RAW Video Database of Mobile Video Quality Prediction (MVQP)

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Abstract - *This paper presents the Mobile Video Quality Prediction (MVQP) project. A new QoE tool solution, named MVQP, relies on a non-reference QoE measuring tool. The project aims at developing a tool for the assessment of video streaming quality on mobile phones devices. MVQP project consist of two phases. Phase entails development of a raw video database that contains forty representative 4K raw videos. This video database is accessible free of cost for researchers on MVQP website for the research purpose. The study ends with an evaluation of live video streaming as a part of phase one of MVQP project.*

Keywords: MVQP, Video quality measurements, RAW video database.

1 Introduction

Wireless cellular networks are expending both in coverage and capabilities. New 3G and 4G-LTE based radio access offers significant throughput capabilities for each user. This led to a revolutionary increase in mobile-video streaming amongst a large number of users [1]. The increase of data traffic over cellular networks is caused predominantly by video-streaming applications. These applications cause a fluctuation on the data rates, which in turn influence the quality of video streaming service itself [2].

The assessment of the quality of video-streaming is, by no measure, an easy task. This assessment faces various challenges like limited computation powers of the mobile device, distorted videos being found, packet loss, delays and other characteristics and troubles posed by the wireless networks [3].

The Quality of Experience (QoE) measurement of the user is the perceived experience of the service provided by the network. In most networks, the quality of service (QoS) measurements are used to manage the network traffic in a cost-effective manner. QoE guarantees a good relationship between networks and end users [4].

2 MVQP Project

Video streaming over mobile platforms is a very popular data communication service. It is used by all age groups and for various purposes ranging from education to entertainment and infotainment. Network customers are interested in all types of streaming video services. The quality of the video streaming matters whether people are watching a video clip from a movie or a clip from a family occasion having sentimental values. The MVQP project aims to deliver a new scheme to predict the quality of the video streaming using both 3G and 4G-LTE based cellular networks. One finds that calculation and estimation of the quality of the video streaming over the cell phones devices is an issue that has not been satisfactory addressed. At the moment not many solutions have been proposed. Partially, this may be attributed to computational, size and other inherent limitations of the mobile devices.

MVQP project will be able to recognize the quality of the streaming video for a network implementing 3G/LET air interface and for connections utilized by the smart mobile devices.

3 RAW video database generation

The raw video database test bed (RAW) created for MVQP project is a large database of representative video recordings. It consist of various types of shots of movie clips and of various motions. The video database will serve as a good source of videos for the researchers and students alike [9].

3.1 RAW video camera specs

The model of the camera used for the video collection for the RAW database is Sony PMW-F5 CineAlta Digital Cinema Camera 4K. This camera model comes with a super 35mm image sensor. AXS-R5 option recorder was used, and to do so it was mounted behind the camera. An additional high speed flash storage of 512 GB was used in order to work with the 4K RAW options. Choosing this camera model proved to be the right decision as the results were commendable and every little detail was well captured and preserved with the high quality sensor. This model that

has an option to record 16 bit linear capture was used to preserve the details of the image in terms of tones that even the naked human eye would not be able to differentiate.

3.2 Shots locations

Most of the locations have been selected on Florida Institute of Technology (FIT) campus – Melbourne, FL and some of them between Downtown Melbourne and Melbourne beach.

3.3 Type of video shots

3.3.1 Pan

A panoramic view is the one in which the focus of the image remains constant vertically and the camera is moved only horizontally from left to right or vice versa.

3.3.2 Tilt

When a camera moves either upwards or downwards from one fixed initial location, it is called as a tilt.

3.3.3 Tracking

This kind of shot is the following sort. In tracking, the camera actually follows the moving subject to whatever direction it takes in order to not to let the subject out of the view.

3.3.4 Zooming

This kind of shot offers no actual movement of the camera itself. But it works on the principals of physics using the change in focal length of the lens resulting in an impression that the camera actually moved closer or far from the subject.

3.4 Videos names and descriptions

The lists below are a short description for twenty eight of RAW video out of forty in MVQP database, and the snapshot of each of them are shown in Figure 1.

3.4.1 Soccer game (sg)

Shot on a campus on a sunny afternoon. Players are showing diverse contrasts and colors along with complex motions. The camera is tracking the players both sides horizontally.

3.4.2 Sport car (sc)

Shot on the road on a sunny afternoon. The sport car exhibits fast motion with blooming trees on the side of the road. The camera tracks the car from right to left.

3.4.3 Tree (tr)

Shot on campus on a sunny afternoon. Many small leaves are visible, moving slowly. The camera was fixed.

3.4.4 Building (bu)

Shot on campus on a sunny afternoon. The building is surrounded with a large number of trees all around in which leaves are visible moving slowly. The camera pans across the screen from left to right.

3.4.5 Lawn service (ls)

Shot on campus on a sunny morning. A man is providing lawn services by making use of a lawn machine. The camera tracks the machine from left to right.

3.4.6 Pedestrian (pe)

Shot on campus on a sunny morning. Some students are entering while others are leaving. The camera was fixed.

3.4.7 Students at library (sl)

Shot on main campus library on a morning indoors. Students are sitting near a bookrack and are having discussion on a particular topic. The fixed camera zooms out.

3.4.8 Garden (ga)

Shot in a garden on a cloudy morning. There are light color contrasts and slow motion of tree leaves. The camera tilts the trees from bottom to top with a reflection of the cloudy sky.

3.4.9 Turtle (tu)

Shot at a lake on a cloudy morning. The slow movement of turtle within the water has presented a fascinating scene. The camera was slowly tracking the turtle.

3.4.10 Waterfall (wf)

Shot at a small lake on a cloudy morning. There is a fast and steady movement of water flow, which has created a splash. The camera was fixed.

3.4.11 Spider (sp)

Shot on a campus garden on a cloudy morning. The spider exhibits fast motion to complete web. A water flow beneath a spider is presenting complex textures. The camera was fixed.

3.4.12 Large building (lb)

Shot on campus on a sunny morning. Many small leaves are visible, moving slowly in different directions. The camera was moving from the bottom of the building towards the blue sky diagonally.

3.4.13 Presentation (pr)

Shot in a classroom on a morning indoors. Professor is explaining a diagram related to specific topic, displayed on multimedia. The camera was fixed.

3.4.14 Lecture (le)

Shot in a classroom on a morning indoors. The professor is explaining a concept on white board. The camera was fixed.

3.4.15 Tennis training (tt)

Shot in a tennis filed on campus on a sunny morning. Two players show diverse color contrasts and complex motions. The camera tracks the players.

3.4.16 Fountain (fo)

Shot near a car parking on campus on a sunny afternoon. The continuous flow of the water is presenting a motion of waterfall. The camera was fixed.

3.4.17 Swimming pool (sw)

Shot on campus at a swimming pool on a sunny afternoon. The water looms towards the camera when the individual made a jump. The camera was fixed.

3.4.18 Fencing activity (fa)

Shot at a fencing area on campus. Players with fencing dress are moving slowly forward and backward. The camera tracks the action.

3.4.19 Melbourne downtown (md)

Shot from the top of the roof on a cloudy afternoon. The entire area is comprised of tall buildings and trees and various cars are moving on the road. The camera pans from right to left.

3.4.20 Bridge (br)

Shot across the bridge in the city of Melbourne on a cloudy afternoon. Various cars are moving on the bridge while water waves are moving slowly downstream. The camera was fixed.

3.4.21 Birds (bi)

Shot near Melbourne beach on a cloudy afternoon. The birds are showing a random and fast movement. The camera was moving slowly with the direction of birds.

3.4.22 Melbourne beach 3 (mb3)

Shot in the city of Melbourne beach on a cloudy afternoon. A girl is moving within the fast waves of water on beach. The camera was fixed.

3.4.23 Playground (pl)

Shot in a park on a sunny afternoon. Children with colorful dresses are enjoying themselves on slides full with bright and fascinating colors. The camera was fixed.

3.4.24 Basketball (ba)

Shot in a park basketball field on a sunny afternoon. Children are getting trained for basketball and a complex motion is being depicted through their movements. The camera was fixed.

3.4.25 Basketball training 2 (bt2)

Shot on campus on an afternoon indoors. Different ratios of light are shown with the movement of players. The camera was showing a steady movement.

3.4.26 House (ho)

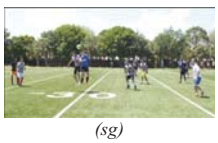
Shot in a residential area during nighttime. The garden in front of house is showing a soothing effect and objects around it are all static. The camera was fixed.

3.4.27 Street at night (sn)

Shot in a street during nighttime. The vehicles are moving at various different speeds and in different directions. The camera was fixed.

3.4.28 Girl talking 2 (gt2)

Shot in a studio on an afternoon indoors. With an extreme close up the girl who is thinking of what to speak on a certain topic. The camera was fixed.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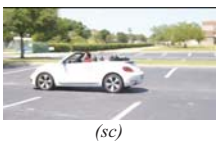
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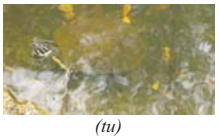
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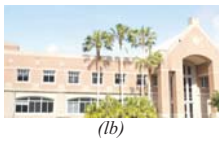
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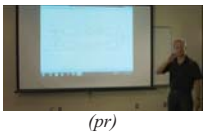
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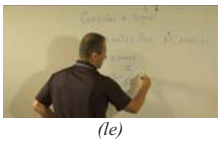
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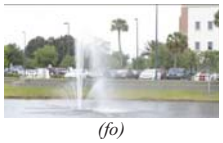
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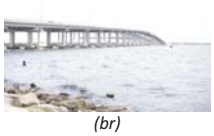
(br)

Figure 1. RAW Videos snapshots

4 MVQP website generation

In support for the MVQP development a website has been created. It is up and running and can be accessed at [9]. The website for now has forty RAW YUV videos and allows free access to help the researchers with their studies. The videos captured are of different kinds both in terms of motion and camera movements. Sony F5 camera was used to record 4K RAW videos which were then sampled down to YUV 2K by using a combination of Sony RAW software and VirtualDub which is an open source technique [8].

5 Quality affecting factors

There are some limitations with the re-production of mobile-videos. These mainly come from display size limitations and the processing capabilities of the end terminals. While low bit-rates, frame rates and smaller screen sizes pose more critical issues, spatial resolutions and the quality of frames are also some of the pressing factors that affect video-quality and the quality of the mobile networks [6]. During the transmission of the coded video, many factors can affect the quality of the video that results in distortion, noise and other forms of quality loss at the receiving end.

For this study, a few of the factors affecting the quality of the video streaming are selected to focus on. These factors are the packet loss with some Radio Frequency (RF) factors to determine the video quality over the mobile phones devices over "CDMA2000/ EVDO-Rev A" on Sprint PCS networks.

5.1 Packet loss

Packet loss is the most important factor that affecting the quailty of reciving videos. Packet loss defined as a rate at which transmitted packets do not reach at their destination [1].

5.2 Received signal code power (RSCP)

Received signal code power (RSCP) is the measure of power at the receiver end pertaining to a specific physical communication channel. It signifies the strength of the signal [7].

5.3 Interference metric (Ec/Io)

(Ec) is the received pilot energy, (Io) is the total power spectral density or alternately the total received energy. Pilot strength is the Ec to Io ratio that is expressed in dB [5].

6 Live video streaming distortion and RF measurements methodologies

Several videos from the MVQP database are selected to work as a test bed for the experiment. Different videos were selected to keep the test bed as diverse as it could possibly be and to ensure the results were optimal. The factors kept under consideration during the experiment are the Packet loss, RSCP, and (Ec/Io). "CDMA2000/ EVDO-Rev A" on Sprint PCS was used to stream the videos and to measure the impact of the above mentioned distortion factors. The results revealed a relationship between the factors, which is shown in part 7.

7 Results

As a preliminary illustration two videos have been selected. The first one is a pedestrian clip, and the second one is a bridge clip. To reference the clips, they are named as (pe) and (br) respectively. One of them is a fast motion and the other one is a slow motion. Sprint PCS mobile networks is used for the live video streaming experiments.

The graphs in Figures 2 and 3 shows the results of the analysis. It is evident from the graphs for both the videos that the packet loss is inevitable if the signal is either low or high with the presence of interference.

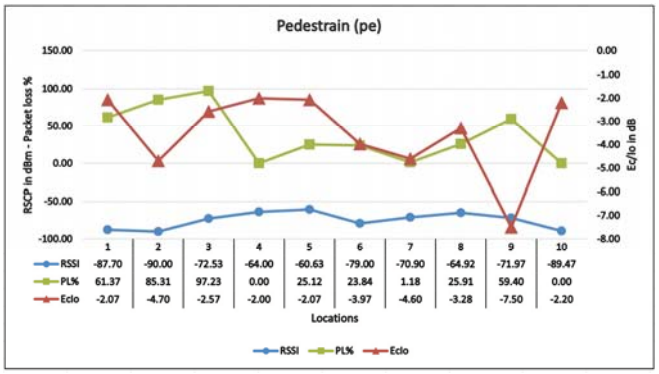

Figure 2. Pedestrian (pe) video streaming analysis.

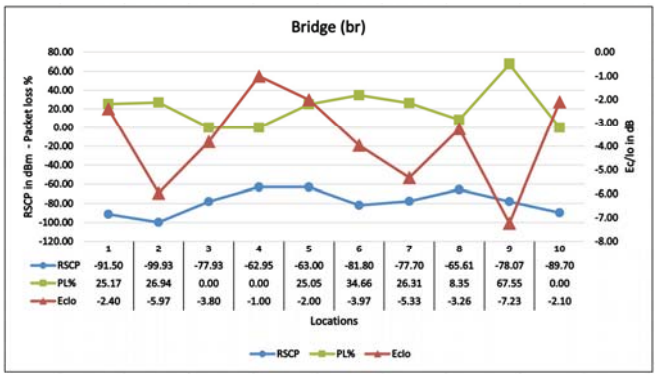

Figure 3. Bridge (br) video streaming analysis.

8 Conclusion

This study proposed an introduction of MVQP that will be the tool of prediction of the quality of video streaming over the mobile phones devices. The study was backed up with the experimental results that showed a relationship between the considered distortion factors. In [10], [11], and [12] we extended this study with another experiments that contained the in depth analysis of the experiments for 3G/4G-LTE video quality streaming measurements.

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