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Building Optimal Scalable Video Streams Using Simulated Annealing Algorithm

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Abstract: ***In this research work, work has been done on scalable video transmission. The scalable video coding is an extension of the H.264 (MPEG, 4AVC) encoding. This concept allows video transmission to scale so that content is delivered without the degradation between various end points. For example, transmission between laptop and a mobile device over WiMAX technology platform. In the current research, the idea is to build a stream of video data that helps in optimization of energy consumption along with quality of pictures. Therefore, the most critical factor PSNR with respect to data rate has been considered. The performance metric is extension for any research work done in this field. It is no- reference quality metric that can help to access the quality of video frame and is behavior with respect to data rate was examined and observed based on this observation references are found with respect to energy consumption and quality of pictures. For all this number of streams has been varied from 10-50 and behavior has been observed. For each stream number of frame were also varied from 10-40 frames. Then comparison has been conducted over a period of 100 consecutive schedule instances. Thus our proposed algorithm works more efficiently.***

Keywords: Multicasting, WiMAX, Scalable video coding, SA, PSNR, SSIM.

1. Introduction

Adaptable or Scalable Video Coding fundamentally covers the whole application scope of H.264/AVC, from low bit rate portable applications, to High-Definition Television (HDTV) TV, and even Digital Cinema that requires about lossless coding and several megabits for every second. Yet, in numerical sense because of inalienable nature of this encoding calculation some misfortune may happen because of sub stream choice procedure. The versatility highlights that SVC adds to H.264/AVC empower a few framework level functionalities identified with the capacity of a framework to adjust the sign to diverse framework conditions with no or negligible preparing . The adjustment relates both to the capacities of possibly heterogeneous recipients (varying in screen determination, handling speed, and so forth.), and to contrasting or time-fluctuating system conditions like mpls . The adjustment can be performed at the source, the destination, or in intermediate media-aware network elements (MANEs) for last rendering of the video.
There are fundamentally two modes for transmission of SVC information, single-session transmission (SST) and multi-session transmission (MST). In SST, a solitary RTP session is utilized for the transmission of all scalable layers involving a SVC bit stream ; in MST, the adaptability layers are transported on distinctive RTP sessions. In SST, packetization is a clear however in MST, four distinct modes are characterized in this update. They vary on regardless of whether they permit interleaving, i.e., transmitting Network Abstraction Layer (NAL) units , Decoding order recovery is performed using either inter-session timestamp alignment or cross-session decoding order numbers (CS-DONs) . In this process, many implementations can be done for building sub streams for target platform, therefore many research projects are now working towards this goal. This research work also proposed a scheme of things and use of nature inspired algorithms for building a better video rendering platform for emerging device platforms , the details are in further sections of this paper .

2. Literature Survey

1. Yu Wang; Chau et al [1] talks about the issue of scalable bit stream extraction .For a given the data transfer capacity limitation and the display resolution of the end client device , the demonstrated calculation will choose the spatial resolution of the sub-stream to be removed in view of the investigation of the information data to amplify the perceptual feature quality. Exploratory results show the effectiveness of the proposed calculation. The paper discusses about the trustworthy transmission of video over heterogeneous devices obliges effective coding, and in addition adaptability to diverse customer device abilities, framework assets and system conditions. Scalable features coding gives a full scalability containing good level of adaptability, spatial adaptability and quality adaptability to build its flexibility to network and customer conditions. It encodes the features at a full specific rate, however empowers removing fractional streams to remake the feature contingent upon the particular rate and determination needed by a certain application.
2. Chandra, R.; Saravanaselvi, et al [2] focused on multicasting of video streams over WiMAX networks. Their goal was to achieve the quality of service in WiMAX networks. In the paper, the objectives carried out for this are (i)methods involved to carry out its sub-stream formation of video stream, (ii) the scheduling algorithm and (iii)performance evaluation comparison. The main idea was proposed for improving performance metrics such as throughput, loss rate and average delay in order to achieve the quality of service of WiMAX networks. For the calculation of delay jitter, throughput and loss rate the scheduling algorithm used in the paper was Deficit Round Robin (DRR), Weighted Round Robin (WRR) and Virtual

Clock (VC). For their results they measured throughput, delay jitter and loss rate for 1 sec. for varying frame sizes. Their results shows that DRR and VC gives better throughput i.e. 2,58,016 and 2,73,368 respectively and VC gives lesser loss rate i.e. 37,853 and lower delay jitter , in comparison to other algorithms. So, their technique is useful for selecting optimal sub-streams of scalable video streams under bandwidth constraints and to maximize the quality of mobile receivers.

3. Jin Yang et al [3**]** demonstrate that, the executed calculation in the paper bypasses JVT- W043 rate control algorithmic calculations by giving more precise yield bit rate for every layer, keeping up stable support completion, decreasing edge skipping and quality variance, at last, enhancing the general coding quality. According to this paper the rising H.264 Scalable Video Coding (H.264/SVC) obliges the rate control calculation to manage the yield bit rate of all the coarse-grain-versatility, fleeting, spatial and joined upgrade layers. In this exploration, the specialists executed an incremental rate control calculation for H.264/SVC. Initial, a Rate-Complexity-Quantization (R-C-Q) model is stretched out in scalable video coding in light of H.264/AVC previous stream calculations. Second, an intricacy measure for Intra-frame was utilized to correctly focus QPs (Quantization Parameters) for Intra-frames. At long last, the authors received an incremental way to deal with register QPs of between frames and a Proportional + Integral + Derivative (PID) support controller to give strong control to every layer.
4. Hai Gao; et al [4] highlighted and addresses some other key execution issues of the MP4 inventor for SVC versatile video spilling. In this presentation this paper says that with the advances in the Internet and versatile systems, shoppers now wish to make the most of their live and on-demand sight and sound substance at whatever time, anyplace and over any gadget. Adaptable Video Coding (SVC) gives an exceptionally appealing answer for accomplish this objective. Then again, SVC streams themselves are not stream-capable by a spilling server. The SVC streams must be put away in a legitimate document configuration to encourage parcel based gushing. MP4 documents are intended to contain timed media for spilling purposes. A MP4 document contains media test information, test timing data, and test packetization data, among which test times are the most essential data. In this paper, the creators have exploited the extraordinary SVC progressive B-pictures coding structure and propose to utilize an altered beginning postponement ((GOP/2)*duration) for SVC creation times as opposed to parsing the entire record to figure out the best possible starting deferral. The authors likewise recommend that specimen times of the full SVC streams ought to be gotten firstly, and then the example times for SVC sub-streams were basically coordinated from the example times of the full SVC streams, as opposed to ascertaining specimen times for every sub-stream, for both single-RTP-stream and various RTP-stream packetization modes.
5. Ruixiao Yao; et al [5**]**shows that the Scalable video has common favorable circumstances in adjusting to the multichannel remote systems. And some current works attempted to further streamline the adaptable video transmission by consolidating the unrefined layer-significance mapping with some outward procedures, for example, Forward Error Correction (FEC) and Adaptive Modulation and Coding (AMC). Nonetheless, the inherent adaptability of scalable video transmission over the multichannel remote systems was disregarded. In this paper, the creators have used the natural adaptability by breaking down the needs of H.264/SVC video information at the system reflection layer unit (NALU) level, and then outlining the need legitimacy conveyance plan for the adaptable video gushing. With this technique, the sub-stream extraction is astutely balanced by historical data, and the more critical information in a gathering of pictures (GOP) is conveyed through the more reliable channels. Arrangement of test results likewise approve the procedure's viability in enhancing the target quality and perceptual experience of the got video.
6. Radakovic, D.; et al[6] show that a Content-Based Rate Adaptation (COBRA) model is executed to enhance the nature of feature transmission over numerous data various yield (MIMO) framework with channel state data input (CSI). Other than this , the paper represents a model that catches connections among the feature substance sort, feature sub-stream bit-rates, achievable crest sign to-clamor proportions (PSNR), and channel bit blunder rate (BER). COBRA encourages joint choice of physical layer parameters and feature sub-stream setup. Not at all like existing techniques, the COBRA model offers an effective method for adjusting misfortunes in PSNR because of channel slips and non-transmission of a few improvements layers in a sub-stream, with a wise system of selecting sub-stream designs and correspondence parameters. Reenactments demonstrate that COBRA keeps up feature quality at adequate levels over extensive variety of low channel sign to-clamor proportion (SNR) values. It accomplishes the same feature PSNR as got by the complete stream transmission at 10 dB higher channel SNR.

3. Research Gaps

The main research gaps found after conducting systematic literature survey:

a) The rendering of the video in current technology context of hardware devices like mobile phone, tab, note books, laptops and desktop need different approaches.
b) The heterogeneous networks will need careful planning, selection of frames for rendering videos due to different data rates resolutions and capacities.
c) Same set of video frames cannot be send to all devices.
d) Selection of video frames has energy and performance implications.
e) Right Selection of video frames makes the sub stream algorithm more productive in terms of quality of video rendering and energy.
f) Limited work has been reported in building algorithms that use Bio or Nature inspired algorithms for building a sub stream selection algorithm.

3.1 Proposed Methodology

In this segment we will be delineated the working of proposed work which likewise endeavors to conquer the limit of the past work done around there .The execution of the proposed structure is portrayed in the accompanying chart shown below:

Implementation of Steps:
Step 0: Build a trace based repository of the historical data related to the PSNR, SSIM and Data Rate and make arrangement for storing current stream/ frame statistics.

Step 1: Read the each Video frame Statistics from the repository for selection of video characteristics and other network Parameters as shown below:

• InputFile 1st/orig/BUS_352x288_30.yuv
• Video Source Width 352 # Input frame width
• Video Source Height 288 # Input frame height
• Video Framerate In 30 # Input frame rate [Hz]
• Video Framerate Out 30 # Output frame rate [Hz]
• VideoMGSVectorMode 0 # MGS vector usage selection

Step 2: Read parameters extracted from video analysis of "yuv" trace files:
1) Read the buffer state of each type of receiver at different time instants.
2) PSNR values
3) Date Rates values
4) SSIM values of videos

Step 3) Run Hill Climbing based Simulated Annealing algorithm, set the initial startup search point using two factor equation model based on least square method. The two equations act as objective function of SA to build a current trend for selection of frames. Assuming that:
1) The equations are correctly identified based on the relationship between the data rate vs. PSNR and data rate vs. SSIM.
2) The error variance of all the variables is more or equal, as it done against data rate in both the cases.
3) Error terms are normally distributed since, the video traffic follow normal distribution curve.
4) It is assumed that the outlier(s) is removed from the sampled data.
5) Since this method requires that observations should be independents of each other, the method still work fine it also assumes that there is a secondary predictor that is correlated to the problematic predictor (the value which helps us find an optimal frame) but not with the error term. Given the existence of the instrument variable, the following two methods are used: In the first stage, a new variable is created using the instrument variable. In the second stage, the model-estimated values from stage one are then used in place of the actual values of the problematic predictors to compute the model for the response of interest.

Step 4) Observe performance metrics and goals of SA
Step 5) Fine tune the parameters of SA for better and Improved metrics.

4. Results

The overall evaluation process tries to evaluate the transmission, selection of sub stream frames mechanism of the videos by using the trace based simulation to fulfill the objectives of this research work. The main research objective was to find the a tradeoff between the quality of the frame and energy it may consume in the process .This was achieved by considering multiple parameters, which reflected the overall performance of the network transmission .The videos traffic can only be generated as per the data rate requirements, if the network infrastructure as low data rate , the protocol builds a stream which transmits frames that can be rendered on low bandwidth medium and will hence have matching quality and energy characteristics . Hence, a mathematical relationship was modeled based on the PSNR, Data Rate, SSIM values so as to show below in graphs. The term video trace metrics refers to set of these values.

4.1 Interpretation of Graphs:

a) It is clear from the graph beneath that the minimum square strategy (LMS) has the capacity discover relationship between the irregular variables values by minimizing the error between the characteristic values and their numerical relationship between the Data rate and PSNR and SSIM respectively . This relationship quality is reasonable in most the cases as there the pattern between the Data rate and PSNR or SSIM is not unsurprising and some of the time arbitrary in nature. Be that as it may, least square model has the capacity handle it within the limit points of the PSNR between 30 db to 50 db .And for SSIM; it has the capacity do with its full range between -1 to +1.

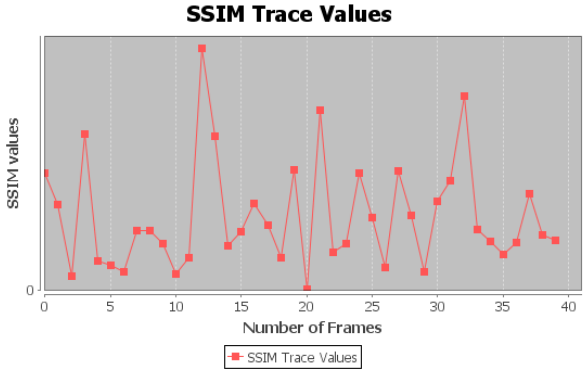

Figure 1

b) The prediction function f(y) of both the PSNR and SSIM equations acts as input to the simulated annealing algorithm as set of data points based on which the search space can be build to find feasible solution following the method of the hill climbing algorithms . This search space offers a platform to find similar value frames connected at different layers of the steam sequence and give us set of frames to build a sub stream which consumes optimal energy.
c) It is clear from the above diagrams that PSNR as metric is one the best marker of nature of frames as it is affecting the quality as for the information rate likewise, it can be seen from the above diagram that as the estimations of the Data rate increment, there is increment in PSNR additionally as

more information is streaming as stream at any given time. It can be seen in figure 2.

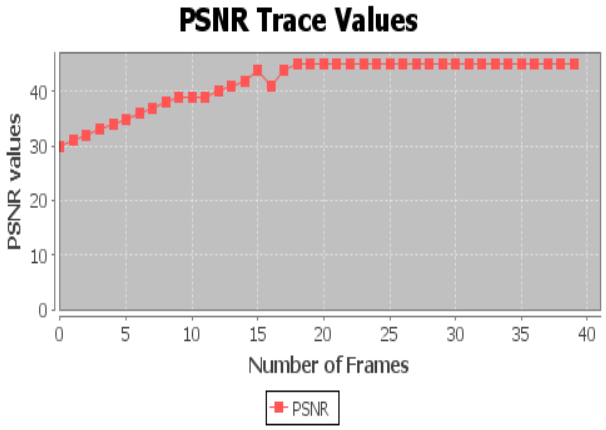

Figure 2

d) On the other hand, if there should arise an occurrence of SSIM, which is full reference metric, it may not take a predictable pattern, but rather here the figure 3 demonstrates that with the increment in Data rate, there is increment in SSIM towards the positive estimation of 1. This demonstrates that the quality enhances because of more prominent stream the streams and subsequently no congestion prompting less energy utilization.

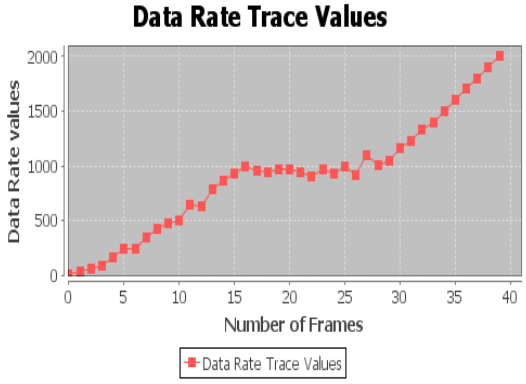

Figure 3

e) It is clear from the above chart that SA has the capacity to discover the blend of just those frames that offer ideal tradeoff between the base energy and conceivable quality of frame.

f) It is clear from the above graphs that the current research offers a challenge in terms of finding highest point in the search space which consist of large number of frames have two quality metric value . Therefore, the objective here is to get to the highest point; however, it is not enough to use a simple hill climb algorithm method, as there are many local maxima. By cooling the temperature slowly the global maximum is found, which is best possible point of tradeoff between the quality of frame and its energy consumption pattern with respect to the condition of streams and WiMAX communication channel quality at given time .

g) In the figure 4 it is clearly evident that energy efficiency is more in the case of the proposed algorithm as the values lies between a close range between 86-87% when the number of streams vary from 10-50, this shows that the standard deviation is also very less which shows that proposed algorithm is quite stable in its performance as compared to the previous algorithm which performs between the range of 84-86% efficiency.

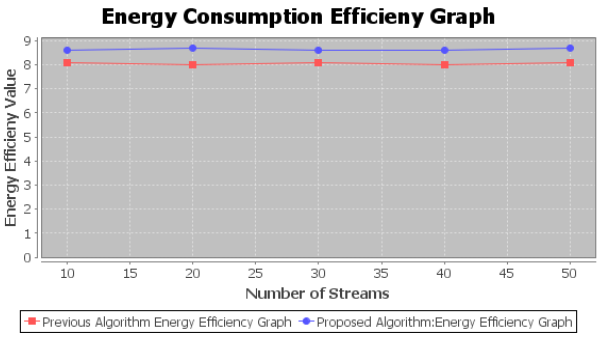

Figure 4

5. Discussions and Conclusion

In this research &examination work, a strategy in which three components investigation has been connected to assemble another qualifying quality metric for the choice of video frames for building it sub stream has been done. This quality parameter covers both PSNR and SSIM. This quality parameters is computed on the premise of the conduct of the PSNR as metric regarding the Data Bit Rate and with the SSIM, and hence , we get two qualities at any given time of transmission at given time space , along these lines we are ready to join all the three variables into one arrangement utilizing variable based on algebra , these qualities are figured on the premise of minimum square model , which causes in discovering answers for least energy utilization issue ,or in basic words the issue of discovering a vector x [data purposes of value measurements as for the file of each frame] that is a nearby minimizer to a capacity that is a total of squares, perhaps subject to video stream limitations, including length of frames& stream , estimation of PSNR , SSIM and so on. This way we were able to find a way to build frame stream which take less energy. Video Stream handling frameworks itself may present a few measures of quality in the video signal, so video quality assessment is an imperative issue and consequently requires a measuring framework that deals with the idea of different variable assessment that impact the energy utilization and the nature of the video streams frames. The reason for the SSIM as metric has been taken here in our exploration work is that ,it helps in picking best frames that must be a reference point in view of which quality is to be judged. In this process we have picked a reference and non-reference measurements or variables factors to land at two scientific connection mathematically that get us the comparable edges in understanding the utilization of network,

Since, SSIM is intended to enhance conventional techniques like PSNR and mean squared errors (MSE), which have turned out to be conflicting with human eye discernment which actually, is not imperative in our present setting additionally as streams are construct at run time and no human based assessment of the sub stream should be possible on the fly. Hence, we are utilizing mix of the two

measurements that are figured on the premise of least squares techniques. Minimum Squares - alludes to the idea that a variable conduct is minimized, for the squared error between the information [PSNR & SSIM values] as for rough information of [PSNR & SSIM values] regarding the information rate of the steams , which is plainly leverage , as serves to picked best fit or patterns that can at long last help fabricate/build improved video streams

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6. Future Scope

In this current research work two factors were considered for arriving at a selection decision of frames of the videos, so that the rendering of the video is possible on multiple heterogeneous device networks. This is nothing but a way the Internet of things (IoT) will work, the diversity of the devices is increasing both in terms of hardware and software. There would remain a need to further enhance in this algorithm of streaming live videos on network, the need to optimize resources in terms of bandwidth, computational resources also along with energy. For future, we suggest that parameters which influence the bandwidth and computation cost must also be taken into consideration, this way we may need to do more than two factor analyses that would build an optimal sub stream for video processing.

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