Neural Network Model of QoE for Estimation Video Streaming over 5G network

Asma Lounis, Farid Alilat, Nazim Agoulmine

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LOUNIS Asma[1], ALILAT Farid[1], and AGOULMINE Nazim[2]

[1] Image Processing and Radiation Laboratory, EII, USTHB, Algiers, Algeria
asma.lounis@usthb.dz faralilat@yahoo.fr
[2] , Laboratory of Information, Integrative Biology and Complex Systems, University of Evry Val dEssonne, Bd Franois Mitterrand, Evry Cedex. France.
Nazim.Agoulmine@ibisc.univ-evry.fr

Abstract

With the rapid increasing demand of commercial video streaming, the satisfaction of the end user is becoming more and more important to measure and assure.The quality of experience (QoE) is defined as the measure of the overall level of customer satisfaction with the usage of a service provided by a vendor. Many works have addressed this issue in many different scenarios in cellular networks however most of these works have addressed video streaming over LTE networks (Long Term Evolution network). Up to day, there are few contributions of work that address the QoE over 5G network since there still still some challenges in this later to address. In this paper, we present the specific aspects we consider important in the evolution from 4G to 5G in term of traffic management and a solution to estimate this QoE in this new context. We adopted an approach based on Neural Network (NN) to estimate the QoE parameters. NN have been successfully used in many domains where it was difficult to derive an exact analytical model of the system so is the case of the 5G network.

1 Introduction

Recent years have seen an amazing evolution in information and telecommunication technologies. The development of multimedia streaming services (Netflix, Youtube, Facebook, etc.) and innovative end user devices (e.g. smart phones, wearable devices, tablets, laptop) has created a huge demand for high data rate services.

According to the latest Cisco Visual Network Index (VNI)[1], global mobile data traffic will increase almost ten times in the next ten years, where three-quarters of this traffic will be video streaming. The latter has pushed many researchers to investigate new technologies in the frame of the 5G (Fifth Generation of Cellular Networks). The expectation from 5G are huge with the promising enormous amount of spectrum in the millimeter wave (mmWave) bands it plans to use[2].

The goal of 5G is not only to provide high data transfer rates but also to improve the quality of experience (QoE)of end users and more particularly video streaming which are one of the most critical services that will be supported by 5G networks at large scale. Nowadays, video streaming traffic counts for more then 70 percent of all Internet traffic, and it is expected to reach 82 percent by 2020 [3]. This increase in the volume of video traffic is fueled by the emergence of new applications that will emerge quickly in the market such as social video, virtual reality (VR), augmented reality (AR), etc.., the latter shows that the multimedia streaming or more precisely the streaming video will be more and more important in the human society (smartcity, eHealth, Industry 4.0; etc.).

Actually, each class of services has its own QoS (Quality of Service) parameters that influence/impact the QoE of end users. Researchers have been working on finding methods to quantify and map these factors into a QoE model to be able to assess the quality of the corresponding service[4]. Most existing contributions in this area are related to LTE and wireless network. There are very few articles that address specifically the case of future 5G network,in [5] the autors proposed an analytical method that reduces delay and packet loss rate (PLR) to increase QoE of video streaming over 5G. In [6] the autors present a novel method of performance evaluation for service chains within cloud networks by task graph reduction,they evaluate this methos by cloud based mobile video streaming as an example of a service chain in a 5G network for evaluation. In [7] the autors propose a novel QoE model for evaluating video streaming,they use a non-linear regression and exponential function to get the formula of estimation the QoE of streaming video over 5G

Therefore, the objectif of this paper is first to present these contributions and then propose a new solution for the estimation the QoE of 5G network end users for streaming video over millimeter wave, the 5G millimeter wave network should be used to obtain the higher bandwidth and bit rate gains.

The remainder of this paper is structured as follows: in section II, a definition of QoE is presented, next, we discuss the different state of art QoE evaluation methods. in section III, we present the architecture of video streaming system over 5G network and the proposed methodology to estimate the QoE of streaming videos. Finally, in Section IV, a conclusion of the work is presented as well as some future works.

2 QoE Definition and State of Art Assessment Methods

2.1 QoE Definition

As today, it is difficult to find a unique definition of the Quality of Experience. The International Telecommunication Union (ITU-T) has defined it as the overall acceptability of an application or service, as perceived subjectively by the end user. Recently, in the European Qualinet community, the QoE was defined as the degree of delight or annoyance of the user of an application or service. It is clear from these two definitions, that the general understanding of QoE remains the same to a large extent despite some specific formulation in different context of interactions between a user and a provided service.

2.2 State of Art Assessment Methods

State of art QoE assessment methods can be categorized into three category: subject assessment, object assessment and hybride assessment. Subjective assessment is the most direct way to evaluate users QoE since the results are given by humans directly during the usage of the service. The evaluation consists of constructing a panel of human observers who will evaluate the sequences of videos according to their point of view and their perception. The output of the test is generally in terms of Mean Opinion Score (MOS). Since the subjective approach is not appropriate for implementation (because it is very expensive and takes a long time to achieve).

The latter pushed researchers to find other more less subjective methods,where the QoE is mathematically modeled with some objectively measurable factors as input variables, and the value of QoE is the corresponding output as proposed in[7]. The researchers found many objective measures such as Peak-to-Signal-Noise Ratio(PSNR),Structural Similarity MetriC(SSIM)and Video Quality Metric(VQM)[8] to optimize streaming video.

Between the two approaches described above, a hybrid evaluation called pseudo subjective quality assessement (PSQA) was created to provide an accurate assessment of QoE as perceived

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by humans. The method is based on statistical learning. The current classical machines learning approach used in(PSQA)are recurrent neural network (RNN) model,The support vector machines (SVM),model decision tree and Bayesian network [3].

Based on experiences researching QoE, it is realized that in many situations,the relation between influencing factors and QoE cannot be expressed by mathematical formulas explicitly. Furthermore, even if a mathematical model can be established, system parameters may be hidden in the beginning. In order to explore the implicit relation and the system parameters,machine learning methods are widely applied,there are for we use machine learning methods in our proposed scenario.

3 Scenario of evaluation the QoE of streaming video over 5G

3.1 The architecture of video streaming system over 5G networks

Due to the shortage of frequency spectrum below 6 GHz bands and the demand for higher data rate, higher frequencies, e.g., the millimeter-wave (mm-Wave) frequency bands, have been suggested as candidates for future 5G smartphone applications, as the considerably larger bandwidth could be exploited to increase the capacity and enable the users to experience several-gigabits-per-second data rates [9][10].

In our architecture, we use millimeter wave link model to build video streaming client and server side, which achieves the goal of spread of video streaming [10][11] Our architecture for video streaming system over 5G network is showed in Fig. 1 From the figure we can see it includes two parts, the first one is to build millimeter wave network by using ns-3 simulation tools which is defined and explained in [12]. The second constitutes the estimation model for video streaming over 5G.

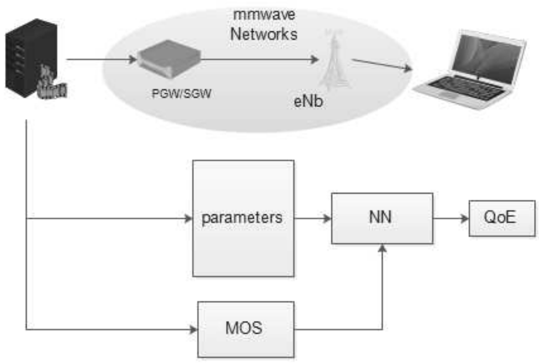

Figure 1: Architecture of video streaming system over 5G network.

3.2 millimiter wave network 5G

Millimeter-wave (mmWave) communication is widely considered to be a promising candidate technology for fifth generation (5G) cellular and next-generation wireless local area networks(WLANs). The implementation of millimeter wave devices comprises the propagation and channel model, the physical (PHY) layer, and the MAC layer. The module completely is explained in [7],and described in fig 2.

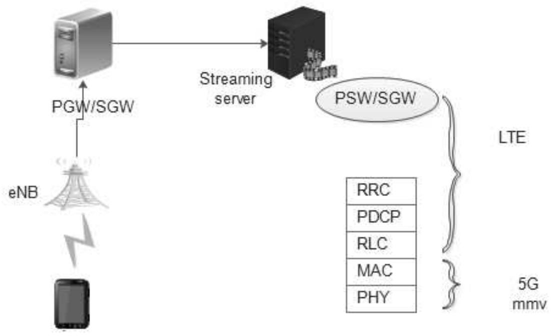

Figure 2: 5G millimeter wave end-to-end network with video streaming system.

As we can see in fig 2 the architectures is very robust the millimiiter MAC layer is designed to meet the ultra-low latency and high data rate demands, as presented in [13].. the mmWave bands potentially enable ultra-low latency and massive bandwidths at the physical (PHY)which is designed for multiple function like achieve channel model frame structure parameters, including millimeter wave transmission path loss model, MIMO technology to achieve beam-forming technology, the channel configuration parameters...ect .

3.3 Estimation of the parameters

Our scenario of estimation of QoE for video streaming over millimitter wave in 5G is shown in fig 3. As we can see from the architecure of our estimation of QoE is over a Neural Network

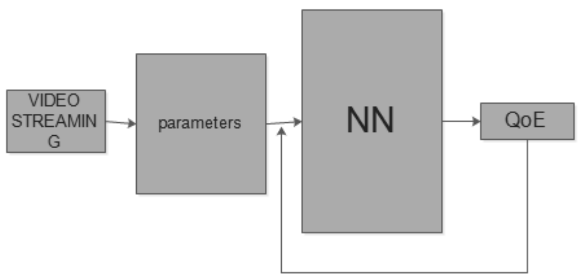

Figure 3: architecture of our scenario.

where we need to introduce some parameters so : Firstly the Peak Signal to Noise Ratio (PSNR) of the videos is calculate and it will be mapped to Mean opinion score (MOS) value of the user as showed in Table I

secondly we alculate the parameters of quality of service QoS (jitter, packet loss, delay) in order to characterize videos. as showed in figure 4

Table 1: PSNR-MOS

PSNR	MOS	Estimated Quality
> 37	5	Excellent
31-37	4	Good
25-31	3	Reasonable
20-25	2	Poor
< 20	1	Bad

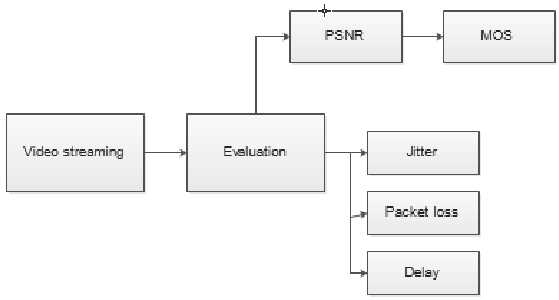

Figure 4: .Estimation of QoS parameters and MOS.

also it will be important to find a parameters for introduces the user profil which is a very important factor to improve the QoE. The QoS parameters (jitter, delay, packet loss,human profil) and MOS will be used for automatic learning part. Thereinafter, we will describe this part in detail.

The third part concerns the automatic learning of the selected neural network. In our QoE assenssement we adopt the fuzzy ARTMAP (FAM)neural network. Since its inception in 1992, the fuzzy ARTMAP (FAM)[14] neural network has attracted researchers attention. FAM excels in fast incremental supervised learning in a non-stationary environment and using few examples. The network enables the learning of new data without forgetting past data, addressing the so-called plasticity-stability dilemma [14] . The FAM is considered one of the leading algorithms for classification [15].

The parameters of QoS (jitter, packet loss, delay,human profil) will be the input of our NN and the output will be the QoE as showed in fig 4.

we will select a number n of vodeos for learning and a number m (n ¡¡ m) of videos for the test. The two bases will be chosen independent of each other. From these videos, we will determine the parameters characteristics (jitter ,delay ,packet loss,human profile) which will constitute the signature of the videos.

4 conclusion

In 5G future networks , QoE metric is e a challenging task.So in this paper, we propose to use a Fuzzy artmap neural network to estimate the QoE of video streaming system over 5G network. The parameters of QoS (jitter, packet loss, delay,human profil) will be the input of our neural network and the output will be the QoE. We will complete this work by a comparative study of different architectures using different neural networks and architectures using mathematical models.

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