RUNTIME TEMOTE VIDEO QUALITY ASSESSMENT

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ABSTRACT - Runtime Remote Video Quality Assessment is a real-time video analysis system designed to evaluate the quality of video streams without requiring the original reference video. With the rapid growth of applications such as video conferencing, online education, telemedicine, live streaming, and remote surveillance, maintaining high video quality has become essential for ensuring a better Quality of Experience. However, factors such as network congestion, bandwidth limitations, packet loss, compression artifacts, and environmental conditions can significantly degrade video quality during transmission. The proposed RVQA system uses computer vision and machine learning techniques to analyze video quality automatically. The system accepts a video as input, extracts frames using OpenCV, preprocesses the frames, and computes important visual features such as brightness, contrast, sharpness, blur, and noise. These extracted features are then processed by a machine learning model to estimate the overall video quality and classify it into categories such as Excellent, Good, Fair, or Poor. A web-based interface developed using Flask allows users to upload videos, perform real-time quality analysis, and view the assessment results through graphs and quality metrics. The system is implemented using Python, Flask, OpenCV, NumPy, Matplotlib, and Scikit-learn, providing a lightweight, scalable, and user-friendly solution for runtime video quality monitoring. The proposed system helps detect quality degradation efficiently and supports applications including multimedia streaming, online learning, video conferencing, telemedicine, and intelligent surveillance. Overall, the Runtime Remote Video Quality Assessment system offers an effective approach for improving video quality monitoring and enhancing the overall user experience in modern multimedia communication environments.

KEYWORDS: - Runtime Remote Video Quality Assessment (RVQA), Video

Quality Assessment (VQA), No-Reference Video Quality Assessment (NR-VQA), Computer Vision, Machine Learning, OpenCV, Real-Time Video Processing, Quality of Experience (QoE), Flask.

INTRODUCTION

The rapid growth of digital communication and multimedia technologies has significantly increased the demand for high-quality video streaming services. Applications such as video conferencing, online education, telemedicine, live broadcasting, cloud gaming, and remote surveillance rely on uninterrupted video transmission to deliver a better user experience. However, video quality is often affected by factors such as network congestion, bandwidth limitations, packet loss, compression artifacts, noise, and latency, resulting in degraded visual quality and reduced user satisfaction.

Runtime Remote Video Quality Assessment is a system designed to evaluate the quality of videos in real time without requiring the original reference video. The system processes video frames continuously, extracts important visual features such as brightness, contrast, sharpness, blur, and noise, and applies machine learning techniques to predict the overall quality of the video. Based on the analysis, the video is classified into quality levels such as Excellent, Good, Fair, or Poor. The proposed system is implemented using Python, Flask, OpenCV, NumPy, and Scikit-learn, providing an efficient web-based platform for uploading and analyzing videos. It enables users to monitor video quality instantly and identify degradation during transmission. The RVQA system offers a lightweight, scalable, and cost-effective solution that enhances the Quality of Experience in multimedia applications such as online learning, video conferencing, telemedicine, surveillance, and live streaming.

RELATED WORK

Video Quality Assessment has become an important research area due to the rapid growth of video streaming, online communication, and multimedia applications. Traditional video quality assessment methods, such as Full-Reference and Reduced-Reference approaches, compare the received video with the original reference video to measure quality. Although these methods provide accurate results, they are not suitable for real-time applications because the original video is often unavailable during transmission.

To overcome this limitation, researchers introduced No-Reference Video Quality Assessment techniques, which estimate video quality using only the distorted video. Recent studies have applied computer vision and machine learning algorithms to extract visual features such as blur, brightness, contrast, sharpness, noise, and compression artifacts. These features are then used to predict the overall quality of a video without requiring a reference video. Modern approaches also employ deep learning models, including Convolutional Neural Networks, to improve prediction accuracy and robustness.

The proposed Runtime Remote Video Quality Assessment system builds upon these advancements by integrating Python, Flask, OpenCV, and machine learning techniques to perform efficient real-time video quality analysis. Unlike conventional methods, the system provides a lightweight web-based platform that enables users to upload videos, analyze quality instantly, and view the assessment results through an intuitive interface. This approach makes the system suitable for applications such as video conferencing, online education, surveillance, telemedicine, and multimedia streaming, where maintaining high video quality is essential for ensuring a better Quality of Experience.

LITERATURE SURVEY

The rapid growth of multimedia applications has increased the need for accurate and efficient Video Quality Assessment techniques. Researchers have proposed various methods to evaluate video quality in applications such as video conferencing, online education, live streaming, telemedicine, and surveillance. Traditional approaches, including Full-Reference and Reduced-Reference methods, compare the distorted video with the original reference video to measure quality. Although these techniques provide reliable results, they are not suitable for real-time applications because the reference video is often unavailable during transmission.

To address this limitation, researchers developed No-Reference Video Quality Assessment methods that estimate video quality using only the received video. Recent studies focus on extracting visual features such as blur, sharpness, brightness, contrast, noise, and compression artifacts using computer vision techniques. Machine learning algorithms and deep learning models are then employed to classify the video quality accurately. These approaches have significantly improved the efficiency and accuracy of video quality prediction.

The proposed Runtime Remote Video Quality Assessment system is based on these advancements and integrates Python, Flask, OpenCV, NumPy, and machine learning techniques to perform real-time video quality analysis. The system automatically processes uploaded videos, extracts quality-related features, predicts the quality level, and displays the results through a user-friendly web interface. This approach provides a practical, lightweight, and scalable solution for modern multimedia applications, helping improve the Quality of Experience for users.

EXISTING SYSTEM

The existing video quality assessment systems primarily rely on Full-Reference and Reduced-Reference methods to evaluate video quality. In Full-Reference techniques, the original video is compared with the received video using quality metrics such as Peak Signal-to-Noise Ratio and Structural Similarity Index Measure. Reduced-Reference methods use only partial information from the original video to estimate quality. Although these approaches provide accurate results, they require access to the reference video, which is often unavailable in real-time streaming applications. Recent systems have introduced No-Reference Video Quality Assessment methods that estimate video quality without using the original video. However, many of these systems rely on complex deep learning models that require high computational power, large datasets, and powerful hardware such as GPUs. As a result, they are not always suitable for real-time deployment or resource-constrained environments.

In addition, many existing solutions focus only on offline video analysis and do not provide an interactive web-based interface for users. They often lack real-time processing capabilities, graphical result visualization, and easy integration with multimedia applications. These limitations reduce their effectiveness in applications such as video conferencing, online education, telemedicine, live streaming, and remote surveillance. Therefore, there is a need for a lightweight, efficient, and user-friendly system that can perform runtime video quality assessment with high accuracy and minimal computational cost.

PROPOSED SYSTEM

The proposed Runtime Remote Video Quality Assessment system is designed to evaluate video quality in real time without requiring the original reference video. The system uses computer vision and machine learning techniques to analyze video frames and predict the overall quality efficiently. It accepts a video as input through a web-based interface, processes the video frame by frame, extracts important visual features such as brightness, contrast, sharpness, blur, and noise, and then predicts the video quality using a trained machine learning model. The RVQA system is implemented using Python, Flask, OpenCV, NumPy, Matplotlib, and Scikit-learn, providing a lightweight and user-friendly platform for video quality analysis. The processed results are displayed in the form of quality scores, quality categories (Excellent, Good, Fair, and Poor), and graphical visualizations, allowing users to easily understand the quality of the uploaded video. Compared to existing systems, the proposed solution offers faster processing, lower computational cost, and better usability for real-time applications. Its modular architecture makes it easy to maintain and extend with advanced technologies such as deep learning and cloud computing. The system can be effectively used in video conferencing, online education, multimedia streaming, telemedicine, and surveillance applications, where continuous monitoring of video quality is essential for improving the Quality of Experience and ensuring reliable multimedia communication.

SYSTEM ARCHITECTURE

The Runtime Remote Video Quality Assessment system follows a modular architecture that performs real-time video quality evaluation using computer vision and machine learning techniques. The process begins when the user uploads a video through the Flask-based web interface. The uploaded video is then processed using OpenCV, where individual frames are extracted and preprocessed to improve analysis. Important visual features such as brightness, contrast, sharpness, blur, and noise are extracted from each frame. These features are provided to a machine learning model, which predicts the overall quality of the video and classifies it into categories such as Excellent, Good, Fair, or Poor. Finally, the quality assessment results are displayed on the web interface along with graphical visualizations, enabling users to monitor video quality efficiently. The modular design ensures easy maintenance, scalability, and integration with future technologies such as deep learning and cloud computing.

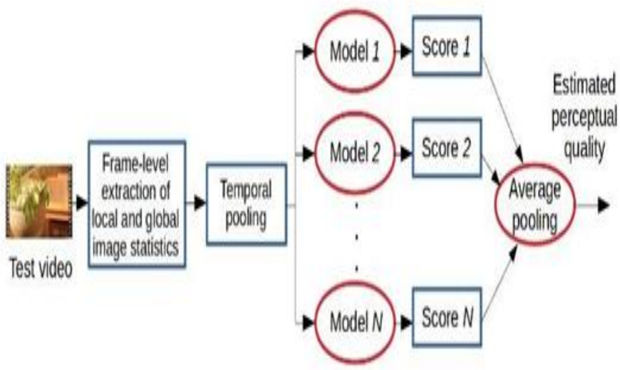

Fig 1: System Architecture

METHODOLOGY DESCRIPTION

The Runtime Remote Video Quality Assessment system uploads a video, extracts frames using OpenCV, preprocesses them, extracts visual features, applies a machine learning model to predict video quality, and displays the quality score and graphical results through a Flask-based web application.

- User Interface: The user uploads a video through the Flask web application.
- Video Processing: OpenCV extracts and preprocesses video frames for analysis.
- Feature Extraction: Visual features such as blur, brightness, contrast, and sharpness are computed.
- Machine Learning Module: The extracted features are analyzed to predict the video quality level.
- Result Display: The system displays the quality score, quality category, graphs, and processed output to the user.

RESULTS AND DISCUSSION

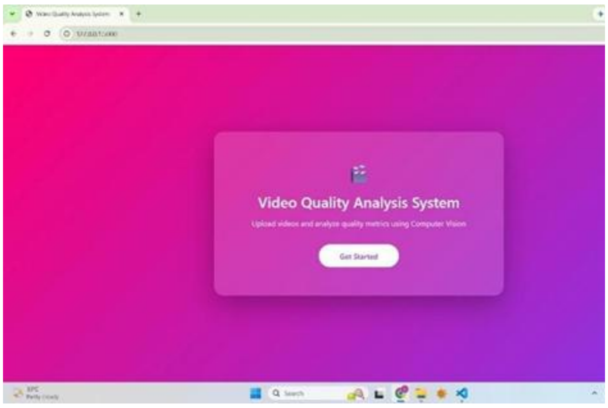

Fig2: Home page of Video Quality Analysis

The above figure shows the welcome page of the Runtime Remote Video Quality Assessment system. It is designed with a modern and attractive user interface using a colorful gradient background and a centered dashboard. The page displays the project title, "Video Quality Analysis System," along with a brief description indicating that the application analyzes video quality using computer vision techniques. The "Get Started" button allows users to navigate to the main interface, where they can upload videos for quality assessment. This welcome page serves as the entry point of the application, providing a simple, user-friendly, and visually appealing interface that enhances the overall user experience while introducing the functionality of the RVQA system.

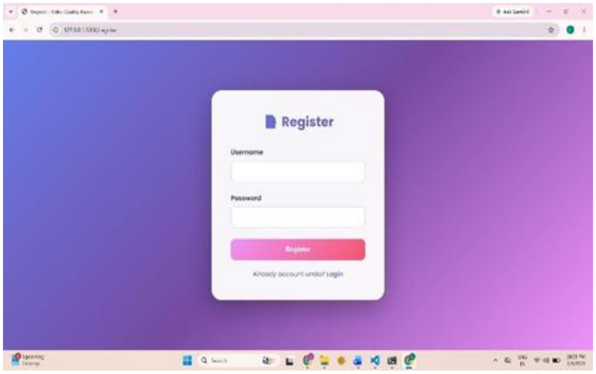

Fig 3: Register of this page

The above figure illustrates the User Registration page of the Runtime Remote Video Quality Assessment (RVQA) system. This page enables new users to create an account by entering a valid username and password. After filling in the required details, users can click the Register button to securely register and gain access to the application. The page also includes a Login link for existing users, allowing them to sign in without creating a new account. The registration module provides a simple, user-friendly, and secure authentication process, ensuring that only authorized users can access the system and perform video quality assessment tasks.

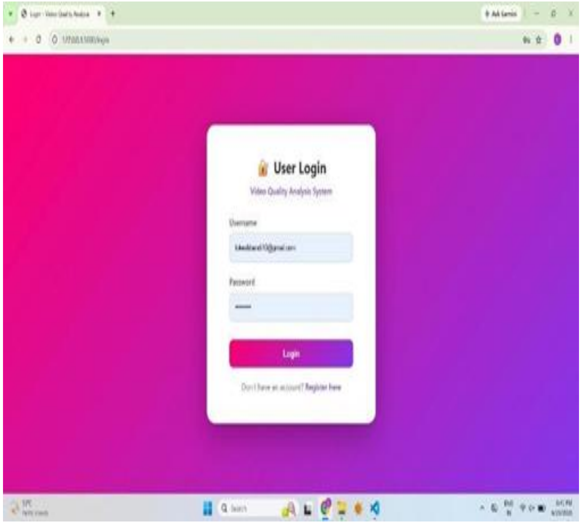

Fig 4: Login of this page

The above figure illustrates the User Login page of the Runtime Remote Video Quality Assessment system. It allows registered users to securely access the application by entering their username and password. After successful authentication, users can log in and access the main dashboard to upload videos and perform real-time video quality assessment. The page also provides a "Register here" link for new users who do not have an account, ensuring easy user registration. With its clean and user-friendly interface, the login module enhances security while providing quick and convenient access to the system's features.

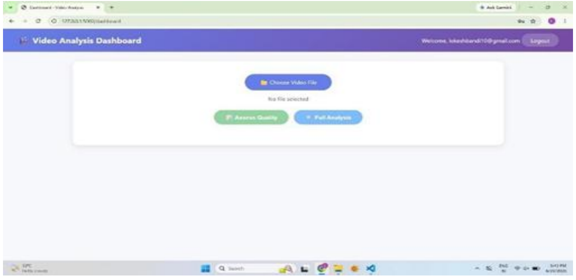

Fig 5: Video Analysis Dashboard

This image displays the initial landing interface of the "Video Analysis Dashboard" running on a local development server at port 5000. The upper portion of the page contains a purple header bar showing a welcome message for a logged-in user alongside a logout action button. In the center, a clean white card acts as the primary interaction hub, displaying a blue button prompting the user to "Choose Video File". Directly underneath this selection button, the text placeholder reads "No file selected", indicating that no media has been uploaded yet. Finally, two shaded action buttons labeled "Assess Quality" and "Full Analysis" sit at the bottom of the card, remaining inactive until a valid video file is provided.

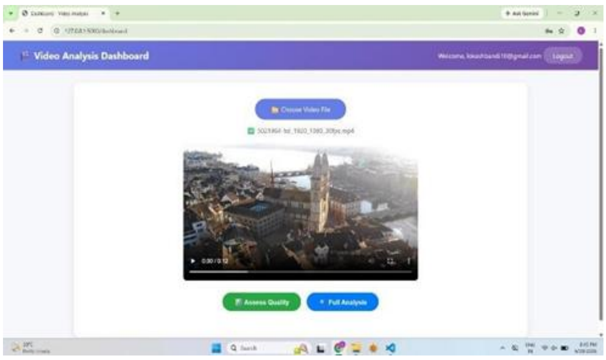

Fig 6: Upload a file in Dashboard

This image displays a web application interface titled "Video Analysis Dashboard," running locally at the address 127.0.0.1:5000. The interface provides a user-friendly platform where an MP4 video file has been successfully uploaded for processing, showing a built-in media player with a preview of the video content. A welcome message indicates that a user is logged into the application via a specific email address. Below the video preview, two action buttons, "Assess Quality" and "Full Analysis," allow the user to initiate different diagnostic tasks. The entire application is captured as a desktop screenshot, showing a standard Windows taskbar at the bottom.

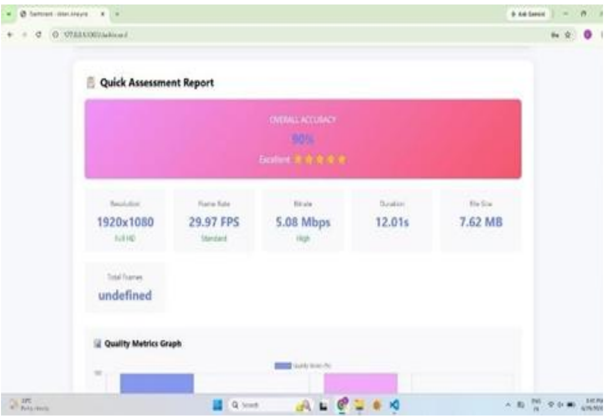

Fig 7: Quality report

This image displays the "Quick Assessment Report" page of a locally hosted video analysis dashboard running on port 5000. The interface presents a prominent pink banner indicating an "Overall Accuracy" of 90%, paired with an excellent five-star rating. Key video specifications are broken down into individual metric cards, showing a Full HD resolution of 1920x1080, a standard frame rate of 29.97 FPS, a high bitrate of 5.08 Mbps, a duration of 12.01 seconds, and a file size of 7.62 MB. However, a technical bug is visible under the "Total Frames" metric, which fails to render properly and reads as "undefined". Scrollable content at the bottom introduces a "Quality Metrics Graph", suggesting deeper analytical data visualization is available further down the page.

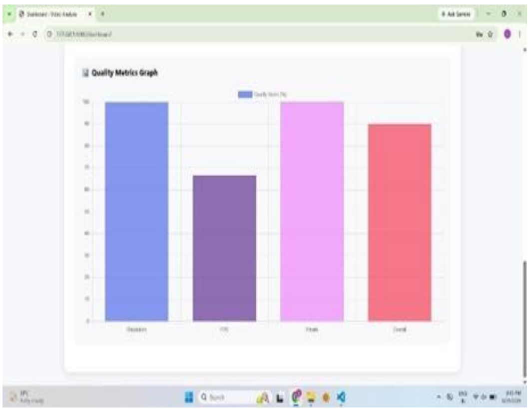

Fig 8: Quality metrics graph

This image displays the "Quality Metrics Graph" section of the locally hosted video analysis dashboard running on port 5000. It features a clean bar chart plotting "Quality Score (%)" along the vertical axis against four distinct evaluation categories along the horizontal axis. The chart indicates that both "Resolution" (represented in light blue) and "Bitrate" (represented in light pink) achieved a perfect quality score of 100%. In contrast, the "FPS" metric (represented in purple) scored significantly

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lower at approximately 66%, dragging down the "Overall" performance score (represented in coral red) to 90%. This data visualization allows users to quickly identify that the video's frame rate is the primary bottleneck affecting its comprehensive quality assessment rating.

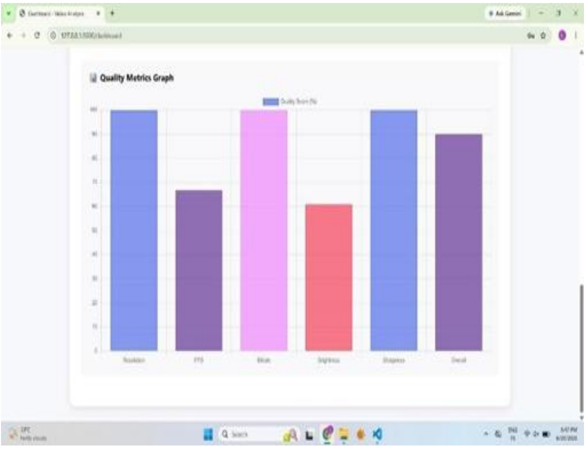

Fig 9: Full Analysis Report

video analysis dashboard running on port 5000. The interface showcases a prominent pink banner indicating an "Overall Accuracy" rating of 90% along with an excellent five-star rating. It lists key video specifications including a 1920x1080 Full HD resolution, a 29.97 FPS frame rate, a 5.08 Mbps bitrate, a 12.01s duration, and a 7.62 MB file size. Crucially, the previously unresolved technical bug has been successfully fixed, and the "Total Frames" metric now accurately displays a calculated value of 360. At the bottom, the dashboard once again scrolls down to show the beginning of the "Quality Metrics Graph" for visualizing performance.

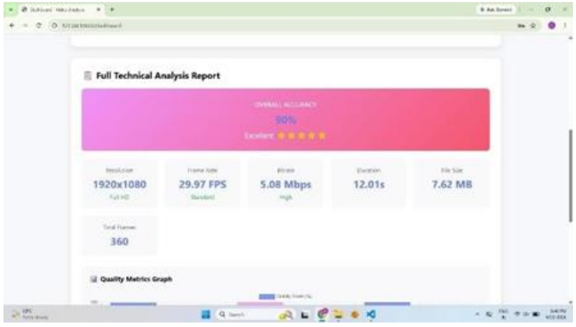

Fig 10: Full Analysis graph

This image displays the expanded "Quality Metrics Graph" section of the locally hosted video analysis dashboard running on port 5000. The bar chart tracks the "Quality Score (%)" across an increased number of evaluation metrics compared to previous versions. It reveals that "Resolution", "Bitrate", and the newly added "Sharpness" metric all achieved a perfect quality score of 100%. Conversely, "FPS" sits lower at approximately 66%, and the new "Brightness" metric ranks the lowest at roughly 61%. These combined performance bottlenecks dictate the final "Overall" quality rating, which is visually aggregated and calculated at 90%.

CONCLUSION

The Runtime Remote Video Quality Assessment system provides an efficient and reliable solution for evaluating video quality in real time without requiring a reference video. By integrating Python, Flask, OpenCV, and machine learning techniques, the system automatically analyzes video frames and predicts quality based on visual features such as brightness, contrast, sharpness, blur, and noise. The web-based interface allows users to upload videos and obtain instant quality assessment results with graphical visualization. The proposed system is lightweight, scalable, and user-friendly, making it suitable for applications such as video conferencing, online education, multimedia streaming, telemedicine, and surveillance, while improving the overall Quality of Experience.

FUTURE SCOPE

The Runtime Remote Video Quality Assessment system can be enhanced by incorporating advanced deep learning models such as CNNs, LSTMs, and Vision Transformers to improve prediction accuracy. Future versions can support live video streaming, cloud-based deployment, and GPU acceleration for faster real-time processing. The system can also integrate advanced quality metrics such as VMAF, SSIM, and PSNR for comprehensive evaluation. Developing mobile applications and interactive dashboards will improve accessibility and user experience. Additionally, the RVQA system can be integrated with smart surveillance, telemedicine, video conferencing, and multimedia streaming platforms to ensure continuous monitoring and improved Quality of Experience.

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