VIDEO SUMMARISATION AND SEGMENTATION

PROJECT REPORT – PHASE I

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

By

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Hari Kiran (41110682)** who carried out the Project entitled "**VIDEO SUMMARISATION AND SEGMENTATION**" under my supervisionfrom June 2024 to December 2024.

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DECLARATION

I, **Hari Kiran (Reg. No- 41110682),** hereby declare that the Project Report entitled**"VIDEO SUMMARISATION AND SEGMENTATION"** done by me under the guidance of **Dr. B. Ankayarkanni, M.E., Ph.D.,** is submitted in partial fulfillment of the requirements for the award ofBachelor of Engineering degree in **Computer Science and Engineering**.

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ABSTRACT

This project aims to develop an advanced “Video Summarisation and Segmentation System” that efficiently condenses lengthy videos into concise, informative summaries. Leveraging state-of-the-art techniques in video processing and Natural Language Processing. the system performs precise segmentation and extracts key frames and segments to produce meaningful summaries. The project involves implementing various video segmentation methods, including shot boundary detection, semantic segmentation, and temporal segmentation. For summarisation, it employs keyframe extraction, segment-based summarisation, and multimodal analysis to integrate visual, audio, and textual information. Additionally, the system incorporates automatic speech recognition (ASR) to convert speech to text, using NLP techniques for text summarisation. The user-friendly interface allows customisation of summary length and focus areas, enhancing the usability and relevance of the summaries. By optimising for real-time processing and using pre-trained deep learning models, the system provides an efficient solution for quickly understanding and navigating through extensive video content, making it a standout project in the field of video analysis and summarisation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTIO

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In the age of information overload, video content has become a dominant medium for communication, education, and entertainment. However, the sheer volume of video data presents a significant challenge: how can users efficiently extract meaningful insights from lengthy and often unwieldy videos? This project addresses this challenge by developing an advanced "Video Summarisation and Segmentation System," designed to transform extensive video content into concise, informative summaries that enhance user understanding and navigation.

The core objective of this project is to leverage state-of-the-art techniques in video processing and Natural Language Processing (NLP) to create a system capable of efficiently condensing and summarizing lengthy videos. By implementing sophisticated video segmentation methods, such as shot boundary detection, semantic segmentation, and temporal segmentation, the system will precisely segment videos into manageable parts. This segmentation is crucial for extracting key frames and segments that contribute to coherent and meaningful summaries.

The summarisation component of the system employs a combination of keyframe extraction, segment-based summarisation, and multimodal analysis. Keyframe extraction identifies representative frames that capture the essence of each segment, while segment-based summarisation provides detailed insights into each segment's content. Multimodal analysis integrates visual, audio, and textual information, ensuring a comprehensive understanding of the video content.

Incorporating Automatic Speech Recognition (ASR), the system converts spoken content into text, which is then summarized using advanced NLP techniques. This integration of speech-to-text conversion with textual summarisation enhances the depth and accuracy of the generated summaries.

A key feature of the system is its user-friendly interface, which allows users to customize summary length and focus areas according to their preferences. This customization ensures that summaries are not only relevant but also tailored to individual needs.

Optimized for real-time processing and leveraging pre-trained deep learning models, the system offers an efficient solution for navigating and understanding extensive video content. By addressing the challenges of video analysis and summarisation, this project stands out as a significant advancement in the field, aiming to make video content more accessible and manageable for users across various domains.

CHAPTER 2

LITERATURE

SURVEY

1. **J. Wang, Y. Wang and Z. Zhang, "Visual Saliency Based Aerial Video Summarisation by Online Scene Classification," *2011 Sixth International Conference on Image and Graphics*, Hefei, China, 2011, pp. 777-782, DOI: 10.1109/ICIG.2011.43**.

Aerial video is crucial for both military surveillance and commercial monitoring, such as tracking forests and crops. With the increasing volume of aerial video data, efficient methods for transmission and storage are needed. Redundant data between adjacent frames makes it unnecessary to transmit or store every frame. To address this, we propose a video summarization method that focuses on transmitting and storing only the most informative frames, thus reducing redundancy.

Current video summarization techniques face challenges with aerial video due to limitations in storage, computation, and communication capabilities on aerial vehicles. Conventional methods, often designed for structured videos with clear edit boundaries, are not suitable for the continuous, dynamic nature of aerial footage. Traditional summarization approaches also rely on offline processing of short clips, which is impractical for the massive, real-time data streams of aerial video.

Our proposed method introduces a novel approach to summarizing aerial video in real-time. Unlike traditional methods that segment video based on edit boundaries, our approach divides aerial video into temporal segments using scene classification. We also present an online clustering method for scene classification to accommodate the continuous nature of the data stream. Key frames are selected from each temporal segment using a combination of visual saliency index (VSI) and inhibition of return mechanisms. This method aims to enhance the efficiency of aerial video summarization, making it feasible to manage and interpret large-scale video streams effectively while addressing the specific constraints of aerial systems.

2. H. Y. Adel, R. M. Elmasry and M. A. . -M. Salem, "Object-Based Video Archive Summarisation," 2023 International Mobile, Intelligent, and Ubiquitous Computing Conference (MIUCC), Cairo, Egypt, 2023, pp. 351-356, doi: 10.1109/MIUCC58832.2023.10278378.

Video data is integral to modern life, encompassing everything from security footage to personal recordings. However, raw video content is often lengthy and redundant, making it difficult and time-consuming to review, especially in security situations. This challenge necessitates effective methods for exploring and extracting relevant information from videos.

Video summarization addresses this problem by condensing lengthy footage into concise summaries that capture the video's key elements. The goal is to make it easier for users to find and analyze essential content without wading through hours of footage.

In this paper, we introduce a system designed to summarize long video footage based on user queries. The system operates by first receiving a user-defined query related to an object of interest. This query is then matched against a pre-trained model that identifies and classifies objects using COCO object classes. If the query aligns with one of these classes, the system detects and tracks the specified object throughout the video.

The output is a focused video that highlights only the movements of the targeted object. This approach ensures that users receive a streamlined and relevant summary, tailored to their specific needs, thus making video exploration more efficient and manageable.

3. K. S. Ramasubramaniam and G. Annamalai, "In-source video summarisation," 2016 IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, 2016, pp. 548-550, doi: 10.1109/ICCE.2016.7430726

Modern transmission standards such as ATSC, DVB, and ISDB use MPEG compression to manage an increasing number of video channels and recordings. As the volume of content grows, users often face challenges in tracking which programs they have watched or need to watch. Movie summarization helps address this issue by providing concise previews of movies, allowing users to quickly determine if a film is worth watching or if they have already seen it.

Traditional summarization algorithms focus on video attributes like brightness and contrast but often fail to cater to individual genre preferences. For instance, a user with a preference for romance might find romance scenes in a thriller more memorable, yet these scenes may be overlooked by algorithms that do not account for genre-specific content.

Current video summarization methods involve decompression up to but not including the Inverse Discrete Cosine Transform (IDCT), which requires substantial computational resources. These methods are not easily adaptable to various genres, and manual intervention is often necessary to ensure the summarization's accuracy and relevance.

To overcome these limitations, this paper proposes a novel approach that embeds summarization information directly into the source video stream. This mechanism integrates summarization data into the stream in a way that complies with existing standards, simplifying the decoding process and improving the relevance of summaries across different genres and user preferences.

4. X. Teng, X. Gui, H. Dai, T. Du, Z. Wang and H. Li, "A Smooth Video Summarisation Method Based on Frame-Filling," 2020 IEEE 20th International Conference on Communication Technology (ICCT), Nanning, China, 2020, pp. 1418-1422, doi: 10.1109/ICCT50939.2020.9295765.

Video data is crucial for various applications, including movies, surveillance, and news, thanks to advances in storage and editing technologies. However, the vast increase in video volume makes it challenging to retrieve, store, and extract useful information. Video summarization helps by condensing long videos into concise summaries, highlighting key content for easier review.

Video summarization methods can be divided into dynamic and static types. Static summarization, for example, involves clustering frames with high information content to create summaries. Research in this field focuses on three main approaches: key-frames, key shots, and time intervals.

1. **Key-frames Based Approaches**: These include methods based on video characteristics (like shot boundaries and motion), traditional machine learning techniques (such as clustering and hybrids), and deep learning methods. Deep learning approaches can extract features and ensure accuracy but often increase computational complexity and may not address user-specific needs effectively.

2. **Key Shots and Time Intervals**: These methods segment videos into significant shots or time intervals but might struggle with balancing user preferences and managing semantic redundancy.

Existing summarization algorithms have notable shortcomings:

1. **Performance vs. Complexity**: High-performance algorithms may compromise space-time efficiency, lacking a balance tailored to user requirements.

2. **Semantic Redundancy**: Some methods introduce redundancy to preserve content integrity, affecting summary quality.

3. **Discontinuity**: Gaps between key-frames can reduce the readability and coherence of the summaries.

To overcome these challenges, this paper proposes a new static video summarization scheme. This method includes an efficient algorithm for removing redundant frames during pre-processing, which enhances summary quality and simplifies the summarization process. It also features a frame-filling strategy using a smoothing function to ensure semantic integrity and produce a coherent video summary.

5. M. -Y. Zhang and W. -Y. Cai, "Multi-view Video Summarisation Algorithm for WMSN," 2014 International Conference on Wireless Communication and Sensor Network, Wuhan, China, 2014, pp. 213-216, doi: 10.1109/WCSN.2014.50

Wireless Multimedia Sensor Networks (WMSNs) utilize numerous camera sensors for video surveillance and object tracking. The advent of inexpensive video cameras and cost-effective memory has increased interest in multi-view video, where multiple cameras capture overlapping scenes to provide a comprehensive view.

In WMSNs, the dense deployment of camera sensors generates overlapping video streams, necessitating efficient multi-view video coding for effective storage and transmission. Multi-view video sequences, which offer different perspectives of the same scene, enhance the overall content but also introduce significant redundancy.

To handle this, the H.264/AVC standard has been extended to include Multi-View Coding (MVC), which combines temporal and inter-view predictions. This method allows frames to be predicted from both their temporal neighbors and corresponding frames in adjacent views. While MVC improves multi-view video processing, it still suffers from redundancy, which is problematic for bandwidth-limited WMSNs.

A promising solution is summarizing multi-view videos into a single mono-view using correspondence matching. This approach reduces data redundancy, significantly compresses the video data, and improves the efficiency of storage and transmission in WMSNs.

6. P. G. Shambharkar and R. Goel, "Analysis of Real Time Video Summarisation using Subtitles," 2021 International Conference on Industrial Electronics Research and Applications (ICIERA), New Delhi, India, 2021, pp. 1-4, doi: 10.1109/ICIERA53202.2021.9726769.

The proliferation of video content across the Internet and multimedia platforms has made video a key medium in various applications such as digital broadcasting, interactive TV, video on demand, and multimedia devices. As the volume of video data grows, effectively managing, storing, and indexing this content has become increasingly challenging.

Video summarization addresses these issues by condensing lengthy videos into concise representations. This technique extracts essential frames or sequences, enabling users to quickly browse and grasp the core content of the video. Summarization can take the form of static keyframes or dynamic video skims. Keyframing involves creating still images from significant frames, while skimming speeds up or compresses the video, integrating both visual and audio elements for a more dynamic summary.

There are two main types of video summarization based on timing: real-time and static. Real-time summarization selects critical frames during live video recording, which is useful for immediate content capture. Static summarization applies to recorded videos and is performed after the video has been captured.

This paper focuses on improving video summarization by aligning frames with automatically generated subtitles. The process involves mapping summarized text to video frames and creating an audio track that accompanies the summarized footage. This method aims to enhance the accessibility and comprehensiveness of video summaries, making it easier for users to understand and navigate through large volumes of video content.

7. A. Vimalaksha, S. Vinay, A. Prekash and N. S. Kumar, "Automated Summarisation of Lecture Videos," 2018 IEEE Tenth International Conference on Technology for Education (T4E), Chennai, India, 2018, pp. 126-129, doi: 10.1109/T4E.2018.00034

Technological advancements have significantly transformed education, particularly in how lectures and content are delivered. However, as technology evolves, managing and utilizing these tools effectively can become challenging. To address these issues, a new tool has been developed to simplify the use of lecture recordings in educational settings.

This tool addresses common problems by splitting lengthy lecture videos into shorter, topic-based segments. It operates based on predefined time intervals and ensures that splits occur at logical points, avoiding cuts in the middle of words. This approach maintains the continuity of the content and improves the overall viewing experience.

Additionally, the tool enhances efficiency by incorporating transcription and summarization techniques, which help in reducing the length of the videos while retaining key information.

Usage statistics from a college for September show that lecture video engagement increases during exam periods, highlighting the tool's practical value, even though these figures do not capture peak usage.

By converting a single extensive lecture video into a series of clear, concise segments, this tool improves navigation and understanding. The segmented videos make it easier for students to find and comprehend specific topics, thereby enhancing their learning experience.

8. P. Tarare and D. Jadhav, "A novel video summarisation technique using weighted combination of color and texture feature," 2015 International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT), Davangere, India, 2015, pp. 403-408, doi: 10.1109/ICATCCT.2015.7456917.

A. Necessity of Video Summarization

The explosion of multimedia content—text, audio, images, animations, and videos—creates massive data volumes that are challenging to process manually. With the rise of digital media, including sports, news, TV shows, and movies, handling such large video datasets efficiently is crucial. Advances in digital recording and distribution have made creating and sharing content easier, but watching entire videos is often impractical for users. Video summarization addresses this issue by condensing long videos into shorter, more manageable summaries. This technique facilitates efficient storage, fast browsing, and quick retrieval of relevant information.

B. Video Summarization

Video summarization creates concise versions of lengthy videos while maintaining key elements and reducing redundancy. To produce an effective summary, it must:

1. Highlight significant entities and actions from the video.
2. Exhibit continuity and flow.
3. Avoid repetition.

The process involves extracting frames from the video, analyzing features such as texture, color, motion, and shape, and identifying key frames. These frames are then compiled into a summary that captures the essence of the original video. This approach not only simplifies content navigation but also ensures that users can quickly access important information without watching the entire video.

9. Y. Thu and W. P. Pa, "Generating Myanmar News Headlines using Recursive Neural Network," 2020 IEEE Conference on Computer Applications(ICCA), Yangon, Myanmar, 2020, pp. 1-6, doi: 10.1109/ICCA49400.2020.9022817.

With the vast amount of information on news websites, users need efficient methods to extract relevant details quickly. Document summarization addresses this need and is categorized into two types: extractive and abstractive. Extractive summarization selects key sentences from the original text, while abstractive summarization involves encoding the text into a latent representation and then decoding it to generate a summary. Although abstractive methods can produce summaries from scratch, they often struggle with encoding long documents effectively, leading to slower and less accurate results.

Recursive RNN-based summarization models, which generate concise summaries or headlines by focusing on essential points, are particularly useful. These models have shown effectiveness in various languages, including Myanmar. Due to the limited availability of summarization tools for the Myanmar language, this paper introduces three key contributions**:**

1. **Context Vectors:** Extracting context vectors from Myanmar news documents for extractive summarization.
2. **RNN Model:** Utilizing an RNN-based model to train and generate summaries for Myanmar news**.**
3. **Context Vector Application:** Applying document context vectors to produce summaries of Myanmar news articles.

The paper is organized as follows: Section 2 reviews related work, Section 3 addresses challenges in Myanmar news summarization, Section 4 provides an overview of the RNN-based summarization model, Section 5 discusses experimental setups and results, and Section 6 concludes with future work directions.

10. A. Vimalaksha, S. Vinay, A. Prekash and N. S. Kumar, "Automated Summarisation of Lecture Videos," 2018 IEEE Tenth International Conference on Technology for Education (T4E), Chennai, India, 2018, pp. 126-129, doi: 10.1109/T4E.2018.00034.

Advancements in technology have significantly transformed education, particularly in how information is communicated to students. However, as technology evolves, users often struggle to adapt and utilize these new tools effectively. To address these challenges, a sophisticated tool is needed to simplify and enhance the use of technology in educational settings.

A newly developed tool aims to improve the viewing experience for students and faculty by efficiently managing lecture videos. This tool addresses several issues associated with lecture video services, such as effectively splitting videos into manageable segments based on specified time intervals. Importantly, it avoids splitting videos in the middle of a word, which enhances clarity and coherence. Additionally, the tool reduces video length through transcription and summarization processes, making the content more concise and accessible.

Statistics from the college’s lecture video usage in September demonstrate the tool's effectiveness, with viewing figures increasing significantly during exam periods. The tool’s output consists of clearer, shorter videos segmented by topic, which facilitates better navigation and understanding of the content.

5.1. Inferences and Challenges in Existing System

Inferences:

1. **Advancement in Techniques**: The review illustrates a significant evolution in video summarization from basic methods to sophisticated neural network approaches. Traditional techniques often struggled with accuracy and context. For instance, early methods relied on crowdsourcing or simple algorithms that could not effectively handle complex video content. The emergence of LSTM-based encoder-decoder models marks a major advancement. These models leverage deep learning to understand context and generate more accurate summaries, making them superior to older, feature-based methods that were limited in their ability to manage intricate video narratives.

2. **Challenges with Early Methods**: Initially, techniques such as crowdsourcing and high-frequency sound devices were employed for video segmentation, but these faced considerable accuracy issues. Crowdsourcing often suffered from variability in human input, while high-frequency devices and black screens were not always reliable or scalable. The shift to silence detection for video splitting represented an improvement, as it utilized audio cues to identify natural pauses in speech, thus avoiding the problem of splitting videos mid-sentence. This approach enhances the precision of video segmentation, leading to more coherent summaries.

3. **Tool Effectiveness**: Tools like Sumy have emerged to address the need for effective video summarization by focusing on content retention and compression. These tools use algorithms to extract key frames or sequences and eliminate redundant information. Evaluation metrics such as ROUGE scores are employed to assess the quality of these summaries. Despite improvements, challenges remain, including issues of content overlap and potential loss of critical information. These limitations highlight the ongoing need for refinement in summarization techniques to ensure that summaries are both comprehensive and concise.

4. **Future Potential**: The review indicates that while current neural network-based summarization methods have made significant strides, there is still potential for further enhancement. Future improvements could address issues such as content redundancy and overlap, which currently impact the effectiveness of summaries. Ongoing research aims to refine these techniques to produce more accurate and relevant summaries, further advancing the field of video summarization.

Drawbacks:

1. **Traditional vs. Neural Approaches**: Traditional summarization methods often rely on basic feature extraction, which can be less flexible and less accurate than modern neural network-based methods. For example, early methods might use simple algorithms to extract keyframes based on brightness or motion, but these approaches may fail to capture the nuanced context of a video. Neural network-based methods, such as encoder-decoder architectures and Recursive RNNs, offer greater adaptability and precision. They are capable of understanding complex sentence structures and contextual information, resulting in more coherent and accurate summaries.

2. **Challenges in Video Summarization**: The early reliance on crowdsourcing and high-frequency devices highlighted several challenges. Crowdsourcing can lead to inconsistent results due to human variability, while high-frequency devices and black screens might not provide reliable solutions for accurate video segmentation. These challenges underscore the difficulty in finding scalable and practical solutions for video summarization, particularly in educational or large-scale contexts.

3. **Silence Detection as a Key Tool**: Silence detection has become a crucial tool in improving video splitting accuracy. By identifying natural pauses in audio, this method helps prevent splitting videos in the middle of sentences, thus maintaining coherence. However, while effective, it is not a perfect solution. The accuracy of this method can still be impacted by factors such as background noise or non-standard speech patterns, which can affect the reliability of the video summaries.

4. **Summarization Techniques**: Tools like Sumy that integrate transcription and summarization techniques aim to balance content compression with key information retention. However, ensuring that summaries are both concise and informative remains a challenge. The process involves not only removing redundant content but also preserving essential information, which can be difficult to achieve perfectly. The need to balance these aspects highlights the complexity of creating effective video summaries.

5. **Scalability and Adaptability**: Traditional summarization methods often struggle with scalability, particularly when applied to large volumes of video data. In contrast, neural network-based approaches and techniques like silence detection offer more scalable and adaptable solutions. These methods can be tailored to various contexts and datasets, making them more versatile and effective for a wide range of summarization tasks. However, the implementation of these advanced methods still requires careful consideration of their computational demands and practical applications.

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