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The Influencing Factors of Network Packet Loss's Long-Range Dependence has Impacts on the Packet Loss Rate

Jin Wang

Shijiazhuang Tiedao University
No. 17 Northeast, Second Inner Ring
Shijiazhuang, Hebei, P.R.C. 050043
wangjin_1204@163.com

Abstract

In order to better establish no-reference video quality assessment model considering the network packet loss and further gain a better QoE evaluation to meet the needs of the user's, so we build NS2+ MyEvalvid simulation platform to study the scale characteristic of the network packet loss, scale characteristic of packet loss through the influence of packet loss rate to influence QoE. The experimental results show that, packet loss processes has long-range dependence, the number of superimposed source N, shape parameter, Hurst parameter, the output link speed have impacts on long-range dependence. We came to the conclusion that when superimposed source N is more, shape parameter is smaller, Hurst parameter is bigger, the output link speed is smaller, packet loss's long range dependence is larger, packet loss rate is high.

Keywords: *Influencing factors; no-reference; Quality assessment model; Network packet loss; Long-range dependence*

1. Introduction

At present, the development of international information prompted the international people's exchanges widely, network video business is increasing. In the information industry, network video business has become the most popular application of computer network field, from the international and domestic exchanges to life and entertainment, video penetrated into every aspect of our lives.

But the network itself is not perfect, in essence is a kind of distortion network. Therefore, causes the academia and industry professionals think that, what causes the decrease of the quality of the video and how to evaluate the quality of the network video. So, we set up the video quality assessment model to evaluate the quality of video. Network TCP/ IP protocol itself is only a best effort protocol [1], in this service model, all the business flows fair competition to network resources, cannot meet the bandwidth, delay, jitter and other special requirements of the new application. These new applications contributed to QoS (Quality of Service, QoS) concept appears. In addition, QoS and man-made factors together determine the user's Quality of Experience (Quality of Experience, QoE) [2]. The various business on computer network, presents the long-range dependence [3-4]. Only under the self-similar traffic network's performance conducting the correct analysis and evaluation, we can make the network performance is optimized. One of the most important parameters in QoS is the packet loss rate, different output link speed will affect the packet loss's long range dependence, long-range dependence will further affect the packet loss rate.

In related work, the reference [5-6] mainly proposed scale characteristic of packet loss, scale characteristic mainly refers to in the process of packet loss reflects long correlation. Long- range dependence with the self-similarity is two equivalent

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concept. Because of the long correlation will affect the packet loss and further affect quality of service (QoS), and finally affect the QoE. The packet loss rate is an important measurement parameter in QoS. So study Long-range dependence has an important value and significance. References [7-8] researches in network traffic, discusses several existing Long-range dependence model, comparing their respective advantages and disadvantages, and predict the network traffic associated short and Long-range dependence into account, is the future direction of the traffic model, and be able better to describe any network traffic development direction. Through the study found the number of superimposed source N, shape parameter, Hurst parameter, the output link speed has impacts on Long-range dependence, and further affects the packet loss rate. Finally it is concluded that different output link speeds have a significant impact on long-range dependence, and further to affect the packet loss rate. At the same time, this conclusion will be applied to establish the no-reference video quality assessment model considering the network packet loss.

2. NS2's Principle of Generating Self-Similar Traffic

NS2 provides four types of traffic generator: (1) EXPOO. (2) POO: (On/ Off) Pareto distribution generating traffic. (3) Generate traffic CBR use the determine rate. (4) According to the trace files to produce traffic's TrafficTrace. Including in OTCL class Application/ Traffic/ Pareto's one traffic generator is POO_ Traffic. POO_ Traffic according to Pareto on/ off distribution generate traffic, at a fixed rate send packet in the period of on, no packet transmission in off period. Superimposed source N many heavy tail's On/ Off source superposition can produce self-similar traffic flow. N is greater, the self- similar phenomenon is more obvious.

The location of each files: (1) Application class: In C++ Application class（~/ ns/ apps/ app. h). (2) trafficGennerator abstract base class (~ ns/ tools/ trafgeh. h"). (3) POO_traffic (~ns/ tools/ pareto. cc). (4) CBR_ Traffic (~ ns/ tools/ cbr_ traffic. cc) [9].

In this paper, for example N=3 that is three sending nodes, the simulation code is as follows:

```
set ns [new Simulator]
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set R [$ns node]
set r [$ns node]
$ns duplex-link $n0 $R 1Mb 10ms DropTail
$ns duplex-link $n1 $R 1Mb 10ms DropTail
$ns duplex-link $n2 $R 1Mb 10ms DropTail
$ns duplex-link $R $r 10Mb 10ms DropTail
proc attach-poo-traffic { node sink size burst idle rate shape} {
    #Get an instance of the simulator
    set ns [Simulator instance]
    #Create a UDP agent and attach it to the node
    set udp0 [new Agent/UDP]
    $ns attach-agent $node $udp0
    #Create an Expoo traffic agent and set its configuration parameters
    set traffic [new Application/Traffic/Pareto]
    $traffic set packetSize_ $size
    $traffic set burst_time_ $burst
    $traffic set idle_time_ $idle
    $traffic set rate_ $rate
```

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```
        $traffic set shape_ $shape
        # Attach traffic source to the traffic generator
        $traffic attach-agent $udp0
        #Connect the source and the sink
        $ns connect $udp0 $sink
        return $traffic}
    set sink0 [new Agent/LossMonitor]
    set sink1 [new Agent/LossMonitor]
    set sink2 [new Agent/LossMonitor]
    $ns attach-agent $r $sink0
    $ns attach-agent $r $sink1
    $ns attach-agent $r $sink2
    set source0 [attach-poo-traffic $n0 $sink0 200 2s 1s 100k 1.4]
    set source1 [attach-poo-traffic $n1 $sink1 200 2s 1s 200k 1.4]
    set source2 [attach-poo-traffic $n2 $sink2 200 2s 1s 300k 1.4]
    set f0 [open out0.tr w]
    proc finish {} {
            global f0
            #Close the output files
            close $f0
            #Call xgraph to display the results
            exec xgraph out0.tr -geometry 800x400 &
            exit 0    }
```

Among them, average on (sudden) time is burst_ time_, average Off (free) time is idle_time_, during the sudden time, the package delivery rate is rate_, packet size is packetSize_, Pareto distribution's shape parameter is shape_ [10].

TCL process of record the simulation data:

```
proc record {} {
            global sink0 sink1 sink2 f0
            #Get an instance of the simulator
            set ns [Simulator instance]
            #Set the time after which the procedure should be called again
            set time 0.01
            #How many bytes have been received by the traffic sinks?
            set bw0 [$sink0 set bytes_]
            set bw1 [$sink1 set bytes_]
            set bw2 [$sink2 set bytes_]
            set addbytes [expr $bw0+$bw1+$bw2]
            set alladd_bytes $addbytes
            #Get the current time
            set now [$ns now]
            #Calculate the bandwidth (in MBit/s) and write it to the files
            puts $f0 "$now [expr $alladd_bytes/$time*8/1000000]"
            #Reset the bytes_ values on the traffic sinks
            $sink0 set bytes_ 0
            $sink1 set bytes_ 0
            $sink2 set bytes_ 0
            #Re-schedule the procedure
            $ns at [expr $now+$time] "record"    }
```

Initialization and end of the simulation:

```
$ns at 0.0 "record"
$ns at 0.1 "$source0 start"
$ns at 0.1 "$source1 start"
$ns at 0.1 "$source2 start"
$ns at 327.68 "$source0 stop"
$ns at 327.68 "$source1 stop"
$ns at 327.68 "$source2 stop"
$ns at 327.80 "finish"
$ns run
```

We can synthetic business flow with self-similar properties is N numbers Pareto On/ Off [11] traffic generators. Topology structure including n(0), n(1) , , , n(N-1) these N number sending nodes, R is the routing node and S is the the receiving node. N+ 1 links: n(0), n(1), , ,n(N-1) is N number links to R, 1MB is bandwidth, 10ms is the delay, discard the package excess capacity; 10MB is R to S bandwidth、 10ms is the delay, discard the package excess capacity. In the experiments, through R and S ‘s queue object’s queue-limit set the queue length, make the queue drop strategy is Droptail. The topology structure is as shown in Figure 1. When shape parameter is 1.4, flow rate Figure as shown in Figure 2. The horizontal axis shows the simulation time is 300 s, flow rate value that is the vertical axis is the numbers of packet loss per unit time, as can be seen from the Figure of sudden change of the traffic flow [12], and the linear flow rate values most are 400, 500, 600 these three values.

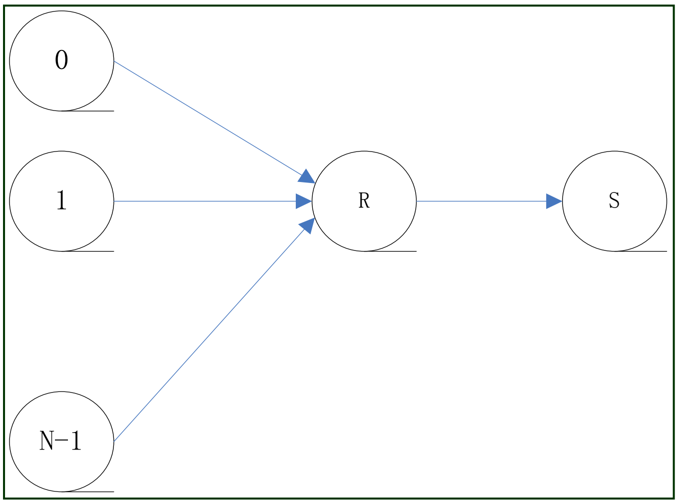

Figure 1. Topology Structure

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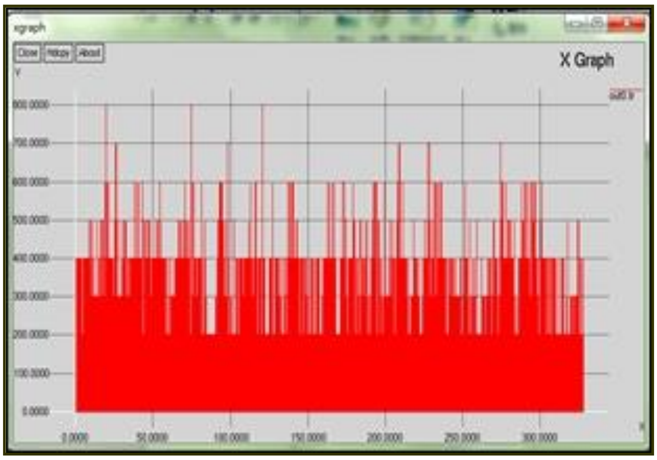

Figure 2. Flow Rate Figure

3. The Definition of Self-Similar Processes

For a generalized stationary random process $\{X_n\}_{n=0,1,2...,}$, set X_n with constant mean $\mu = E(X_i)$ and finite variance $\sigma^2 = E[(X_i - \mu)^2]$, the self-correlation coefficient is[13]:

$r(k)=E[(X_i - \mu)(X_{i+k} - \mu)]/\sigma^2$, ($k$=0, 1, 2 , …)

The self-correlation coefficient only concerned with k, the number of network business entity in the k-th unit of time arrival is called X_k.

Use $L_1(k)$ represents a slowly varying function，that is $\lim_{t\to\infty}\frac{L_1(tx)}{L_1(t)} = 1$, and for all X>0 set up r(k)-$k^{-\beta}L_1(k)$, said the process to satisfy the above conditions called progressive self-similar process[14].

Definition Generalized stationary discrete random process $\{X_n\}_{n=0,1,2...,}$, called strong progressive two order self-similar process，and have self-similar parameter H=$1-\beta$/2, 0<β<1, if for any k>-1 self-similar function all meet $\lim_{m\to\infty} r(k)/k^{-\beta}$=C<$\infty$, C is constants.

Self- similar function H also known as the Hurst parameter, it is the only parameter description of self-similarity. Short time-related 0< H< 1, when there is no correlation H= 1/ 2, long time -related 1/ 2< H< 1. Because the network traffic is long-range dependent, therefore, the range is (1/ 2, 1), H is bigger, the higher the degree of self-similarity.

4. Influence Factors of Long-Range Dependence

4.1. The Influences of Superimposed Source N on Long-Range Dependence

According to the principle of the experiment we can assume, when N is bigger, self-similar is bigger, Hurst parameter is bigger, packet loss rate is bigger. Therefore, do four experiments, when the shape parameter is 1.5, the values of N respectively are 5, 7, 9, 11, and make flow rate Figure under the condition of N value are these values, the horizontal axis represents time, the vertical axis represents the numbers of packet arrival per unit time. When the N value is 5 rate Figure as shown in 3, when the N value is 7 rate Figure as shown in 4, when the N value is 9 rate Figure as shown in 5, when the N value is 11 rate Figure as shown in 6.

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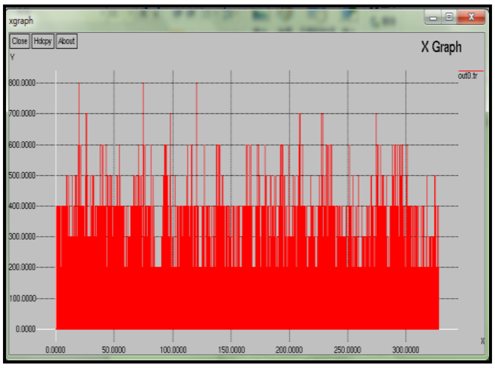

Figure 3. Rate Figure of N Value is 5

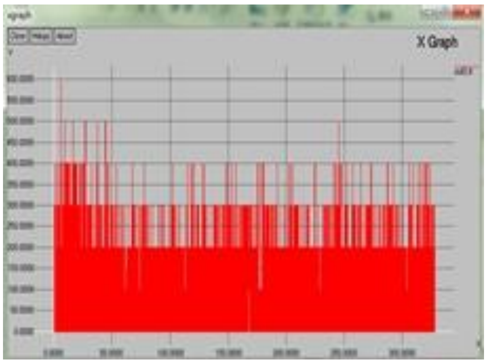

Figure 4. Rate Figure of N Value is 7

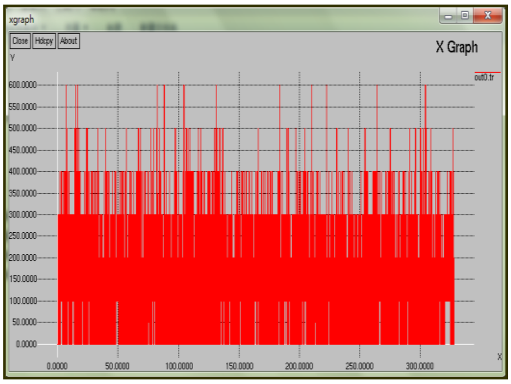

Figure 5. Rate Figure of N Value is 9

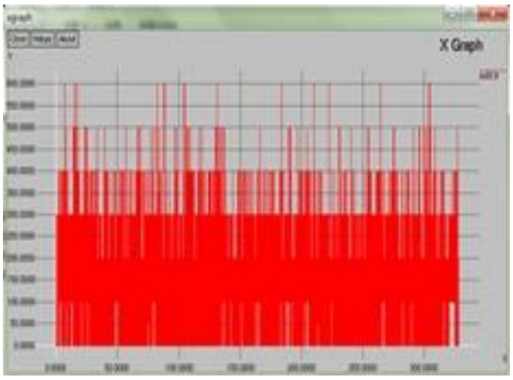

Figure 6. Rate Figure of N Value is 11

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Figure 3 mainly nearly have 6 wave crests, uniform distribution, and Figure 4 nearly have 1 wave crest, at the start of the distribution, Figure 5 nearly have 4 wave crests, uniform distribution, Figure 6 nearly have 5 wave crests, uniform distribution. By observing the above four linetypes of the Figures and the area the linetype and the horizontal axis enclosed we can find, with the increasing of N value, the numbers of packet arrival per unit time that is with flow rate is increasing, self-similar is obvious, Hurst parameter is bigger, packet loss rate is bigger. Thus, we can came to the conclusion that N is bigger, self-similar is bigger, Hurst parameter is bigger, packet loss rate is bigger.

4.2. The Influences of Shape Parameter on Long-Range Dependence

According to the relation type we can assume, shape parameter is smaller, Hurst is bigger, so self-similar is obvious, packet loss rate is bigger. Therefore, do four experiments， shape parameter respectively are 1, 1.4, 1.5, 2, under the condition of shape parameter are these values rate Figures respectively are as shown in Figure 7, Figure 8, Figure 9, Figure 10. Rate Figure's horizontal axis represents time, the vertical axis represents the numbers of packet arrival per unit time. Among them, H=(3- a)/ 2.

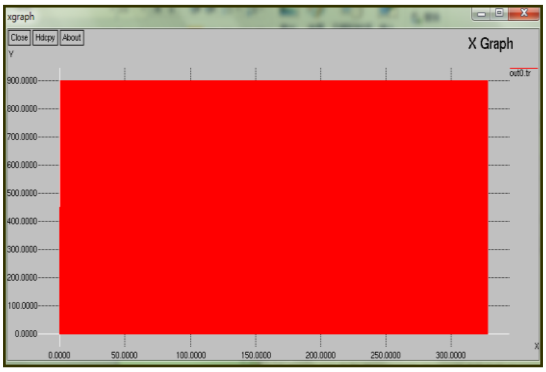

Figure 7. Rate Figure of Shape Parameter is 1

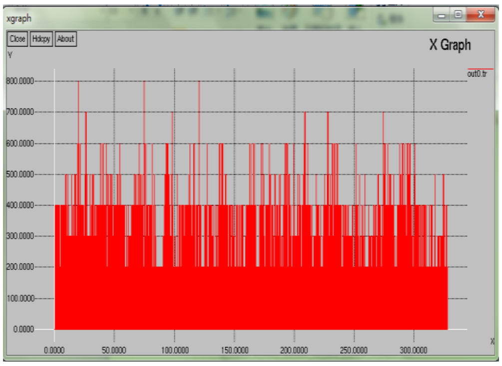

Figure 8. Rate Figure of Shape Parameter is 1.4

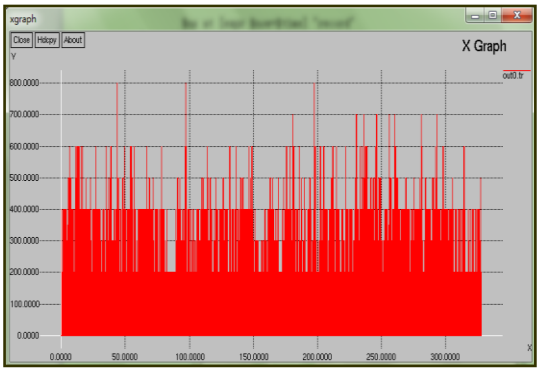

Figure 9. Rate Figure of Shape Parameter is 1.5

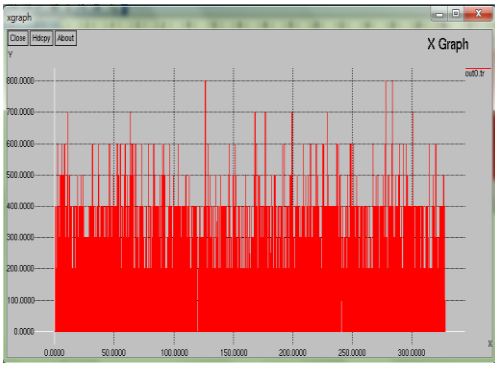

Figure 10. Rate Figure of Shape Parameter is 2

Figure 7 have no wave crests, and Figure 8 nearly have 5 wave crests, uniform distribution, Figure 9 nearly have 3 wave crests, uniform distribution, Figure 10 nearly have 2 wave crests, uniform distribution. By observing the above four linetypes of the Figures and the area the linetype and the horizontal axis enclosed we can find, with the increasing of shape parameter, self-similar is decreases, Hurst parameter is decreases, packet loss rate is smaller. Thus, we can come to the conclusion that shape parameter is bigger, self-similar is smaller, Hurst parameter is smaller， packet loss rate is smaller.

4.3. The Influences of Hurst Parameter on Long-Range Dependence

According to the relation type H=(3-a)/ 2 we can came to the conclusion that Hurst parameter [15] is bigger, self- similar is bigger, packet loss rate is bigger. The specific experiment as 4.1 part.

4.4. The Influences of the Output Link Speed on Long-Range Dependence

N=5, Hurst parameter is 1.5, link=10MB. We can assume the output link speed [16] is bigger, self-similar is smaller, Hurst parameter is smaller, packet loss rate is smaller. The output link speed respectively set to 5MB, 10MB, 15MB, 20MB, under the condition of these settings the flow rate Figures are as shown in Figure 11, Figure 12, Figure 13, Figure 14.

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Figure 11. Rate Figure of the Output Link Speed is 5MB

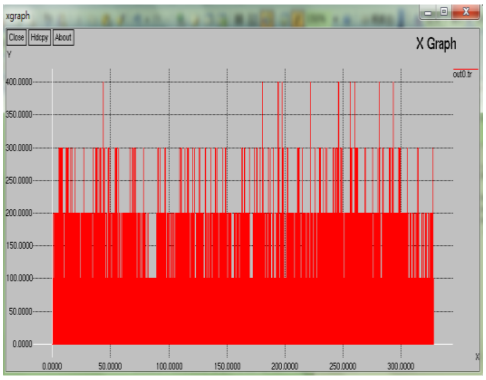

Figure 12. Rate Figure of the Output Link Speed is 10MB

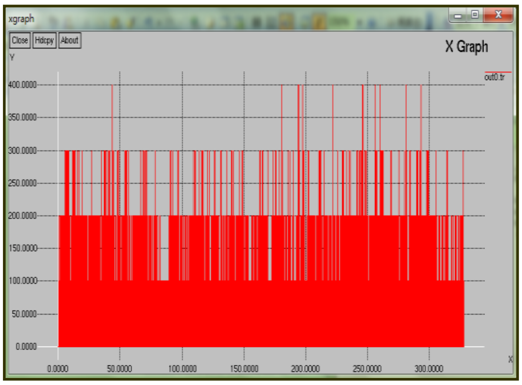

Figure 13. Rate Figure of the Output Link Speed is 15MB

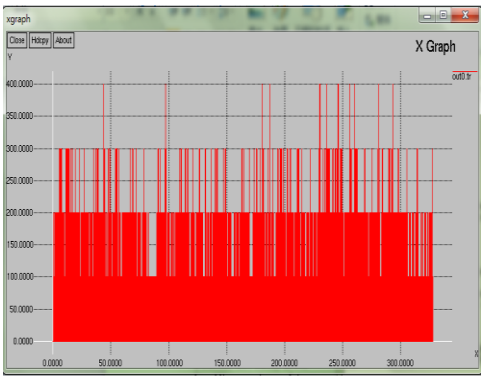

Figure 14. Rate Figure of the Output Link Speed is 20MB

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Figure 11 nearly have many wave crests, and Figure 12 nearly have 3 wave crests, uniform distribution, Figure 13 nearly have 4 wave crests, uniform distribution, Figure 14 nearly have 5 wave crests, uniform distribution. By observing the above four linetypes of the Figures and the area the linetype and the horizontal axis enclosed we can find, with the increasing of the output link speed, self-similar[16] is decreases, Hurst parameter is decreases, packet loss rate is smaller. Thus, we can came to the conclusion that the output link speed is bigger, self-similar is smaller, Hurst parameter is smaller, packet loss rate is smaller.

5. Conclusion

The contribution of this paper is to study the number of superimposed source N, shape parameter, Hurst parameter, the output link speed have impacts on long correlation and how them affect the long correlation and further affect the packet loss rate. Then in the paper, first, introduce NS2's principle of generating self-similar traffic. Second, discuss the number of superimposed source N, shape parameter, Hurst parameter, the output link speed has impacts on long correlation, and further affects the packet loss rate. Finally it is concluded that different output link speeds have a significant impact on long-range dependence, and further to affect the packet loss rate. The above conclusions can be applied to better establish no-reference video quality assessment model considering the network packet loss and further gain a better QoE evaluation, and to meet the needs of the user's terminal. In this paper, use NS2 and random process are better than other methods and theories to study the influencing factors of network packet loss's long-range dependence has impacts on the packet loss rate.

The future work first is the realization of wavelet algorithm, that is wavelet analysis part needs to be further perfect. Second is in the NS2 experiment design, NS2 topology structure node can be more, such as 10 nodes or more and observe the differences with the rate Figure of 3 nodes. Third, this conclusion will be applied to establish no-reference video quality assessment model considering the network packet loss, select the output link speed and packet loss rate as parameters to establish the model.

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Author

Jin Wang, received a Bachelor's degree in Software Engineering from Beijing University of Chemical Technology, Beijing, China, in 2012. And won the National Scholarship in 2010 and won the National Endeavor Fellowship in 2009. Now, she received a master graduate in Computer Application Technology in Shijiazhuang Tiedao University. And won the university scholarship and advanced individual in academic activity and published many papers. Her research interest is video quality assessment in distorting network.

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