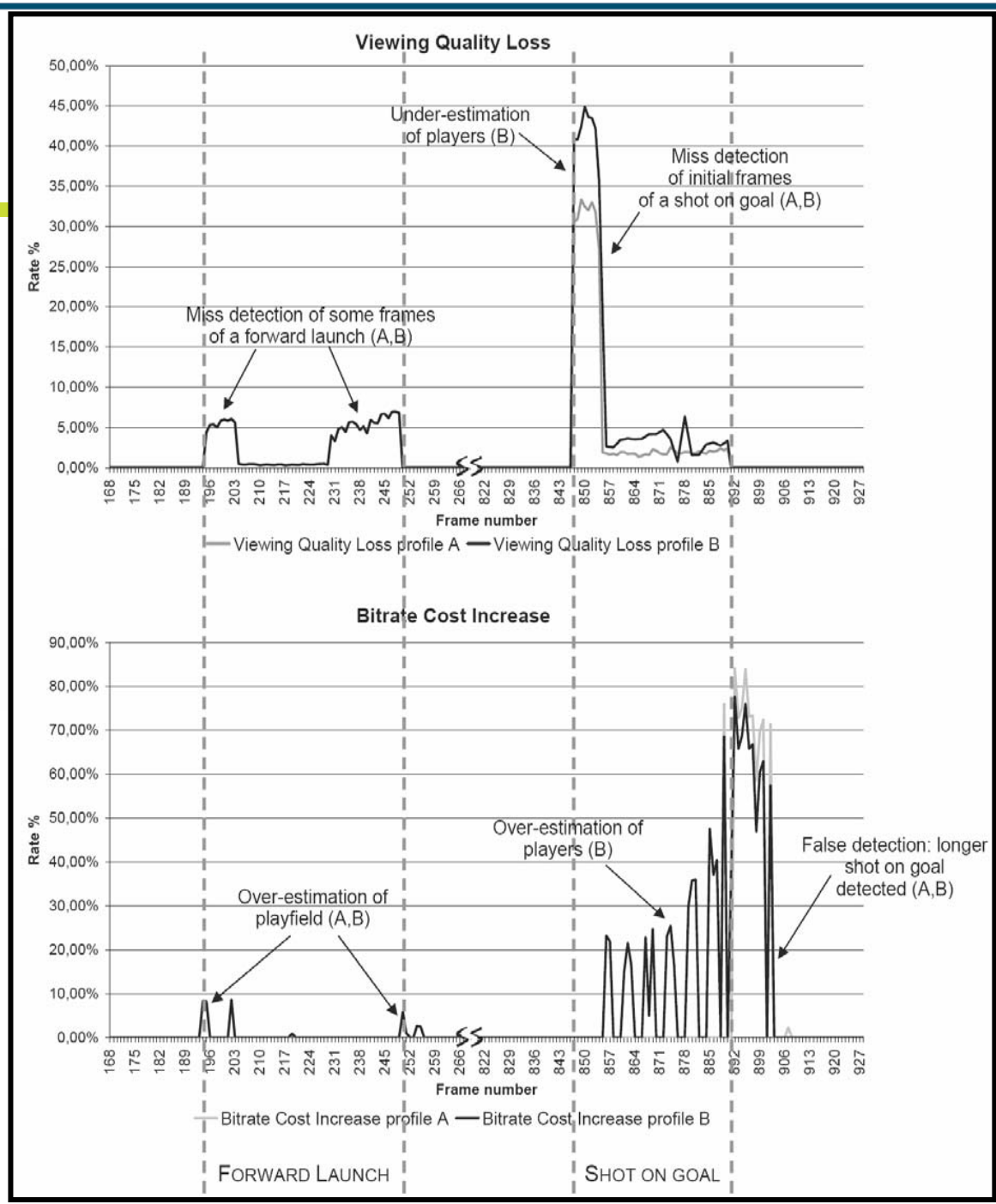
- New user-centered performance evaluation metrics.

Viewing Quality Loss

$$VQL^t = 1 - \frac{PSNR_{Err_Q^t}}{PSNR^{ID}_{Err_Q^t}}.$$

Bit Rate Cost Increase

$$BCI^t = 1 - \frac{BR^{ID}_{Err_C^t}}{BR_{Err_C^t}}$$



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Guidelines for interface design of mobile devices

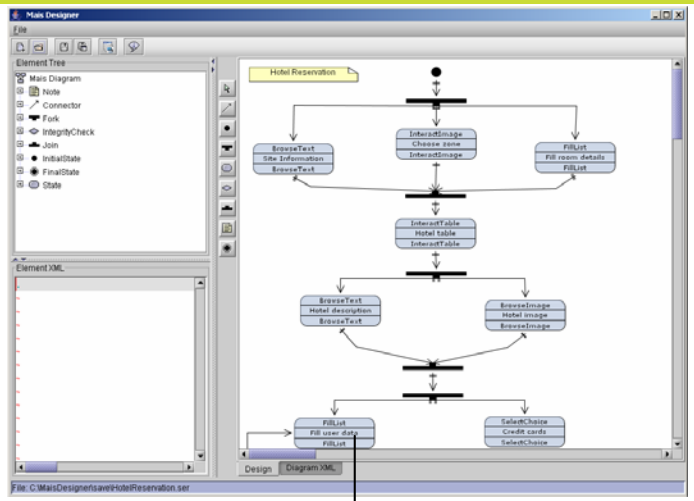
- Investigation of guidelines for the design of DL interfaces for mobile devices:
  - Navigation concepts and styles
  - Search and Search results presentation
  - On-screen keyboard
  - Data entry
  - Color coding
  - Localization
  - Help functions
  - Use of buttons
  - User profiling and adaptation determinants.

- Expert and user-based evaluation of the prototype system.

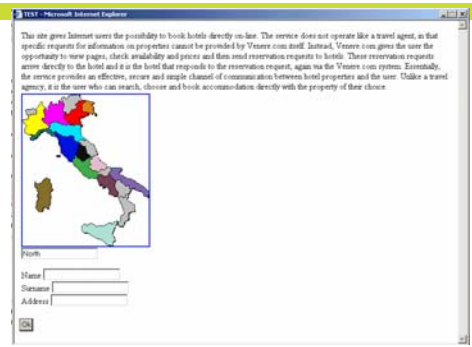
User interface

- Extension of the UML activity diagram to model the small screen user interfaces.
- Definition of a set of *Atomic Interaction Unit* (AIU) to capture user interface information flows and heuristics for their generation based on:
  - The exchanged data characteristics;
  - The mobile device characteristics.
- AIU based UML activity diagram detailed specification (11 AIUs formally defined).
- Implementation of a prototype system for generation of small screen interfaces including:
  - AIU activity diagram editor;
  - Heuristic implementation;
  - Interfaces generator.

User interface

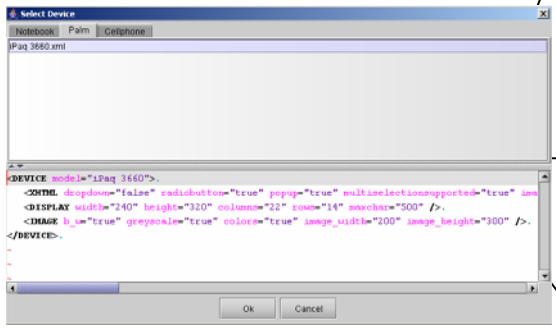


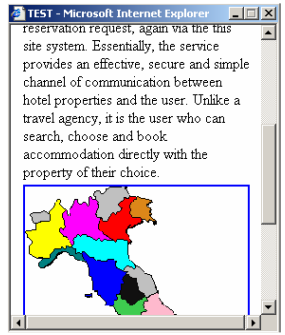
User interaction design



Portable device interface

Device characteristics





Palm device interface

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   </STATE>.
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```

User interaction description (XML)

Cellular phone interface

Results

- Unified framework for video annotation and adaptation:
  - Content-based video adaptation for sport videos.
  - Guidelines for interface design for mobile devices.
  - Extension of the UML activity diagram to model the small screen user interfaces.
  - Definition of a set of atomic interaction unit (AIU) to capture user interface information flows and heuristics for their generation.

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Publications

- M. Bertini, R. Cucchiara, A. Del Bimbo, A. Prati. "An Integrated Framework for Semantic Annotation and Transcoding" in *Multimedia Tools and Applications* - Kluwer Academic Publishers, vol. 26, n. 3, pp. 345-363, 2005.
- M. Bertini, R. Cucchiara, A. Del Bimbo, A. Prati. "Semantic Adaptation of Sports Video with User-centred Performance Analysis," in press on *IEEE Transactions on Multimedia*, 2005.
- M. Bertini, R. Cucchiara, A. Del Bimbo, A. Prati. "Real Time Semantic Adaptation of Sports Video with User-Centred Performance Analysis," Workshop on Image Analysis for Multimedia Interactive Services (WIAMIS), Montreux (CH), April 13-15, 2005.
- M. Bertini, A. Del Bimbo, W. Nunziati. “Players Identification in Sports Videos”, Seventh International Workshop of the EU Network of Excellence DELOS on Audio-Visual Content and Information Visualization in Digital Libraries (AVIVDiLib'05), Cortona, Italy,May 4-6, 2005.
- M. Bertini, A. Del Bimbo, W. Nunziati. “Soccer Videos Highlight Prediction and Annotation in Real Time," 13th International Conference on Image Analysis and Processing (ICIAP), Cagliari (I), September 6-8, 2005 (Springer LNCS).
- C. Grana, G. Tardini, R. Cucchiara. "MPEG-7 Compliant Shot Detection in Sport Videos" in press on Proceedings of IEEE International Symposium on Multimedia (ISM2005), Irvine, California, USA, Dec. 12-14, 2005.
- G. Tardini, C. Grana, R. Marchi, R. Cucchiara. "Shot Detection and Motion Analysis for Automatic MPEG-7 Annotation of Sports Videos" in Proceedings of the 13th International Conference on Image Analysis and Processing (ICIAP 2005), Cagliari, Italy, pp.653-660, 6-8 Sept, 2005.
- R. Cucchiara, C. Grana, G. Tardini. "Shot Detection for Formula 1 Video Digital Libraries" in Proc. of 7th International Workshop of the EU NoE DELOS on Audio-Visual Content and Information Visualization in Digital Libraries, Cortona, Italy, pp.131-140, 4-6 May, 2005.
- C. Grana, G. Tardini, R. Cucchiara. "Adaptation and Annotation of Formula 1 Sport Video" in Proc. of 1st Italian Research Conference on Digital Library Management Systems, Padova, Italy, Jan. 28, 2005.
- A. Prati, R. Cucchiara. "On the usefulness of object shape coding with MPEG-4" in press on Proceedings of IEEE International Symposium on Multimedia (IEEE ISM 2005), Irvine, CA - USA, 12-14 Dec., 2005
- E. Bertini, G.Santucci. “Modeling user-system data exchange to design adaptive interfaces,” Proc. International Workshop on Plastic Services for Mobile Devices PSMD05, Rome, Italy, Sept. 12, 2005, during the10th International IFIP Conference on Human-Computer Interaction Interact 2005.

Current and future work

- Activities distribution over the rest of the JPA2 according to the last task meeting:
  1. User modeling: completed;
  2. Video annotation: completed;
  3. Interface generation: completed;
  4. Video summarization;
  5. System integration and usability evaluation.

	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05	Jan 06	Feb 06	Mar 06	Apr 06	May 06
1)												
2)												
3)												
4)												
5)												

Future perspectives

- Future perspectives:
  - Exploitation of classes of relevance defined in an ontology: by means of user's feedback optimal summary of the video are automatically constructed, not limited to content transcoding.
  - Creation of adaptive multimedia presentations of the video content by managing the different modalities embedded into the videos: video, audio and text.
  - Extension of the user interface envisioned to be used on a mobile device. This may communicate with the video server that provides and assembles the summary to decide which parts of the videos are the most interesting for the user. In this way, the interface can adapt itself in order to alert the user that a particularly interesting highlight is being shown.

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