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A comparison of AR full motion video traffic models in B-ISDN

A. Alheraish *

Department of Electrical Engineering, King Saud University, P.O. Box 800, King Khalid Road, Riyadh 11421, Saudi Arabia

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Abstract

Full motion video traffic is envisaged to be a major source for Internet and broadband integrated services digital networks (B-ISDN). Accurate traffic models of full motion video are needed to design networks and improve video services. Auto-regressive process (AR) proves to be a viable modeling approach of full motion video. A considerable amount of effort on AR video modeling has been reported in the recent studies which need to be thoroughly investigated. The aim of this paper is: (1) to survey a number of AR models for full motion video; (2) to classify the models according to their properties and framework; (3) to compare and contrast the models based on their attributes: residual, coding scheme, capturing scene changes, number of parameters, level of modeling, and complexity; (4) to show the ability of these models to predict accurately different aspects of network performance; (5) to give recommendations that might be helpful in determining the appropriate model for full motion video based on the target application; (6) to give direction for future work on this important modeling scheme.

Keywords: Video transmission; Video model; Video networking; Auto-regressive

* Tel.: +966 14676806; fax: +966 14676757.
E-mail address: heraish@ksu.edu.sa

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1. Introduction

A video traffic model is a stochastic process which can be used to test and design current and future communication networks. A good video model allows for better admission control, bandwidth allocation, and bit rate control that guarantees a desired quality of service such as packet loss probability, delay and statistical gain. The useful video model should capture and match the essential characteristics of the real video traffic. These characteristics are generally defined as: marginal distribution, autocorrelation, mean, variance, and Hurst parameters. In addition, the performance results for the model should accurately predict those of the real video stream when it passes through a network. One of the promising and versatile stochastic processes for modeling video traffic in broadband network (B-ISDN) is the Auto-regressive process (AR). AR process is simple as it requires few parameters. In an AR process, the current value is a function of weighted linear combination of past values. The finite AR process is generally expressed as

$$x(n) = \sum_{k=1}^{p} a_k x(n-k) + e(n) \tag{1}$$

where $x(n)$ is the bit rate of the coded video during the nth frame, $e(n)$ is a Gaussian process with zero mean and variance σ^2, and a_k are the correlation coefficients among successive frame rates. Such a process is denoted by AR(p) and p is called the order of the AR process. The sequence $\{e(n)\}$ consists of i.i.d. random variables, known as the residual (or error process), that give the AR model its stochastic nature.

This paper analyzes and compares a variety of AR video models that have been recently proposed for full motion video. These models are classified as: Hybrid AR models (Motion classified AR, composite AR); Pure AR models (scene based models, GOP GBAR model, nested AR, and NAR model); and Projected AR models. In the comparison, the following methodology for each underlying regression model is used: (1) we give a short description and highlight the main features; (2) we examine advantages and limitations; (3) where appropriate, we show some results of the statistical properties and the ability of the model to predict the queuing performance of a single and multiplexed video sequence and (4) we point out the validation procedure.

The rest of this paper is organized as follows. Section 2 introduces the full motion video properties. Section 3–5 examine the full motion video models. Summary, recommendation and open issues are discussed in Section 6. Finally, Section 7 gives the distinct of the present study to the previous work.

2. Full motion video properties

Generally, video models are classified based on two types of video: teleconference video and full motion video. Teleconference video consists of video scenes in which one or several people are talking with very little movement and almost unchanged background. Full motion video, unlike teleconference video, does not restrict its attention to scenes of people talking, but rather exhibits a wide range of video scenes (low, medium, and high) and includes background and foreground with frequent scene changes as in general TV program, news, and sports broadcast. This sort of video