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Advanced Image Processing Techniques for the Detection and Monitoring of TV Datacenter System

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Abstract—TV Datacenter is the primary storage facility where servers for data storage are located. TV Datacenters have exploded in popularity over the last decade, becoming the epicenter of the technical landscape. As the size and ability of the centers grow, the complexity in managing them grows as well. The information and functionality grid are in danger of imploding, with potentially catastrophic consequences. As a result, solutions that can keep pace with the growth of data delivery, as well as Datacenter storage sizes, are needed. The main objective behind this research study is to propose a complete and advanced system for accommodating the enlargement of Datacenters, for enhancing data delivery in Datacenters, and for detection of errors and problems in TV Datacenters. Moreover, the system will also perform advanced and robust monitoring of TV Datacenters. The significance of the study relies on the algorithms that are proposed since these algorithms are completely novel as well as they are highly performant. In addition, these algorithms incorporate new technologies of image processing. The results obtained using the algorithms showed a detection rate obtained of 83.33% which can be considered to be an indicator of the high performance of the proposed detection system. Moreover, according to the results, the minimum time of replacement is zero seconds meaning that the replacement was done automatically after the detection of the corruption in the video. The results also showed that for all videos, the detected number of frames were all successfully replaced. The frame replacement showed 100% efficiency for every video.

Keywords—TV Datacenter, Detection, Monitoring, Image Processing, Video Frames, Detection Rate, Video Replacement

I. Introduction

A datacenter, at its most basic level, is a physical place where corporations store mission-critical software and data. A datacenter's architecture focuses on a network of computing and storage resources that enable the delivery of shared applications and data. A TV Datacenter is a structure that houses computer systems and other components such as telecommunications and storage systems. It usually consists of redundant or backup power supply, redundant data links, environmental controls (such as air conditioning and fire suppression), and security equipment. Broadcast automation is the technique of using broadcast programming technology to automate broadcasting procedures. It can manage a facility in the absence of a human operator, whether it's at a radio station, a television station, or a broadcast network

The relentless growth of new technology and the need for new broadcasting services has been and continues to be unstoppable. Broadcasters are searching for technologies that will allow them to build more modern production and transmission facilities with higher degrees of automation and more complex processes. In addition, the rapidly growing multimode distribution sector needs the inclusion of more channels across a wider range of delivery platforms at a lower cost per channel. Individuals engaged in television broadcasting operations require playout software. Playout automation software programs are becoming increasingly important in the television industry as hard drive storage space grows. These applications play the original media and then distribute it to the audience in a form that they may consume.

Many playout software is available on the market with each one offering various advantages and specs. However, this software has relatively very high cost and have not been well adjusted to deal with video errors that can happen during TV broadcasting. Thus, detection and correction of broadcast failures become a must.

Therefore, the goal of this work is to provide a technically advanced solution for solving errors that occur with videos during TV broadcasts. An implementation based on algorithms built using Mat-lab (Math works, Natick, MA, USA, 2019) is proposed. The main objective is to propose an automated system that tracks and detects errors and faults in videos being played and then in a consecutive step be able to replace the videos in a very short delay or even directly after the error is detected. The objective relies on building a set of algorithmic manipulations based on image processing that is adaptable to different video inputs and that can mainly detect videos that suddenly stop while being played and the screen turns to black and video that suddenly freeze and become corrupted.

By achieving this, a new system for video fault/error detection and correction would have been proposed. This system is founded on a highly achieving technique for automatically detecting different errors in any input video and is accurately and automatically able to replace the corrupted video or video part.

II. Literature Review

Many research studies have been conducted to improve the management and monitoring of TV Datacenters.

The authors in [1] applied a cloud-based television monitoring and analysis system. What the authors looked at, in a simplified schematic form, are the prospects of transforming the Datacenter, one of today's most energy-intensive products, into one of the most sustainable and environmentally friendly technological goods while still transmitting the information needed. With the integration of different technologies, either singularly or in numerous forms, the authors proposed the possibility of decreasing the Smart TV station's Datacenters is a substantial matter. This in turn, as the authors deliberated, will improve the capacity of Datacenter management, allowing them to provide better content with greater clarity and speed. To achieve this, a cloud computing-based television program monitoring and analysis system was built, and a 20T Datacenter was constructed for the regular collecting and update of relevant data from roughly 30 portal and news websites, 30 forum sites, and Sina microblogs, to improve the monitoring and analysis of relevant television program opinions on the internet. The results reached in this study are very promising; on a single PC (one collection terminal) connected to a 100M campus network, the average speed of information collection and interpretation for news websites was 47 pages per second. The accuracy of the interpretation was 94.8 percent. To be noted that the authors in [1], relied on technologies already applied for the detection and tracking [2], [3], [4] and [5].

On a similar perspective, [6] also proposed a radio and television operators cloud computing infrastructure research system. The study analyzed the applications of radio and television carrier services, researched how to build legitimate broadcasting operators' cloud computing architecture for supporting the corresponding business applications, how to improve user perception, reduce stress operator core system for enterprises, and make cost efficiency.

The latter study was based on other similar studies with similar cloud-based computing [7], [8] and [9]. As a summary, it can be said that these studies showed that the cloud makes provision for entire applications and other necessities such as hardware as well. Ranging from Public type clouds to Private (entity-based) clouds, these may run multiple tasks for the end-users such as hosting applications, the storage and backup of data, delivering content, e-commerce, the hosting of the media, and indeed Smart TV station applicability.

In the study conducted in [10], an original television broadcasting monitoring system is proposed and subsequently implemented to suit the pressing needs of the radio and television industries' rapid development. the authors in [10] were able to develop and implement a set of techniques based on cyclic extraction and remote dispatching to compensate for simple typical TV monitoring approaches which are based on a report and look-back technique, which causes hysteresis in TV broadcasting monitoring [11], [12], [13] and [14].

Design and implementation of broadcasting and television program monitoring systems were proposed in [15]. This research suggested a monitoring system called the broadcasting and television program monitoring system (BTP-MS), which is utilized to improve program monitoring on an autonomous, intelligent, and network-level and also to ensure broadcasting safety.

The need and scope of private cloud technology for public authority for radio & television in Oman were studied in [16]. Radio and television have become the primary means for people to obtain information, and they play a critical role in the growth of a country and the formation of a society

In [17], the paper showed that consumers can choose from a growing number of channels and programs thanks to widespread deployment of Internet Protocol Television (IPTV), Cable Television (CATV), Internet, User Created Contents (UCC), and Digital Television (DTV).

TV program recommendation for groups based on multidimensional TV-anytime classifications was proposed in [18]. The authors state that the introduction of digital television and personal digital recorders promises to alter how people watch television

On the same perspective, the study [19], proposed an analysis, design, and implementation of a helpdesk management system and the case study proposed was the Albanian radio television. The authors stated that as companies grow, so do the complex demands placed on the IT Department. Therefore, without good Help Desk Software, IT Departments can begin losing the ability to effectively provide employees with the technical support they need to do their jobs.

Many enterprises rely on IT Ticketing Systems to deliver fast, reliable internal customer service, resulting in improved IT department operations and satisfied.

III. Study Design and Methodology

The methodology adopted involves the following basic steps (implemented in Matlab (Mathworks, Natick, MA, USA, 2019)):

- Input of a corrupted or a freezing video
- Detection of the corrupted/freezing part of the video
- Direct replacement of the corrupted/freezing part of the video

The algorithms involve processing of video frames (image processing). The video/image processing method can be scripted as shown in Figure 1.

First, a video is an input and the properties are extracted and displayed. Then in a major step, the video is divided into video frames and each frame is extracted separately. Now each video frame can be treated as a single independent image with specific features and properties.

Next, a loop is created to analyze image by image over the video frames. The principal step in this method is to convert the images from Red Green Blue (RGB) format to Hue Saturation Value (HSV) color space. The red, green, and blue values of each RGB image are converted to hue, saturation, and value (HSV) values of an HSV image.

We also use the HSV color space for histogram generation where each pixel contributes its intensity. So, the method proceeds by generating a one-dimensional histogram from each of the HSV spaces (Hue histograms, Saturation histogram, and Value histogram) where a perceptually smooth transition of color is obtained in the feature vector. Now, each image frame is represented by three histograms. This enables us to view the Hue, Saturation, and Value values of each image in a histogram representation.

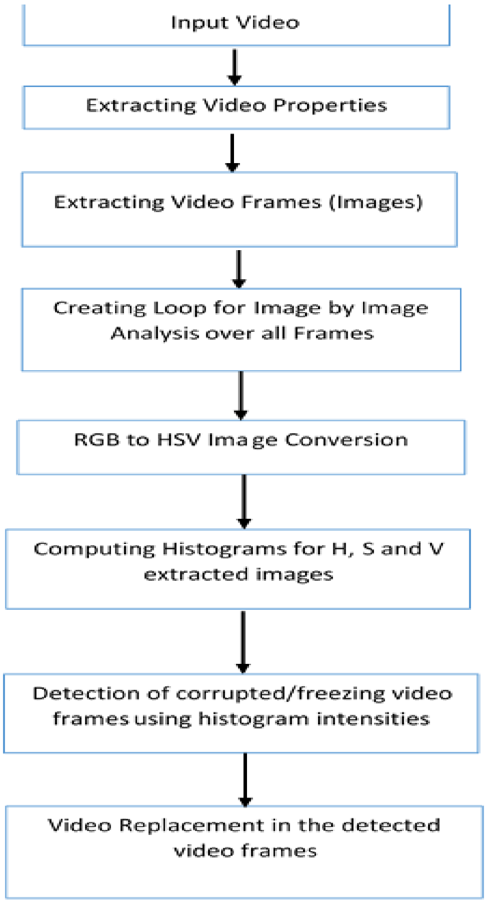

FIGURE 1: Block Diagram for the Video/Image Processing Method

As the calculated histograms for the image frames are a representation of the intensities in the image, then for the corrupted/freezing frames of the video the histograms are calculated and turn out to be zero relative to the zero intensities in the image. Therefore, the first video frame where the intensities are calculated to be zero is detected. Then a search algorithm is initiated to detect all video frames that have zero intensities. The search algorithm continually detects the frames with zero histograms up till the last frame. The video frames for the zero histograms detected across the corrupted/freezing video part are then extracted and a corrective step is applied. The corrective step involves introducing a new video that is limited to all video frames detected when the original video is corrupted/freezing.

The video replacement can take place in a few milliseconds after the search algorithm detects the first zero histogram value. Finally, at the end of the zero histogram video frames of the corrupted/freezing video, the new video is stopped and the original video is played again.

IV. RESULTS

A. Detection Rate and False Positive Detections

We evaluated the performance of the proposed system by calculating the Detection Rate (DR).

The Detection Rate refers to the percentage of the tested corrupted videos that were successfully detected and replaced out of the total number of videos tested.

The Detection Rate is calculated as follows:

$$\text{Detection rate} = \frac{\text{Number of Sucessful Video Detections}}{\text{Total Number of Detections}}$$

$$\text{Detection rate} = \frac{10}{12} \times 100 = 83.33\%$$

The detection rate obtained of 83.33% can be considered to be an indicator of the high performance of the proposed detection system

B. Image frames successfully treated

We represent the number of frames that were successfully replaced out of the total detected frames for every video (Table 1). This shows the ability of the processing algorithms adopted in detecting and replacing video frames of variable lengths. The results showed that for all videos, the detected number of frames were all successfully replaced. The frame replacement showed 100% efficiency for every video.

TABLE I. FRAMES OF VARIABLE SIZES REPLACED

Video	Number of Detected Frames	Number of Frames replaced	Efficiency
Video 1	70	70	100%
Video 2	308	308	100%
Video 3	123	123	100%
Video 4	120	120	100%
Video 5	147	147	100%
Video 6	180	180	100%
Video 7	222	222	100%
Video 8	185	185	100%
Video 9	235	235	100%
Video 10	150	150	100%

C. Calculation of Replacement Delay

As indicated in the methodology, after the detection of the corrupted part of the video is achieved, the second step is to replace the corrupted part with another video to ensure continued streaming to the viewers.

The delay between the detection of the corrupted frame and the replacement of the video is a very important parameter that can also characterize the performance of the proposed system.

According to the results shown in **Error! Reference source not found.**, the minimum time of replacement is zero seconds meaning that the replacement was done automatically after the detection of the corruption in the video. The maximum replacement delay is 0.25 seconds. The average is 0.08s seconds.

In the literature, it has been stated that the acceptable delay time is between 2 and 5 seconds.

Therefore, the average delay time achieved using the proposed system (0.08 seconds) is less than the minimum standard delay time and thus can be considered an excellent achieved delay and therefore reflects the excellent performance of the proposed system.

TABLE II. TIME OF DETECTION OF CORRUPTED VIDEOS, TIME OF REPLACEMENT, AND REPLACEMENT DELAY

Video	Time of Corruption	Time of Detection	Time of Replacement	Replacement Delay
Video 1	20 sec	20 sec	20.1 sec	0.1 sec
Video 2	6 sec	6 sec	6.025 sec	0.25 sec
Video 3	24 sec	24 sec	24 sec	0 sec
Video 4	55 sec	55 sec	55.05 sec	0.05 sec
Video 5	10 sec	10 sec	10.2 sec	0.2 sec
Video 6	44 sec	44 sec	44 sec	0 sec
Video 7	17 sec	17 sec	17 sec	0 sec
Video 8	16 sec	16 sec	16 sec	0 sec
Video 9	27 sec	27 sec	27.02 sec	0.02 sec
Video 10	31 sec	31 sec	31.2 sec	0.2 sec

V. DISCUSSION AND CONCLUSION

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A. Discussion

For obtaining the above results, the methodology adopted involves the following basic steps:

- input of a corrupted or a freezing video;
- detection of the corrupted/freezing part of the video;
- and direct replacement of the corrupted/freezing part of the video.

The algorithms implemented involve both processing of video frames (image processing)

The image processing stage included processing images extracted from the input video. In the procedure implemented, first, a corrupted video is manually made. For example, in one scenario, the option is a football video that stops playing after a few seconds and the screen goes blank. A football video is another example of a video that is designed to freeze after a few seconds (same time as the previous case) while playing. The video's attributes are then retrieved, including the duration, number of frames, frame height and width, and so on. The video is set to play like a movie. The video frames are then retrieved one by one in the pre-processing phase, as the processing phase will be applied to every frame.

The video is divided into video frames and each frame is extracted separately. The video is processed frame by frame during the video processing step. Each video frame can be treated as a single independent image. A loop is created to analyze image by image over the video frames. The images are then converted from Red Green Blue (RGB) format to Hue Saturation Value (HSV) color space. To construct the intensity histograms, the Hue Saturation Value (HSV) is applied to every frame. A one-dimensional histogram from each of the HSV spaces is generated. Each image frame is represented by three histograms. This enables to view the Hue, Saturation, and Value values of each image in a histogram representation

As the calculated histograms for the image frames are a representation of the intensities in the image, then for the corrupted/freezing frames of the video the histograms are calculated and turn out to be zero relative to the zero intensities in the image. When the histograms fade to zero, it indicates that the video frame is corrupted or frozen. As a result, the video frame where the video becomes damaged or freezes is identified. The processing continues until the last video frame, at which point the video is no longer contaminated. The search algorithm continually detects the frames with zero histograms up till the last frame. The video frames for the zero histograms detected across the corrupted/freezing video part are then extracted and a corrective step is applied. The corrective step involves introducing a new video that is limited to all video frames detected when the original video is corrupted/freezing. To compensate for the viewer, the identified corrupted/freezing video segment is replaced with another video (may be an advertisement video). The video replacement can take place in a few milliseconds after the search algorithm detects the first zero histogram value. Finally, at the end of the zero histogram video frames of the corrupted/freezing video, the new video is stopped and the original video is played again.

B. Conclusion

Playout automation software programs are becoming increasingly important in the television industry as hard drive storage space grows. These applications play the original media and then distribute it to the audience in a form that they may consume. A playout program might be as basic as a CD/DVD player or as sophisticated as expensive television broadcasting software. Traditional broadcasting for TV or radio, as well as personal usage, are examples. These playout systems, on the other hand, are not the same as regular media players. These are automated, and they include a lot of planning for the material that has to be executed. They have many more advantages than regular players.

There are many different types of playout software on the market, each with its own set of benefits and features. However, this software comes at a hefty price and isn't well-suited to dealing with visual problems that might occur during TV broadcasting. As a result, detecting and correcting broadcast faults becomes essential.

In this project, we provided a technically simplified solution for resolving video-related issues during TV transmission. This has been accomplished through the use of rather advanced image processing technique for the automatic identification and rectification of video errors that may arise when videos are being broadcast on television. In this study, two forms of video defects have been considered: videos that halt and become black, and films that freeze.

An implementation based on Matlab (Mathworks, Natick, MA, USA, 2019) algorithms have been proposed. The major goal has been to present an automatic system that tracks and identifies problems and defects in movies that are being played, and then replaces the films in a subsequent step with a very short delay or even immediately after the error is identified. The aim has been to provide a collection of algorithmic manipulations based on image, video, and signal processing that are adaptive to various video inputs and can identify films that abruptly cease playing and the screen goes black, as well as videos that freeze and become corrupted

A new method for visual fault/error detection and repair is offered based on this accomplishment. This system is based on a high-performing approach for automatically identifying various defects in any input video and replacing the corrupted video or video segment precisely and automatically.

As a conclusion, the automation system proposed in this study can efficiently replace other playout automation systems as it has achieved a high detection rate and a very low replacement delay. Thus, the system can enhance TV broadcasting and offer a new perspective to deal with faults that occur in broadcasting.

Disclosure and conflicts of interest:

'The author(s) declare(s) that there is no conflict of interest '.

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