TECHNOLOGICAL FEATURES OF MODERN VIDEO-SHARING PLATFORMS

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Abstract

This study explores the fundamental components of modern video-sharing platforms, focusing on metadata, video coding and encoding formats, and user interface elements. Metadata, which provides structured information about video and audio files, enhances discoverability, enables search engine optimization, and supports efficient organization and management of digital content. It is generally classified into descriptive, structural, and administrative categories, each serving specific functions in identification, navigation, and preservation. Video coding transforms visual data into a compact binary format to enable storage and transmission, relying on lossless, perceptual, and lossy compression principles. Video encoding formats define how content is packaged and delivered, affecting streaming performance, storage efficiency, and cross-platform compatibility. Finally, the user interface—comprising the video player, search engine, and recommender system—facilitates intuitive navigation, personalized content interaction, and efficient media delivery. Together, these technical and informational components underpin the effective functioning of contemporary digital media ecosystems, ensuring high-quality content access, discoverability, and user engagement.

Key words: metadata, video coding, video encoding, recommender system

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Metadata standards and interoperability

Metadata refers to information that describes other data, such as a video file, audio recording, or web page. It plays a key role in improving the discoverability of video content for both individual users and organizations that host videos on their websites or on platforms such as Google, iTunes, YouTube, MySpace, Youku, and Vimeo. Metadata does not alter the content of a video but serves as an informative label. When metadata is created or extracted from a video, it allows for the selection of relevant keywords and descriptions that support search engine optimization (SEO). Search engines use metadata to determine the ranking of content within search results and to generate brief descriptions displayed in those results. This process enhances both the visibility and the quality of traffic directed to websites. Metadata is particularly important for video materials, as video files lack inherent textual elements that can be used for keyword-based searches. While video producers may include keywords in file names, additional descriptive metadata is necessary for computers and search engines to accurately interpret and locate video content [8].

In most metadata standards, there is no explicit mechanism for representing multiple views of a single scene, particularly when these views differ in their temporal duration. In contrast, support for multi-channel audio is generally more advanced due to its longer history of standardization. Although most standards allow the representation of multi-view video content, such representations usually depend on application-specific semantics, and multiple alternative approaches are often possible [1].

In general, metadata are data describing the nature and characteristics of other data.. It can be compared to the index of a book, which contains concise information summarizing the book's content. By reading the index, a reader can gain an overview of the book without going through the entire text, although the index itself does not include detailed information. Similarly, metadata offers a structured

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summary that supports data organization and retrieval. In the context of search engines, metadata plays an essential role in locating specific web pages that match a user's query, thereby improving the accuracy and efficiency of information retrieval [8].

To clarify the concept of metadata, it can be divided into several categories that reflect their distinct roles within information systems. The classification of metadata depends on the specific domain, user requirements, and the nature of the represented resources or entities [4]. Metadata is generally classified into three main categories: descriptive, structural, and administrative metadata [2]. Each of these categories plays a specific role in describing, organizing, and managing digital resources, as shown below:

• Descriptive Metadata – provides information that enables the identification, discovery, and understanding of a digital resource. Common elements include title, author, and subject. Its main purposes are discovery, presentation, and interoperability.

• Structural Metadata – describes the internal organization of a digital resource and the hierarchical relationships among its components. It typically includes information about sequence and position within a hierarchy, supporting navigation and presentation.

• Administrative Metadata – contains information necessary for managing the lifecycle of digital resources, including their creation, maintenance, and preservation. It may include attributes such as file type, size, creation date, preservation activities, copyright status, and licensing information. The main functions are interoperability, digital object management, and preservation. This category is further divided into:

- Technical Metadata – specifies the technical characteristics and dependencies required for decoding and rendering a digital file.
- Preservation Metadata – records information necessary for the long-term maintenance and accessibility of digital materials, such as hardware and software dependencies.
- Copyright Metadata – documents details related to intellectual property rights and licensing associated with the digital content [4].

Metadata offers detailed information about the contents of a video library and supports the organization and management of such collections. It consists of descriptive information associated with a file, which may include details such as copyright data, author, keywords, file size, media format, people involved, location, and information related to captions or subtitles. This information is embedded within the file and remains attached when the file is copied, shared, or published. In the context of video, metadata is generally categorized into two main types:

• Automatic metadata – generated by devices or software such as cameras. It records technical details like date, time, camera model, aperture, shutter speed, GPS location, and other settings, usually in the Exchangeable Image File Format (EXIF). Most EXIF data cannot be changed after recording.

• Manual metadata – created by people to describe the video's content. It includes titles, descriptions, and transcripts that make videos easier to search and categorize. Manually added metadata improves visibility in search engines and supports marketing by helping viewers find relevant content.

Both types of metadata are essential for video sharing and discovery. Platforms like YouTube rely on metadata to classify videos and enhance search and recommendation functions [8]. In general, video metadata is structured information embedded within a digital video file that describes its content and technical characteristics. It can be extracted from different parts of the file's hierarchical structure, such as headers or specific data segments. This metadata may include details related to video, audio, and subtitles, and is essential for organizing, analyzing, or verifying video files across different encoding standards [10].

Video coding principles and encoding formats

In the digital media landscape, video data must be efficiently represented, transmitted, and stored without significant loss of quality. This efficiency is achieved through video encoding, a process that compresses raw footage while maintaining visual fidelity and ensuring compatibility across devices and platforms. To support this process, various encoding standards and formats have been developed, each balancing compression performance with image quality and playback flexibility.

Video coding transforms visual data into a compact binary format to enable efficient storage and transmission. Over the past two decades, the main international video coding standards have been jointly developed by two organizations: ISO/IEC’s Moving Picture Experts Group (MPEG) and ITU-T’s Video Coding Experts Group (VCEG). These collaborations produced a series of widely adopted standards: H.262/MPEG-2 (1995), H.264/AVC (2003), H.265/HEVC (2013), and H.266/VVC (2020). All these standards rely on three core principles:

• Lossless compression, which removes spatial and temporal redundancy through techniques such as motion estimation and entropy coding.

• Perceptual compression, which discards information not noticeable to the human visual system.

• Lossy compression, achieved through quantization to further reduce data size [3].

While video coding establishes the theoretical framework and algorithms governing video compression, video encoding represents the practical implementation of these principles. It determines how a video stream is processed, packaged, and stored in specific file formats for playback or distribution.

Video encoding format refers to the technical structure and compression method used to represent a film or video file. It defines the file’s quality, adaptability, and usability across different platforms and devices. Numerous encoding formats exist, including AVI, DV, HDV, MOV, WMV, MPEG-1, MPEG-2, MPEG-4, MJPEG, MKV, and 4K, among others.

Raw video recordings occupy substantial storage space, often several gigabytes per minute depending on resolution and frame rate. Therefore, compression is essential to reduce file size for efficient storage, distribution, or streaming. Different compression methods vary in efficiency, quality retention, and compatibility, influencing the choice of format based on production needs and technical requirements. Video encoding formats determine how a film is stored, accessed, and distributed—whether on physical media such as VHS or VCD, on digital storage devices, or via online streaming platforms. The format also affects the level of compression possible, the resulting image quality, and the ease of modification or playback. Over time, multiple standards have been developed to address evolving technological demands and media applications [6].

Within the technological framework of modern video-sharing platforms, video coding and video encoding formats play a central role in optimizing content delivery and playback. Platforms rely on standardized coding algorithms such as H.264/AVC and H.265/HEVC to compress and transcode uploaded videos into multiple formats and bitrates. This enables adaptive streaming, ensuring consistent quality across devices and varying network conditions. The efficiency of the selected coding standard and encoding format directly influences streaming performance, storage requirements, and overall user experience, making them essential components of contemporary digital media infrastructure.

Fig. 1 illustrates the principles of video coding and the corresponding encoding formats.

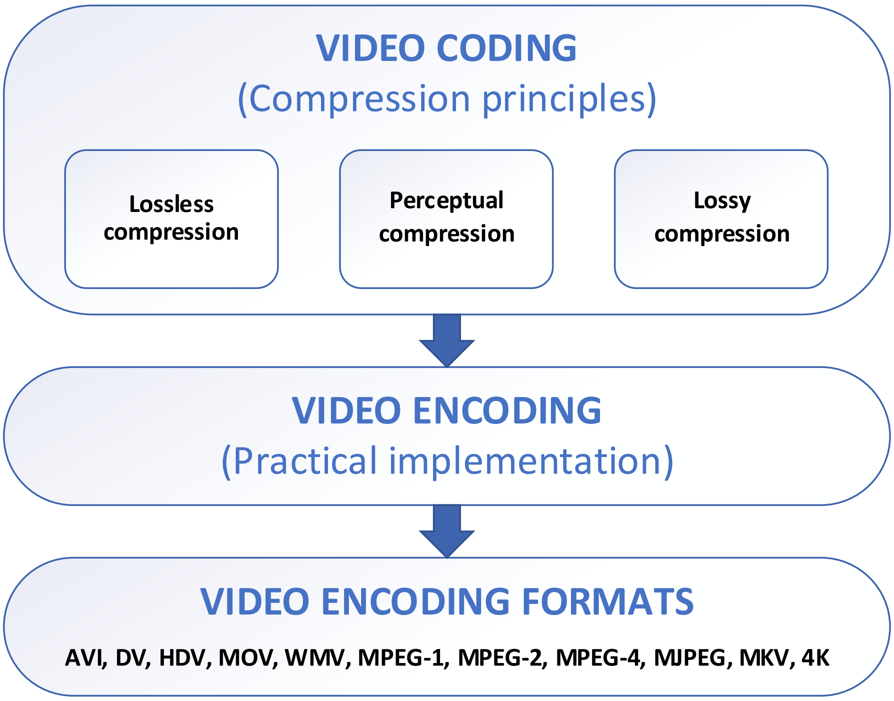

Figure 1: Overview of video coding principles and encoding formats

User interface main components of video-sharing platforms

In the context of modern video-sharing platforms, several components of the user interface play a decisive role in shaping user engagement and content accessibility. The main technical components of the User Interface (UI) in modern video-sharing platforms are designed to facilitate efficient media delivery, intuitive navigation, and personalized content interaction. These components integrate playback technologies, search functionalities, and recommendation algorithms to create a cohesive and responsive user experience across devices. In such user interfaces, three core elements can be identified:

• Video Player. As a central module of video-sharing platforms, the video player provides users with direct access and control over audiovisual content. The adoption of HTML5 eliminated the need for external plug-ins or proprietary software by introducing native support for open multimedia formats in web browsers. This standard enables smooth streaming, adaptive playback, and consistent performance across devices such as smartphones, tablets, computers, and smart TVs. Through HTML5 integration, video delivery has become more stable, secure, and widely accessible, establishing a technological foundation for modern online media playback [9].

• Search Engine. Search functionality allows users to efficiently discover videos or channels from vast platform databases. Technically, a search engine retrieves information based on user-specified keywords or phrases, using indexed metadata—such as titles, descriptions, and tags—to return relevant results. In platforms like YouTube and Vimeo, these engines are optimized for multimedia retrieval and often employ personalization algorithms to adapt search results to individual viewing patterns and interests [7].

• Recommender System. Recommendation mechanisms personalize content access by suggesting videos that match a viewer's preferences and past interactions. Evolving from earlier domains such as book or movie recommendation, these systems now underpin major platforms like YouTube and Netflix. By analyzing user behavior and video attributes, they predict content likely to sustain engagement. Beyond improving user experience, recommendation algorithms serve a strategic role in increasing retention, visibility, and viewing time, making them a defining element of contemporary video-sharing ecosystems [5].

Conclusion

From the conducted research, the following key points can be summarized:

- Metadata represents information that provides details about other data, such as video files, audio recordings, or web pages. It is classified into three main categories: Descriptive Metadata, Structural Metadata, and Administrative Metadata. Each category serves a distinct purpose in organizing, identifying, and managing digital resources.
- Video coding involves converting visual data into a compact binary format to enable efficient storage and transmission. It is based on the principles of lossless, perceptual, and lossy compression,
- In modern video-sharing platforms, video coding and encoding formats play a vital role in ensuring efficient content delivery and smooth playback. Their effectiveness directly impacts streaming performance, storage efficiency, and user satisfaction, making them key components of the digital media ecosystem.
- Key components of the user interface in modern video-sharing platforms are the video player, search engine, and recommender system. These elements collectively ensure efficient content delivery, intuitive navigation, and personalized user experiences.

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