Optimal Bandwidth Assignment Techniques for Multiple Description Coded Video

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Abstract:
Cinematographic streaming services are essential due to enhancement in technologies for video compression and broadband internet.In Cinematographic streaming over multicast network, user's bandwidth requirement is diverse because user have devices of varying bandwidth, such as, laptop, HD-TV, mobile devices.However, the available bandwidth needs to be assigned optimally when cinematographic streaming takes place over a multi cast network.To assign bandwidth based on user requirement, the users are gathered into different categories which help in handling bandwidth distribution easily.Using MDC (multiple description video) the above problem of bandwidth heterogeneity is resolved.In MDC, Cinematic source is encrypted into numerous independent descriptions. A receiver is associated with one of the descriptions. A receiver links different description to meet their bandwidth necessity.Streaming quality at receiver side is related to the number of descriptions received. So it is important but big problem for MDC cinematic multicast is assigning bandwidth to each description in order to make best use of available bandwidth so that user satisfaction can be maximize.In this paper we tried to find how to assign bandwidth for descriptions to make maximize use of available bandwidth and formulate this problem as optimal problem.

1.Introduction:

Internet has been around which greatly changed the way market is operated and process of business all over the world. World become very small due to communication facilities growth of internet really changed the life of people. Broadband internet paved the way for live streaming video such as football matches and other live events. This greatly enhanced the way content is transferred to many users at a time. Videos are bulky and need techniques of compression. This has led to many companies to develop portals that exclusively deal with videos services over internet [3]. Many user need multicasting of a live video concurrently as shown in **figure1** In figure video streaming being accessed by multiple users of Internet with different devices.

Fig. 1 – Video streaming using MDC to users

It is clear from the figure multiple users able to access video with heterogeneous bandwidth requirement because each user may have devices of different bandwidth and configuration containing varied RAM and processing capabilities. This kind of example can be seen in YouTube, MSN. Online Streaming such as Splitstream, Coopnet, AT&T, PTV, PPLie and AT &T are some examples. The registered users are provided live streaming by these vendors. This can't be achieved easily because it throws some problems. One of the major problems is optimal allocation of bandwidth because, user bandwidth requirement is different because user have devices of varying bandwidth, such as mobile devices, laptop, smartphones, HD-TV. This also means that user's bandwidth requirement is not fixed. Assignment of bandwidth with fair quality in video streaming which increases user contentment is the challenging task to be addressed.

A Simple technique for solving the above problem is to generate many streams with different bitrates to which various users are associated. But this technique has problem that number streams of different bitrates are limited. A good approach is to use MDC (multiple description coded) video that gives facility of encoding of video into many descriptions that are independent and having different bandwidth to which users are associated. MDC is capable of assigning heterogeneous users with required bandwidth with multiple options pertaining to bitrates. This also facilitates the users to use different devices in order to access the given resource live. Descriptions are used to know the varied requirements of users. They make the bandwidth allocation easy. Users can associate with more than a descriptor. Streaming quality at receiver end is proportional to the number of descriptions received [1] .In this case the sum of bandwidths of all these descriptors should best match the requirements of user[3].

User needs to get best match bandwidth that maximizes the quality of video i.e simply solving the problem of bandwidth assignment for heterogeneous users. Allocation of bandwidth can be optimized. Hence this can be considered as optimization problem.

2.MDC(Multiple Description Code)

MDC technique can be used for improving error resilience without using difficult channel coding scheme. MDC is used to create several independent description that can contribute to one or more features of video such as spatial and temporal resolution, SNR, frequency content.

Figure 2 shows a general multiple description coding scenario [2]. An encoder is given the k-dimensional random source vector X to communicate to three decoders over two erasure channels. One decoder (the central decoder) receives information sent over both channels while the remaining two decoders (the side decoders) receive information only over their respective channels. In response to a source vector X, the encoder generates two code words (indices) f1(X) and f2(X) at rates

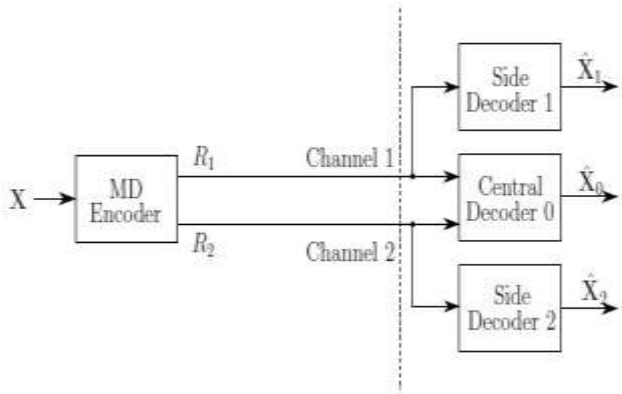

Figure 2 : General MD Coder Scheme with two channels.

MDC Network

The traditional way of MDC with four descriptions and one central decoder is illustrated in Fig. 3. An input image X is compressed by MDC into four descriptions of rates R1, R2, R3 and R4. The central decoder retrieves the image at less distortion R1, R2, R3 and R4 are received[4]. In case of two failures (i.e. two descriptions are lost), the image interpolation techniques are used to estimate the lost pixels at central decoder by neighboring pixels

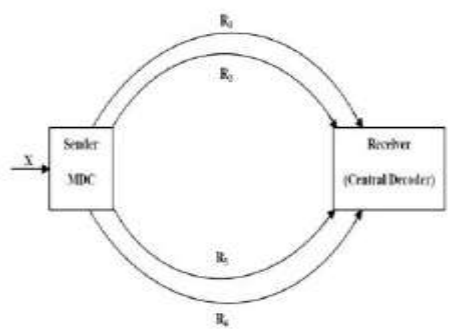

Figure 3: The typical scenario of MDC with 4 descriptions and central decoder.

Encoding Operations

The encoded operation of the proposed method against single lost description can be done as follows:

- ➢ The sender creates the descriptions and encodes each description using baseline JPEG standard with desired quality factor and assigns the descriptions to working paths (links).

- The protection path is achieved by bit-wise operation.

Decoding Operations

The decoding operations are analogous to the encoding operations. The terminal node (receiver) will receive the data from all working and protection paths and will do the decoding operations. In the case of single failure, there are the following possibilities:

If the failed path is a working path, then the terminal node must query all other nodes in order to recover the failed data.

- If the failed path is the protection path, then no need to perform any action, since protected path is used for protection and does not have any valued data

Advantages Of MDC:

- ***Robustness:*** MDC is very robust, even at high loss rate.

- ***Scalability:*** In MDC device used can decode only the number of number of description that suits its power, memory or display capabilities.

- ***Adaptability:*** In MDC, when the channel has varying bandwidth, it would be easy to adapt the transmission to available bandwidth. Descriptions can be simply be dropped.

- ***Independency:*** In MDC descriptions are independents.

3. Bandwidth Assignment techniques

We would try different bandwidth assignment technique to achieve Optimal Assignment technique:

- **Uniform Assignment**: in which all the descriptions have the same bandwidth.
- **Linear Assignment**: in which the description bandwidth is linearly increased.
- **Random Assignment**: in which randomly assigns bandwidth for each description.
- **Exponential Assignment**: in which the description bandwidth is exponentially increased.
- **Threshold and the Exact Solution**: Consider that user bandwidth requirement ranges in [a,b], where a and b are the maximum and minimum user bandwidth requirement, i.e., a=min cj and b = max cj.
- **SAMBA (Simulated Annealing Multiple Bandwidth Assignment)**: In this section, we present an efficient heuristic SAMBA to solve the general problem when description number m is no larger than the threshold. If m is less than the threshold, the problem is to search in an m-dimentional integer space for the optimal description bandwidths. The search space is discrete and finite, because each description can only take integral bandwidth no larger than the maximum bandwidth requirement in the network. This condition makes it feasible to adopt simulated annealing algorithm

  SAMBA has many states and a state is nothing but a vector with description bandwidths. Every state is allocated with an internal energy which is considered to be negative of satisfaction value. SAMBA is iterative in nature. Each node has a neighborhood given by radius. The neighbor is directly used by SAMBA in order to compare states. Temperature field is considered in order to that is best example where it exponentially decreases as the given algorithm iterates.

4.Problem Formulation

In media streaming, heterogeneity is a big problem. Users may have devices of different bandwidth for data receiving or forwarding. In order to provide service to all the users, obviously it is neither efficient nor feasible for the server to transcode the stream to each of the user bandwidths. One easy approach is to encode the video into a number of streams of varying bitrates, which users join to best match their bandwidth requirements.

A better approach is to use MDC, which encodes the video into multiple independent “descriptions” of varied bandwidth. A receiver joins different description to meet their bandwidth requirement. This approach provides more options of video bitrates to meet different user requirements, e.g., n descriptions provide up to 2^n different video bitrates. A user selects to receive a group of descriptions, where the sum of their bandwidth best matches the user bandwidth requirement. We illustrate in Fig. 2 video streaming using MDC to varied bandwidth users.

Let the video is encoded into n descriptions with bit rates b1,b2,b3 b4..d….bn. The users, depending on their access bandwidth, join the descriptions that best match their bandwidth requirements so as to maximize their video quality. In this paper, we study optimal bandwidth assignment for descriptions given heterogeneous bandwidth requirements.

We expect an ideal assignment because of the following:

- if description bandwidths are set very high, the low-bandwidth receivers may not benefit from them because joining them may exceed their bandwidth which leads to low video quality.
- if description bandwidths are set very low, those high-bandwidth receivers may not be able to fulfill their bandwidth by joining them, leading again to low video quality.
- Hence, we expect ideal description bandwidths to achieve the finest overall video quality

Let us denote bandwidth of i^{th} description by d_i. Then d is m-dimensional vector (sorted in increasing order) and shows a particular bandwidth assignment for the descriptions. Total joined video bandwidth v_j is the sum of received description bandwidths. Clearly we need $v_j < c_j$ where c_j is user bandwidth requirement and its importance (in terms of a weight value w_j.

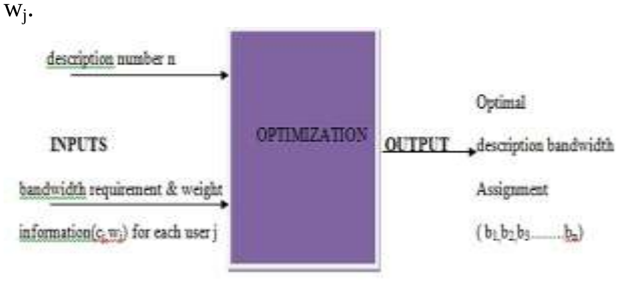

Figure 3. Optimization Model

Let K_{ij} be a binary number with 1 indicating that user j chooses description i.

We have,

$$Vj = \sum_{i=1}^{n} Kij\, dj$$

………eq 1.

Let us consider heterogeneity factor H is the difference between maximum and minimum user bandwidth requirement i.e.

$$H = \max c_j - \min c_j + 1$$

….eq 2

Let us define Rj the band width matching factor given by ratio of v_j and c_j i.e.

$$Rj = v_j / c_j$$

……eq 3

Let us Define coding efficiency factor $\alpha_n \in (0,1)$ given n description, which decreases with n.

The individual satisfaction of user j, is

$$Si=(d;c_j)=f(\alpha_n Rj)$$

….eq 4

Let the number of user in the network is N .then over all network satisfaction is given by

$$Soverall = \frac{\sum_{j=1}^{N} Wj\, Si(d, Cj)}{\sum_{j=1}^{N} Wj}$$

……eq 5.

Our Objective is the to find an optimal bandwidth d* so as to maximize Equation 5 subject to equations 1 ,2,3,4 i.e.

$$S^*=S(d^*)=\max S(d)$$

……..eq 6

5.Applications

Divide-and-rule approach to High Definition TV distribution: HDTV sequence can split into SDTV description.no custom high bandwidth is required.

Cope with low resolution/power/memory: Mobile decodes as many as description/layers as they can- based on their display size, processor speed , battery level and available memory,.

Adaption of quality Level : The user can decide th quality level to enjoy a service from low cost-low resolution (one description) to higher cost-higher resolution (more descriptions) .

Varying bandwidth: The base station can simply drop descriptions/layers, additional user can easily be served and trans-coding process is needed.

Easily Support to Multi-Standard : Description can be encoded with different encoder (MPEG2,H.263,H.264).There is no waste of capacity as descriptions carry diverse information.

Enhanced carousel: Instead of repeating the same data many times, different descriptions are transmitted one after other, the decoder can store and join to get higher quality.

6.Conclusion

In this paper the use of Multiple Description Coding MDC is proposed to support heterogeneous terminals. Based upon the capabilities of the various terminals, all the descriptors or only a subset of the descriptors can be used in the reception. This way the application can be kept unaware of the requirements of the individual terminals. The data flow should be split into large number of descriptors, in order to support a large number of heterogeneous terminals within the system. Terminals with advanced capabilities will use many descriptors, while the terminals with limited capabilities will utilize proportionally smaller subset of descriptors.

This paper also formulate the problem as optimization problem on the basis of matrices first overall satisfaction and second individual user satisfaction

This paper presents an algorithm to assign description bandwidth for MDC. The aim is to optimize the bandwidth allocation to heterogeneous users with varied requirements for live streaming of videos. We consider this as an optimization problem and the proposed algorithm addresses it. We also proposed a heuristic by name SAMBA for optimizing description bandwidth assignment.

7. Future Scope

- To simulate the results of the proposed algorithm and show that it achieves greater user satisfaction with respect to bandwidth allocation to large number of users.
- One Challenge is to find that how frequently description rate should be adjusted
- Another problem is to refine the problem formulation by considering small descriptions. That is, some description rates from the ideal solution may be too low for practical MDC encoding. Hence we have to find a lower bound for description coding rate.

8. References

[1] Naveen kumar, Jaishree Tripathi, Rachana Dubey Mr. Abhishek Srivastava- *Optimal bandwidth assignment for multiple description coded video*||ijecs vol 2.issue5 May 2013

[2] Saeed Moradi- *Multiple Description Coding:Proposed Methods And Video Application*|| Queen's University Kingston, Ontario, Canada August 2007

[3] P. Jagannadha Y.Pragna, P.Monoj Kumar. B.Praveen Kumar, and R.Anil Kumar, — *Maximizing User Satisfaction By Improving Coding Efficiency Of Multiple Descriptions Coded Video* || IJSTR J. vol. 2, no. 2,May. 2013.

[4] Emrah Akyol, A. Murat Tekalp, Fellow, Ieee, And M. Reha Civanlar, Fellow, Ieee, *A Flexible Multiple Description Coding Framework For Adaptive Peer-To-Peer Video Streaming*, Ieee Journal Of Selected Topics In Signal Processing, Vol. 1, No. 2, August 2007

[5] Haakon Riiser, Tore Endestad, Paul Vigmostad,Netview Technology As, Norway, *Video Streaming Using A Location-Based Bandwidth-Lookup Service For Bitrate Planning 2009*

[6] Lorenzo Favalli1, Marco Folli1,Alfio Lombardo2, Diego Reforgiato2, Giovanni Schembra ,*A P2P Platform for Real-Time Multicast Video Streaming Leveraging on Scalable Multiple Descriptions to Cope with Bandwidth Fluctuations*, International Journal of Computer Networks & Communications (IJCNC) Vol.3, No.6, November 2011