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High Quality Multimedia Streaming Up Sampler for Android Platform MobWS

Prof. P. B. Sahane
Department of Computer Engineering
P K Technical Campus
Chakan, Pune, Maharashtra, India
premasahane@gmail.com

Abstract— In modern era internet is fastest mean of digital transportations and use of mobile devices is emerging to access digitized data, multimedia, sports, videos, TV shows, websites etc. from anyplace, anytime. Also people can share live videos mobile to mobile. However, existing methods are having limitations of resources like bandwidth is shared among different clients, which is resulted into drawback of video streaming. Many new mobile devices with high hardware configuration are present in market to support the high resolution by Apple, Sony, Micromax, Google, etc. but because of low resolution in multimedia streaming it will not support to these new mobile devices. This can result into introduction of visual distortion and artefacts. Thus, to provide high quality video streaming and optimized Mobile Web Service (MobWS) with more ease for mobile devices, method is proposed. This investigated approach is to enable the hosting of WebPages with live videos on android smart phones and bridges resolution gap between end user mobile device and multimedia streaming. This up sampling system is designed to evaluate high-quality multimedia streaming onto mobile phones. That is real time video broadcasting and synchronizing to client device with high resolution, to be done with less computation time as compared to previous approaches.

Keywords*- Mobile Device; Audiovisual Quality; Video streaming; upsampling.*

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I. INTRODUCTION

Nowadays, use of mobile multimedia streaming is growing rapidly and become parcel of daily lives. The mobile television and internets are already used in many countries, but its proper adaptation has to be taken as multimedia messaging is also increased in popularity. Data communication and multimedia communication are different as audio and video communications are delays sensitive. Video decoder cannot work properly for late arriving packets. Thus, in multicasting for video communication retransmission technique is not mostly used. To reduce construction delay and streaming overhead parallel multiple nearly disjoint multicast trees protocol can be used [4], which gives video resolution quality of single tree multicast lower than resulting quality.

While development of product evaluation, tests are necessary because perceived quality of video is a critical factor if the application service is to accept. For mobile devices audiovisual parameters have not been mostly studied. Some studies are published about evaluation of low bit rates, frame rates and modern codec's used with small screen displays in mobile devices [5].

In this particular research paper, we are hereby investigating one of the recently method for delivering high quality video streaming from MobWS. This method also bridges the resolution gap between mobile devices and video streaming [5]. Information about high-resolution video, multimedia is not known priori to current upsampling methods so it requires large computations. And also objects details with their boundaries information for the high resolution multimedia is not known whenever we up-sample low resolution multimedia that increases overall computation time.

In opposite to this, applications those having the mobile videos with higher resolution for conversion to properly occupy bandwidth before sending it over the wireless network are taken and synchronized it with a mobile device. Therefore, the recent method which we are discussing prevents this area because we extract metadata for up sampling at client side.

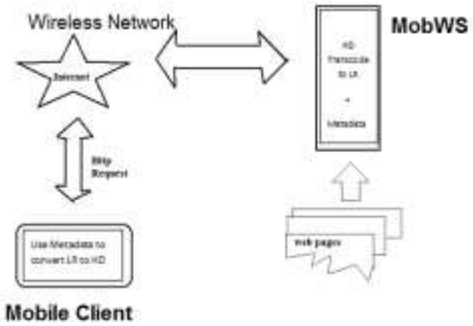

Figure 1. System Architecture for MobWS

As shown in Fig.1 on server side metadata is extracted from HD, a High Definition video and HD is transcoded into LR Low resolution video with appropriate bit rate. Then LR video and metadata delivered to mobile client through wireless network. On the client side, the bit streams received are converted to frames and metadata enables upsampling to low-complexity and converted to HD video, the task of the computations are shifted to the MobWS [5].

In case of server side to extract metadata HD video is segmented into shots and labeled with appropriate upsampling

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method to yield best visual quality. As boundaries of object, features are main visual artifacts in video frames, those are identified. There is no need to modify existing codec as metadata which is summarized is most useful to mobile clients to do upsampling in real time for multimedia. By increasing bit rate the video quality, clarity can be increased but it generates artifacts while upsampling.

The system is to design a web hosting server to the Mobile device i.e. Android OS Platform, So that website can be hosted on personal mobile and any HTTP browser user can access it through wireless network. User can design and upload personal websites with live videos on mobile device. System can be prevented by unauthorized access by giving authentication. Because of more requirement from customer the goals of authentication process is limited so as to prevent the mobile web server to be down.

Users can broadcast websites, events, and live news using only an internet connection and Android OS enabled mobile phones. There are two main points we are discussing over here, first is to bring web-server onto Android Platform and second is maintain video quality while streaming and receiving high quality video at mobile client.

II. LITERATURE REVIEW

A. *Mobile to Mobile video streaming*

A MobWS platform is to used to provide multimedia, video streaming on fly. After dealing with the problems with multimedia extensions and streaming to an existing method, a lightweight MobWS [1] platform is proposed, which is based on Representational State Transfer. For controlling multimedia stream and it's mapping over REST, Real Time Streaming, and Real Time Transport i.e. RTSP and RTP Protocols are used [8, 9]. Different commercial products like Bambuser provides live multimedia streaming for mobile devices like android phones.

However there is no control on analysis and profiling of videos what company does. Mobile users feel that due to conspicuous video, multimedia artifacts video quality is not acceptable [5], because videos are distorted, stretched and not well recovered. For example, DCT based, Nearest Neighbor, bilinear upsampling produces blurring in the details of a image, video when these methods are used to upsample the same, that is for conversion from LR frames to HR frames.

B. *Upsampling*

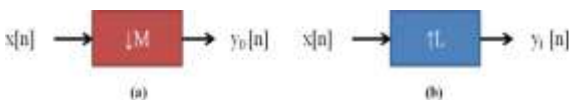

Figure 2. Multirate Processing a) Downsampling b) Upsampling

As shown in Fig. 2 a) Downsampling is given by

$$y_D[n] = x[M_n]$$

and in Fig. 2 b) upsampling is given by

$$y_I[n] = x[L_n]$$

only samples which are input with samples M are retained at output and Z-transform of $y_D[n]$ is given as

$$Y_D = \frac{1}{M}\sum_{k=0}^{M-1} X\left(z^{\frac{1}{M}} W_M^k\right), \quad \text{where } W_M^k = e^{-j2\pi/M}.$$

The original signal spectrum of *M - 1* components will be expanded by 2 while downsampling by *M* operation and can be overlapped and by inserting samples L fold upsampler generates output $y_I[n]$.

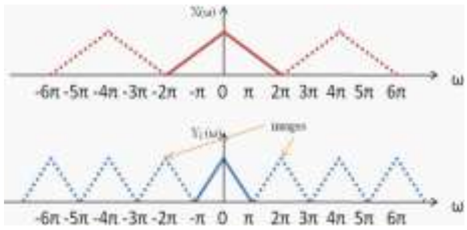

Figure 3. Frequency domain representation before and after interpolation

Imaging effect can be there because of produced multiple images of basic spectrum while upsampling, like in Fig. 3. Interpolation filters can be used to eliminate these imaging effects.

C. *Nokia S60 Web Server*

For Nokia smart phones Nokia developed Apache HTTP server, where Symbian operating system S60 mobile software platform is used and which enables connectivity through wireless networks for HTTP traffic to mobile device.

MobWS components include gateway system, which runs on a mobile with internet access and having valid web address. However, Nokia has been discontinued mobile web server system in January 2010 [8].

D. *Producing and Percieving Quality*

Producing and perceiving qualities are combination of multimedia qualities. The produced quality is normally in between an low level and acceptable of quality in mobile video. However quality perception varies with different sensory channel and devices used, which can be minimized to modulation transfer function (MTF) and sensory threshold.

Auditory and visual data are integrated to a perceptual experience adds the two perceptual channels in a more complicated way in audiovisual perception. It is also necessary to bind the sound and image together for synchronization an obtain good perceptual quality.

Good visual quality can give better audio quality and vice versa by showing recent studies. Value of visual and auditory information of multimedia depends on the content of the same. E.g. Faller and Winkler [10] found that if complexity of multimedia increases at low bitrates then importance of the auditory channel increases. Changing bitrates beyond accepted ranges of different modalities lowered quality of multimedia.

III. PROPOSED SYSTEM

This system includes building a mobile web server, storing website with multimedia on MobWS and then leveraging, downloading from mobile client with good visual quality, which includes following algorithmic blocks.

A. MobWS: Mobile Web Server

Main aim of this system is to design a web hosting server to Mobile phone as shown in Fig. 4 and to make a same running on a Smartphone accessible from wireless network anytime, anywhere using any browser. Firewalls prevent access of internet that is why accessing internet on mobile phone is not straightforward. Websites, videos can be hosted on Android phones and system is responsible for HTTP protocol, which can capture and stream video from mobile web server. RTSP server based on the RFC-2326, and RTP used to transfer to mobile clients. To communicate data, information between the web page and the mobile device, android device communications server was created i.e. web interface was designed for ease and flexibility. Also for interfacing between mobile web server and mobile clients SQL database statements were implemented.

This system helps to take a real-time multimedia or video from an Android phone's camera to a server. Database also includes metadata which is less than 8% of actual multimedia that is to be used while upsampling at client side.

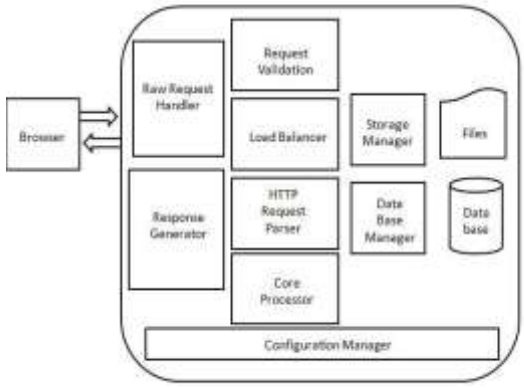

Figure 4. Mobile Web Server (MobWS)

From any web browser available with mobile client can access real-time high resolution video from website. The static website saved inside SD Card can be source for the web server, and can increase the capability of device to become a web server [3].

B. Detection of Video Shot and selection of upsampling

As video content in same shot are continuous, it maintain temporal coherence of frames that is for good perceptual, visual quality. Numbers of upsampling techniques like bilinear, nearest neighbor are suitable for different shots and that technique can be selected. By identifying transition periods, dissolves, fade-in, and fade-out amount of metadata can be reduced by skipping transition frames [6]. Techniques like Bilinear (BL), Nearest Neighbor (NN), and DCT based are used as they provide real time upsampling on mobile devices. PSNR (Peak Signal Noise Ratio) and Structural Similarity Image Quality (SSIQ) are the parameters used to evaluate visual quality. PSNR considers square sum of the pixel value differences and SSIQ can be obtained by combining differences from contrast, luminance, and structure.

To measure local structural similarity between two pixels with neighborhoods, Structural Similarity index (SSIM) used in a window size of 11X11.

Initially, we can find the luminance by weighted mean intensity. Suppose x as well as y are image signals, where both are having N elements.

$$\mu_x = \sum_{i=1}^{N} w_i x_i$$

The normalized Gaussian weighting function can be used. The luminance can be calculated as

$$l(x,y) = \frac{2\mu_x\mu_y + k_1}{\mu_x^2 + \mu_y^2 + k_1}.$$

The estimation of contrast comparison $c(x,y)$ can be calculated by using standard deviations σ_x and σ_y is shown below:

$$c(x,y) = \frac{2\sigma_x\sigma_y + k_2}{\sigma_x^2 + \sigma_y^2 + k_2}$$

$$\sigma_x = \left(\sum_{i=1}^{N} w_i (x_i - \mu_x)^2\right)^{(1)/(2)}$$

We also use correlation to measure structural similarity, which can be calculated as

$$s(x,y) = \frac{\sigma_{xy} + k_3}{\sigma_x\sigma_y + k_3}$$

$$\sigma_{xy} = \sum_{i=1}^{N} w_i (x_i - \mu_x)(y_i - \mu_y)$$

To avoid singularity, we set the SSIM parameters *k3* = 0.15, *k2* = 0.03, and *k1* = 0.01, and then combine contrast, luminance, and structure components in multiplication and find the overall similarity index measure by adjusting exponents. The SSIQ is can be calculated:

$$\begin{aligned}\mathrm{SSIQ}(X,Y) &= \frac{1}{M}\sum_{j=1}^{M}\mathrm{SSIM}(x_j,y_j)\\ &= \frac{1}{M}\sum_{j=1}^{M} l(x_j,y_j)\cdot c(x_j,y_j)\cdot s(x_j,y_j)\end{aligned}$$

Where x and y are images and x_j, y_j are upsampled images in jth local window and M is total local windows in single photo or image.

C. Extracting information from edges and profile generation

During downsampling, we lose information hence required to extract the information of edges, details from High Definition videos required to check the edges and important features of objects. Mobile clients can access and use that information to minimize conspicuous artifacts during upsampling. This method uses Canny edge detection [6], which is known as optimal edge detection method. In the Canny detector, the Gaussian kernel can be placed with bilateral filter to retrieve useful edge information for MobWS, And to remove the boundaries with not important details, a little large blurring parameter is set with the bilateral filter. That is to reduce amount of metadata and computing power in mobile devices. To avoid flickering effects, identify important edges in each frame, and consider temporal coherence from MobWS.

RANdom SAmple Consensus (RANSAC) method is used during upsampling, to avoid complex computation, and to minimize computations in mobile devices. Mostly every edge block in High Definition multimedia is with a edge, and same information can be fetched by it and can construct better edge profiles. MobWS requires only 7 bits, hence amount of data in metadata can be reduced. MobWS also summarize the temporal information in the multimedia to reduce total computations required and forward metadata to the mobile client.

D. Look Up table

At receiving end mobile client values of each unfilled block is to be calculated, for the same we design look-up tables (LUTs) [6], MobWS derive with suitable in-between coefficients for each type of edge blocks. And also same block should be considered as a training dataset.

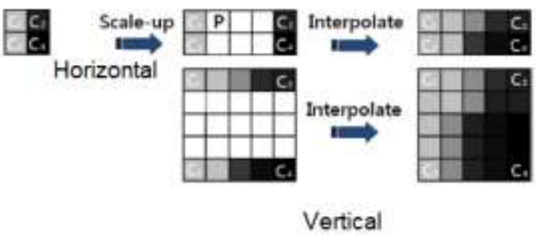

Figure 5. Upscaling in horizontal and vertical direction

Then, as given in Fig. 5 we find the corresponding coefficients. Let c1, c2, and c3 denote four corner pixels spatial intensities. Upscaling image in horizontal and in vertical direction. By taking values of two corresponding corner pixels value of unknown pixel can be calculated in the image block e.g. value of pixel ‘p’ can be calculated as:

$$f(p) = \alpha_{1p}c_1 + \alpha_{2p}c_2.$$

Over determined system can be solved to derive coefficients

$$\begin{bmatrix} c_{11} & c_{21} \\ c_{12} & c_{22} \\ \vdots & \vdots \\ c_{1m} & c_{2m} \end{bmatrix} \begin{bmatrix} \alpha_{1p} \\ \alpha_{2p} \end{bmatrix} = \begin{bmatrix} f(p_1) \\ f(p_2) \\ \vdots \\ f(p_m) \end{bmatrix}$$

Edge blocks of same shape are *m*. Also RANSAC and singular value decomposition (SVD) are utilized to minimize the marginal errors and eliminate outliers.

E. High Resolution video generation

During down sampling, we lose information hence required to extract the information of edges, details from High Definition videos required to check the edges and important features of objects. Mobile clients can access and use that information to minimize conspicuous artifacts during up sampling. This method uses Canny edge detection [6], which is known as optimal edge SR techniques are developed to convert several low resolution frames into high resolution images, like $\{\mathbf{u}_t\}_{t=1}^{T}$ into one high-resolution image result V.

$\{\mathbf{u}_t\}_{t=1}^{T}$ are generated from result V by using 1) a decimation step **D**, 2) Geometrical warps $\mathbf{F}_t$, 3) a noise term $\mathbf{n}_t$, and 4) a discretized Point Spread Function (PSF) of a camera **H**,

$$\mathbf{u}_t = \mathbf{DHF}_t\mathbf{v} + \mathbf{n}_t, \quad \text{for } t = 1, 2, \ldots, T.$$

And V is estimated by

$$\epsilon^2(\mathbf{v}) = \frac{1}{2}\sum_{t=1}^{T} \| \mathbf{DHF}_t v - \mathbf{u}_t \|^2 + \lambda \cdot R(\mathbf{v})$$

where $R(v)$ is algebraic stability, and access knowledge about V. PSF of camera H is appointed by Gaussian filter. Using scaling factor the decimator D is fixed, Motion estimation of frames can be used for construction of geometrical warps $\mathbf{F}_t$.

F. Mobile Client

MobWS can give real-time video, multimedia upsampling with good quality perception. To apply exiting Super Resolution techniques for upsampling, the existing computing resources are insufficient, hence we use metadata derived at server side to minimize computations and remove conspicuous distortions, artifacts in videos, multimedia.

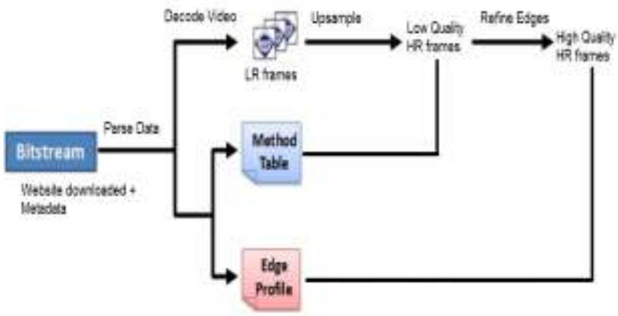

Figure 6. Upsampling at Mobile Client

The metadata includes:

- Video information: It consists of I-frames, P-frames, and B- frames in the GOP and size of GOP. Mobile Client uses this information for temporal compensation.

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- Method Table: Length of each video shot and suitable upsampling method to respective shot is included with this table.
- Edge Profile: It is used to enhance boundary quality and details of multimedia, which contains frames ID, edge block, type and temporal compensation information.

Fig. 6 shows upsampling at Mobile client flowchart, where it performs upsampling procedure i.e. conversion from LR video to HR video as follows:

1. Receive video / multimedia bitstream.
2. Decompose it into two parts i.e. metadata comprises of edge, method table and LR video.
3. Mobile client decode LR video stream to frames and take appropriate upsampling method to convert LR frames to HR frames on shot by shot basis from method table.
4. After getting HR frames using edge profile i.e. Look-up table frames are converted to videos.
5. By using temporal compensation some blocks are copied and high resolution video frames are displayed on mobile clients screen.

MobWS server introduces 3 types of visual artifacts, 1) total edge blocks (b), 2) level of restoration (r), 3) clarity of original edges (c)

$$c = \nabla I = \sqrt[2]{{G_x}^2 + {G_y}^2}, \nabla \mathbf{I} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial I}{\partial x} \\ \frac{\partial I}{\partial y} \end{bmatrix},$$

Each connected edge block is considered with size and by calculating S S I Q between ground truth and upsampled blocks; MobWS measures level for restoration. The importance of edge blocks (IEB) can be calculated like:

$$\mathrm{IEB} = c^{\alpha} \times b^{\beta} \times r^{\gamma}$$

Where α, β, γ are adjusting parameters for c- clarity, b-blocks and r-restoration. Instead of the addition the multiplication is used here to get value of an edge block can decline sharply because of these features.

IV. EXPERIMENTAL RESULTS

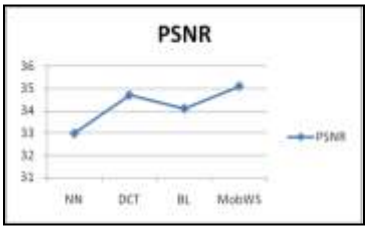
This MobWS is proposed for video upsampling at client side with better visual perception. To check performance, we implemented MobWS on a Android Mobile system and Mobile Client. Using MobWS with bit rates, metadata and LR videos with 384 kbps and also existing methods and MPEG-4 is used with 384 kbps bit rates for encoding LR videos, for proper comparison.

(a) (b) (c)

Figure 7. Implementation approaches (a) original, (b) bilinear upsampling (c) MobWS.

Fig. 7 show the quality of video in different existing and leveraged approaches. Where, (a) shows original video resolution is too small to access on mobile devices, Smartphone's; (b) shows blurring image by using bilinear upsampling., and in (c) MobWS avoid conspicuous artifacts and gives high resolution video.

(a)



(b)

Figure 8. (a) PSNR comparision and 8 (b) SSIQ comparision

Fig. 8 (a) compares MobWS, Nearest Neighbor, DCT based and bilinear approaches with PSNR values. Results gives that MobWS performs best as compared to the existing approaches and Fig. 8 (b) compares with SSIQ values. This value for MobWS is higher than that of the other existing NN, DCT based and BL algorithms. The DCT and BL performs differently for PSNR and SSIQ values. As DCT based method upsample in DCT domain it results in better compression. But it does not perform well as it generates visual artifacts.

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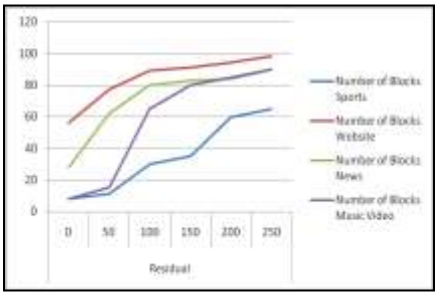

Figure 9. Different content blocks.

Fig. 9 compares different video blocks, as sports and music videos have some more static pages amount of metadata required is less as compares to videos from websites and news. But video quality will be low if it increases residual.

V. CONCLUSION AND FUTURE WORK

Here primary goal is to design a web hosting server to Android OS Platform mobile device, So that anyone, anytime, anywhere can access website. That is from device having browser which supports HTTP protocol can access website which contains multimedia. It is an upsampler MobWS for mobile client devices. MobWS generate and summarize the information from HD videos in the form of metadata which is less than 8 percent of the total data to transmit from server side. Then metadata is combined with actual video while downloading from mobile client so that it can be used for reducing visual artifacts comparing with existing NN, DCT based, BL approaches. As well as MobWS is easy and feasible as it does not require more computations during upsampling.

For future work, we can host multiple websites on android devices, smart phone and can access simultaneously through different clients, because multicore processors are available and we can convert that into the parallel computing upsampling.

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