5 Multimedia Content Description

Literature:
Rosenblatt/Trippe/Mooney, Chapter 6

Unlabelled Video Tapes & The Internet

- The Unlabelled Video Tape Problem
  - Even worse with digital media: Various formats, variants
- Digital media production:
  - Labelling of parts to be composed
    - » Date, time, format, ...
  - Representing the composition
- Digital media on the Internet
  - Identifying digital media
    - » Title, author, genre, ...
  - Searching for specific media, e.g. audio, video content
  - Fine-grained search within media
    - » e.g. person search within video content
  - Bringing together related media (e.g. text news and photos)
    - » (Automated) syndication

Content, Essence, Metadata

- Content
  - consists of *essence* data and *metadata*
- Essence
  - parts of content that directly represent program material such as audio, video, graphic, still-image, text, or sensor-data
- Metadata
  - parts of content that contain data used
    - » to *describe* essence or
    - » to provide information on its *use*
  - metadata objects sometimes called “mobs”

Source: AAF Developer Overview

Metadata Problems

- Creation metadata
  - During the creation of media essence, metadata is created but often ignored
  - Example: EXIF data in JPEG
- Manually added metadata
  - Users notoriously ignore the administration of metadata
- Metadata incompatibility
  - Metadata exists in various formats specific for media types, applications, product vendors, ...
  - Exchange of metadata is difficult
- Broad range of metadata
  - Metadata exists on various levels, covering all is expensive
- Metadata economy
  - How much of the metadata will be used?
  - When to create metadata?

Selected Metadata Standards

- Dublin Core Metadata Initiative (DCMI) &
  PRISM (Publishing Requirements for Industry Standard Metadata)
  - Oriented towards books, magazines, journals etc.
  - Uses XML, RDF, Dublin Core
  - www.prismstandard.org
- ONIX (Online Information Exchange)
  - For books: http://www.editeur.org/onix.html
- MUZE (www.muze.com)
  - De-facto industry standard
  - Company collecting large database of recorded music
- TV Anytime (www.tv-anytime.org)
  - Devoted to audio-visual services making use of local mass-storage
  - Focus on: Electronic Program Guide and user profiles
- EBU P/Meta
  - Devoted to material exchange between broadcasting stations

5 Multimedia Content Description

Literature:
www.w3c.org/RDF

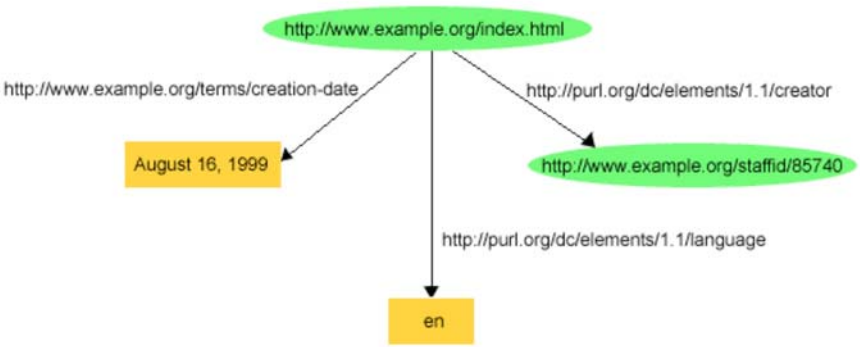
Resource Description Framework RDF

- Language for representing information about resources in the WWW
  - W3C's Semantic Web activity

- *Resource:* Anything that can be identified by a URI (e.g. all Web pages)
- *Property:* An attribute of a described thing which can take on specific values
- *Statement:* A triple consisting of
  - *Subject:* Some resource to be described
  - *Predicate:* A property of the subject
  - *Object:* A specified value
- Properties, values and statements are resources themselves,
  - i.e. can be identified by a URI
  - i.e. can be subject to further description

RDF Example

- **http://www.example.org/index.html** has a **creator** whose value is **John Smith**
- **http://www.example.org/index.html** has a **creation-date** whose value is **August 16, 1999**
- **http://www.example.org/index.html** has a **language** whose value is **English**



RDF/XML Example

- RDF/XML is an XML language for representing descriptions

```
<?xml version="1.0"?>
  <rdf:RDF
    xmlns:rdf=
      "http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:dc=
      "http://purl.org/dc/elements/1.1/"
    xmlns:exterms=
      "http://www.example.org/terms/">
  <rdf:Description
      rdf:about="http://www.example.org/index.html">
    <exterms:creation-date>August 16,1999
      </exterms:creation-date>
    <dc:language>en</dc:language>
    <dc:creator
      rdf:resource="http://www.example.org/staffid/85740"/>
  </rdf:Description>
</rdf:RDF>
```


5 Multimedia Content Description

Literature:

AAF Developer Overview, available at www.aafassociation.org

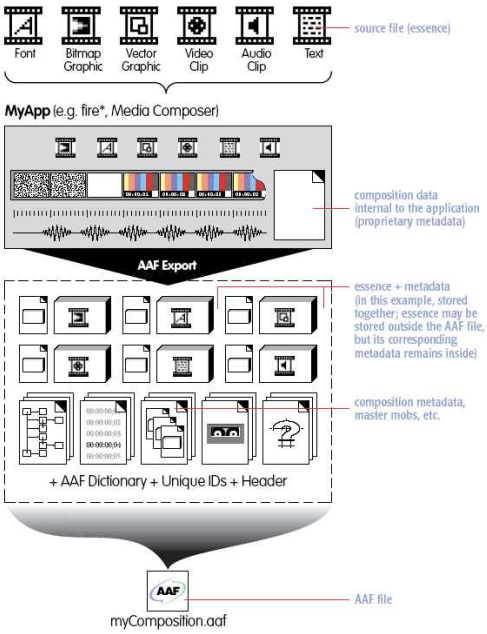
Integration of Digital Media in Video Production

- Example: Putting together all audio elements for a film soundtrack
  - music tracks, ambient sound tracks, performer's synchronized sound, ...
- Multimedia authoring applications
  - Usually use proprietary data formats
  - Important metadata related to creation process (e.g. compositional metadata) kept only in proprietary formats
- Standards in the broadcasting industry
  - SMPTE (Society of Motion Picture and Television Engineers)
  - EBU (European Broadcasting Union)
  - Working on hardware-based standards for a long time
- EBU/SMPTE Task Force for Harmonized Standards for the Exchange of Program Material as Bit Streams (1996-1999)
  - Results further developed into Advanced Authoring Format (AAF)
  - AAF: Industry-driven, cross-platform, multimedia file format

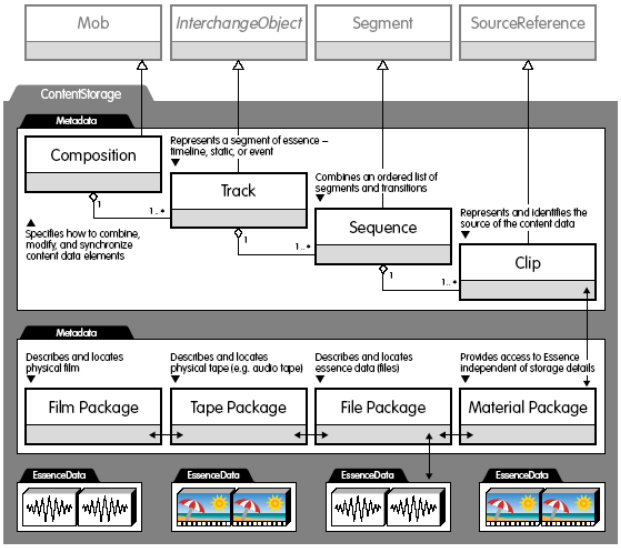
Types of Metadata Covered in AAF

- **Identification and Location Metadata**
  - comprises all forms of metadata that can be used to uniquely identify an item
- **Administration Metadata**
  - definitions of rights, user access, security classifications, encryption, audience listings and other business information.
- **Interpretive Metadata**
  - partly for human-orientated metadata types such as names, artists, organisations and classification.
- **Parametric Metadata**
  - signal coding parameters, device characteristics, sensor parameters (e.g.focal length) plus device storage and streaming parameters
- **Process Metadata**
  - includes all items that describe how essence is assembled, such as editing and compositional metadata
- **Relational Metadata**
  - describes how information is related
- **Spatio-Temporal Metadata**
  - describes places and time including angles, geo-spatial coordinates, dates, creation times, event times, delays and durations

Interchanging Compositions with AAF



AAF Object-Oriented Software Architecture



5 Multimedia Content Description

Literature:

www.chiariglione.org

B. S. Manjunath, Philippe Salembier, Thomas Sikora:
Introduction to MPEG-7, Wiley 2002

MPEG-7

- Moving Picture Experts Group (MPEG)
  = ISO/IEC JTC1/SC29/WG11 “Moving Pictures and Audio”
  Main Web presence now: www.chiariglione.org
- MPEG-7 “Multimedia Content Description Interface”
  - “ ... a standard for describing the multimedia content data that supports some degree of interpretation of the information’s meaning, which can be passed onto, or accessed by, a device or a computer code. MPEG-7 is not aimed at any one application in particular; rather, the elements that MPEG-7 standardizes support as broad a range of applications as possible.”
- Version 1 developed in 1996 – 2001
- Version 2 said to be under development
- Industrial uptake rather slow
  - Very ambitious standard

Parts of the MPEG-7 Standard

- MPEG-7 Systems
- MPEG-7 Description Definition Language (DDL)
  - Descriptors (D) define the syntax and semantics of each *feature* (metadata element)
  - Description schemes (DS) specify syntax and semantics of the relationships between their components, which may be Descriptors or Description Schemes
  - DDL allows the creation of Ds and DSs
    - » XML-based language with some small extensions to XML Schema
- MPEG-7 Visual
- MPEG-7 Audio
- MPEG-7 Multimedia Description Schemes
- MPEG-7 Reference Software
  - eXperimentation Model XM

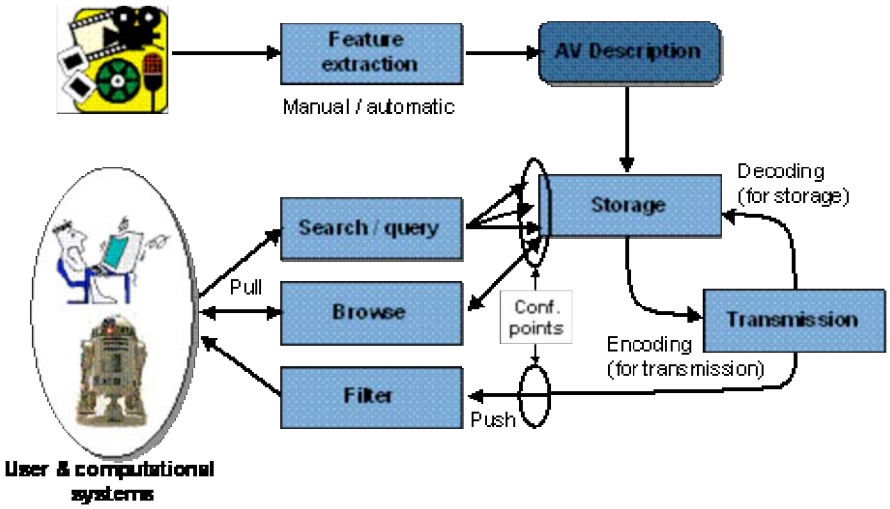
Types of Metadata Covered in MPEG-7

- Technical Metadata:
  - Form (data format, representation parameters like resolution, colour depth...)
  - For live captured material: Time and date of original occurrence
  - Technical parameters of capture (e.g. aperture, exposure etc. for images)
- Content Description Metadata (main focus of MPEG-7):
  - Low level:
    - » Video: Shapes, positions, trajectories etc. of objects (“an object with mainly yellow colour fitting into a box moving from left to right”)
    - » Audio: Key, mood, tempo, tempo changes, position in sound space, ...
  - High level:
    - » Video: “A post car arrives, entering the scene from the left side.”
    - » Audio: Title, composer, etc. or, e.g.: “barking dog”
- Additional information:
  - Digital rights, classification, context, further links, ...

Application Areas of MPEG-7

- Architecture, real estate, and interior design (e.g., searching for ideas).
- Broadcast media selection (e.g., radio channel, TV channel).
- Cultural services (e.g., virtual museums).
- Digital libraries (e.g., image catalogue, musical dictionary).
- Education (e.g., repositories of multimedia courses).
- Home Entertainment (e.g., home video management).
- Investigation services (e.g., human characteristics recognition, forensics).
- Journalism (e.g. searching for video footage of political event).
- Multimedia directory services (e.g. yellow pages, Tourist information).
- Multimedia editing (e.g., personalized electronic news service, media authoring).
- Remote sensing (e.g., cartography, ecology, natural resources management).
- Shopping (e.g., searching for clothes that you like).
- Surveillance (e.g., traffic control, surface transportation).
- ...

A Hypothetical MPEG-7 Chain

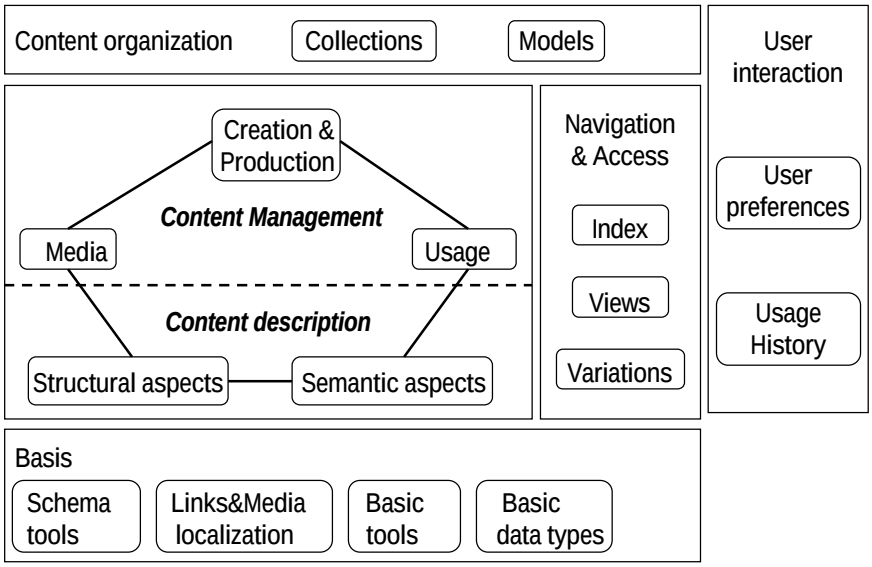


Examples of Advanced Queries

- Play a few notes on a keyboard and retrieve a list of musical pieces similar to the required tune, or images matching the notes in a certain way, e.g. in terms of emotions.
- Draw a few lines on a screen and find a set of images containing similar graphics, logos, ideograms,...
- Define objects, including colour patches or textures and retrieve examples among which you select the interesting objects to compose your design.
- On a given set of multimedia objects, describe movements and relations between objects and so search for animations fulfilling the described temporal and spatial relations.
- Describe actions and get a list of scenarios containing such actions.
- Using an excerpt of Pavarotti's voice, obtaining a list of Pavarotti's records, video clips where Pavarotti is singing and photographic material portraying Pavarotti.

From: MPEG-7 Overview

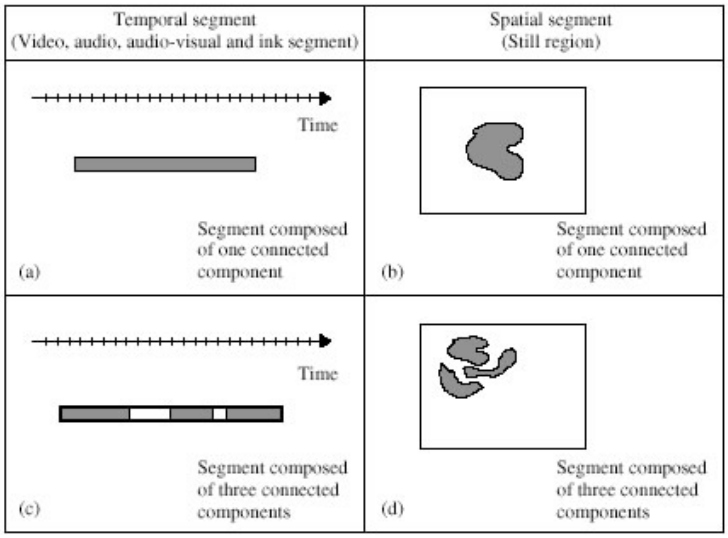
Organization of Multimedia Description Tools



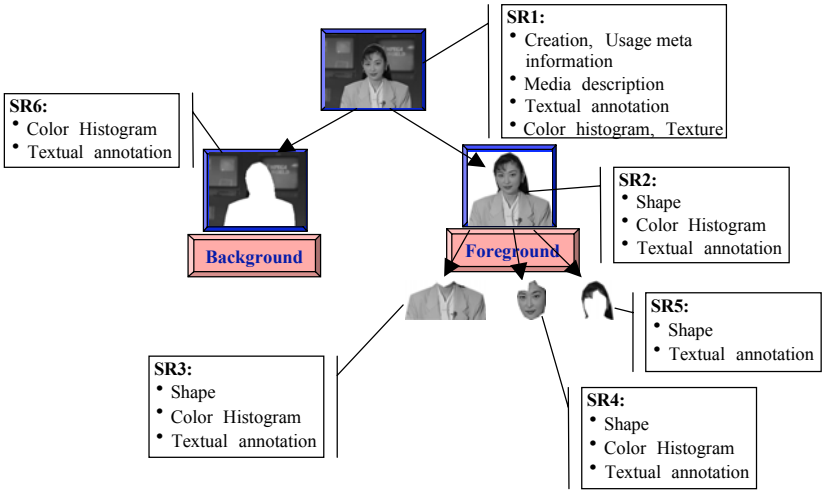
Structural Content Description: Segments

- A segment represents a section of an audio-visual content item.
- The Segment DS is an abstract class (in the sense of object-oriented programming).
- It has nine major subclasses:
  - Multimedia Segment DS
  - AudioVisual Region DS
  - AudioVisual Segment DS
  - Audio Segment DS
  - Still Region DS
  - Still Region 3D DS
  - Moving Region DS
  - Video Segment DS
  - Ink Segment DS
    - » relating to electronic ink from pen, smartboard etc.

Examples of Segments

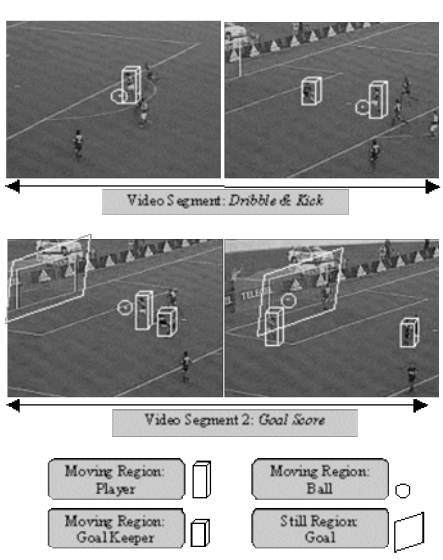


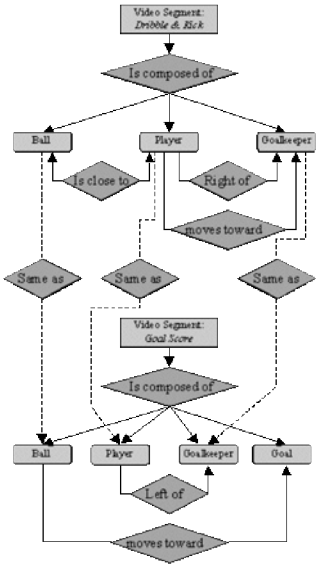
Example of a Segment Tree



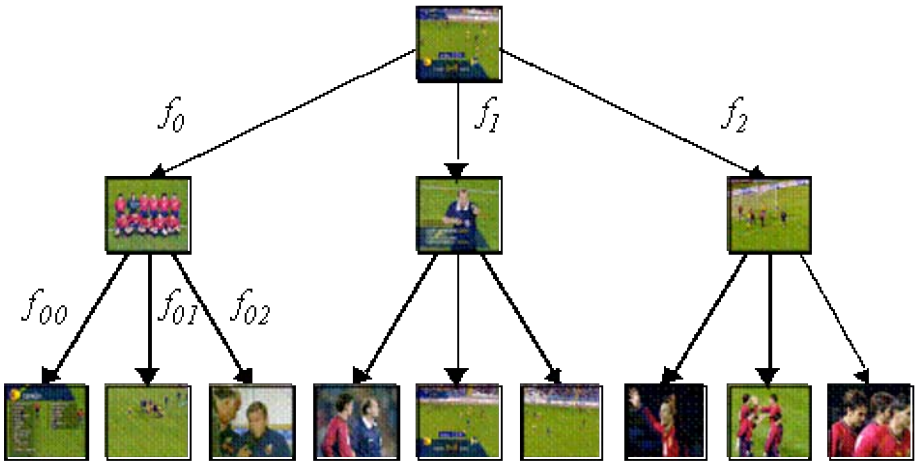
Source: MPEG-7 & R. Klamma

Video Segmentation with Moving Regions



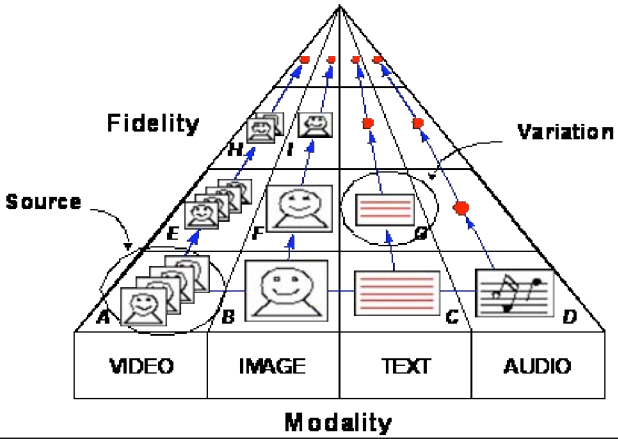


Example: Summary as Hierarchy of Key Frames



Variations

- Components of a complex multimedia object may exist in various variations (different resolutions, languages, etc.)
  - Server or proxy server should be able to select the appropriate variation

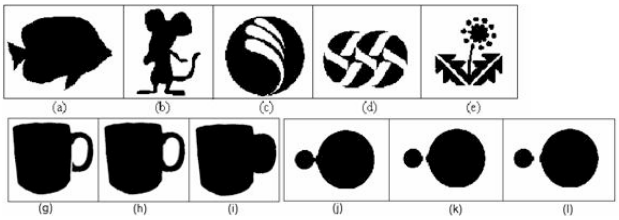


MPEG-7 Visual Description Tools

- Basic structures and Descriptors for the following basic visual features:
  - Color, Texture, Shape, Motion, Localization, and Face recognition
  - Each category consists of elementary and sophisticated Descriptors
- Basic structures:
  - Grid layout, time series, multiple (2D/3D) view, spatial 2D coordinates, temporal interpolation
- Shape descriptors:
  - Region shapes and contour shapes
  - Extraction methods
    - » Able to handle complex shapes
    - » Robust to minor deformations, perspective transformations, occlusions etc.
    - » Compact and efficient

Examples for Shape Descriptors

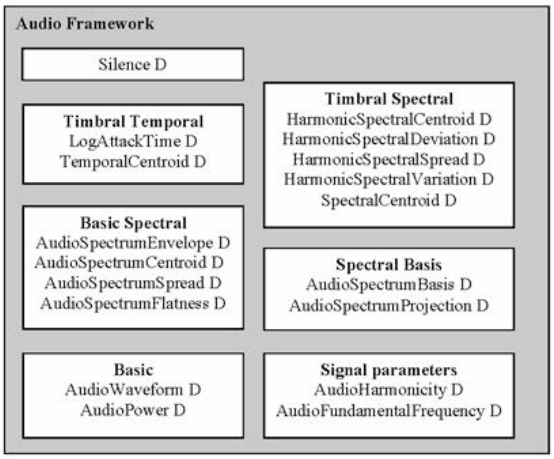
Region shapes:



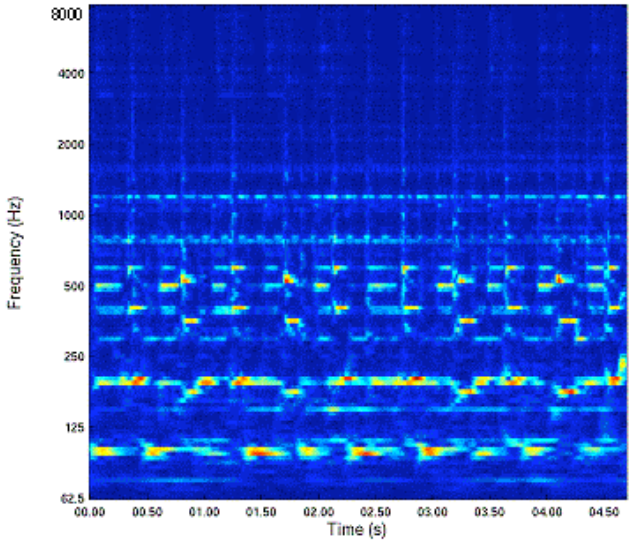
Contour shapes:

MPEG-7 Audio Low-Level Descriptors

- Structures:
  - Single scalar value
  - Series of sampled values
- Features:
  - See figure



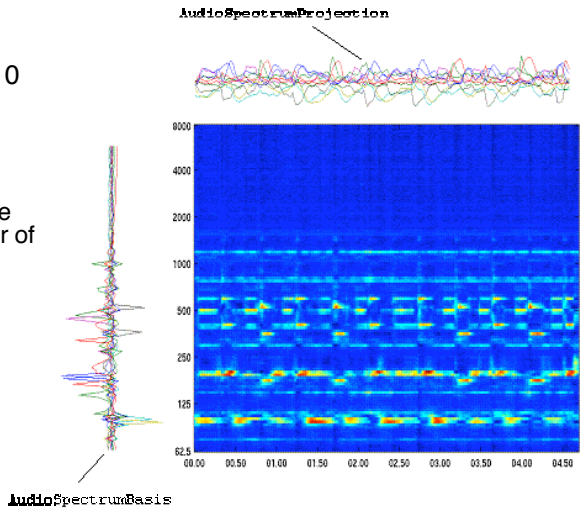
Spectral Analysis with AudioSpectrumEnvelope



Data-Reduced Spectral Representation

- Reconstruction of sonogram using a compact representation of 10 vectors
  - required storage space 10(M+N) values

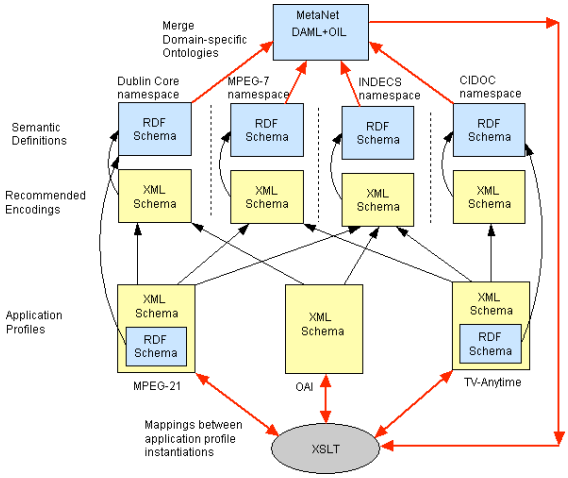
    M number of time points, N number of spectrum bins



MPEG-7 Audio High-Level Descriptors

- Audio signature
  - Statistical summary of spectral flatness descriptor
  - Fingerprinting, identification of audio content
- Musical instrument timbre
- Melody description
  - MelodyContour (terse, efficient)
  - MelodySequence
  - Example: http://www.musicline.de/ --> Melodiesuche
- General sound recognition and indexing
  - Probabilistic classifiers for sound classes
- Spoken content
  - Output and intermediate results of Automatic Speech Recognition (ASR)

Embedding MPEG-7 into the Semantic Web

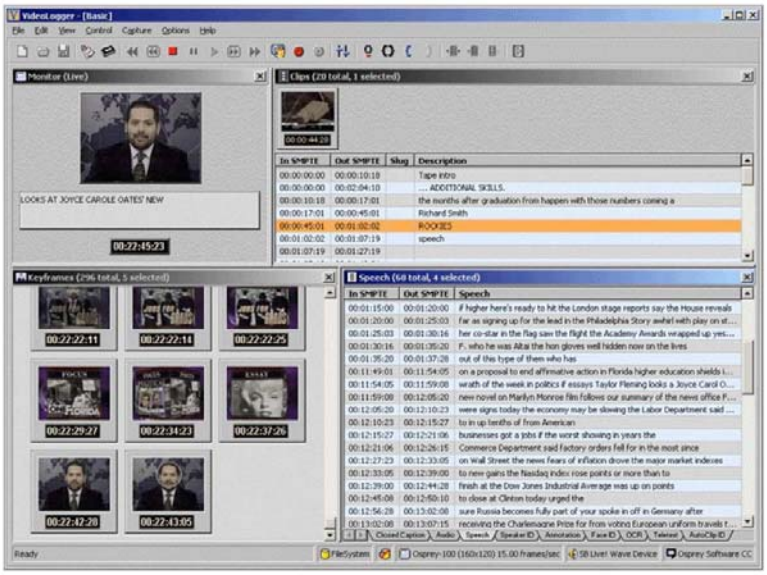


- From: Jane Hunter, Adding Multimedia to the Semantic Web – Building an MPEG-7 Ontology, Proceedings of the First Semantic Web Working Symposium (SWWS), Stanford, USA (2001) 261-281

5 Multimedia Content Description

Literature:
www.virage.com

Virage VideoLogger



Techniques used by Virage VideoLogger

- Signal analysis algorithms to generate keyframes for visual overview
- Speech-to-text transcription
- Sound identification
- Speaker identification
  - voice identification and face identification
- Analysis of embedded textual information:
  - close captioning, teletext
- External metadata:
  - PowerPoint presentations
  - EDLs
  - GPS data
  - transcripts
- Manual annotation:
  - Effective user interface (hot keys etc.)