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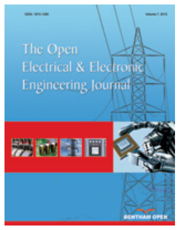

RESEARCH ARTICLE

Minimum Delay Congestion Control in Differentiated Service Communication Networks

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Abstract:

Introduction:

This paper presents a minimum delay congestion control in differentiated Service communication networks. The premium and ordinary passage services based fluid flow theory is used to build the suggested structure in high efficient manage. The established system is capable to adeptly manage both the physical network resource limitations and indefinite time delay related to networking system structure.

Methods:

The effectiveness of the suggested congestion controller system is demonstrated with mathematical consequences in formal framework by using modified sliding controller (MSMC) techniques. This technique provides high utilization and less delay after adapting the state feedbacks controllers with sliding mode controller. The Quality of Service (QoS) requirements in term of effective and dynamic regulation of network resources have been achieved in the existing design.

Results:

The capacity and bandwidth limitations are considered as a restriction on the input of network. The results of this approach are developed and compared with a conventional design.

Keywords: QoS, Network, SMC, MSMC, MATLAB, PID controller.

1. INTRODUCTION

The importance of commercial and military applications increased more and more in researcher thinking to find efficient and reliable communication systems. To realize and achieve the tasks over a large area, the exchanges are required with a number of geometrical components distribution [1]. The communication network system with technical development entrenched have been coming to such components and processing capabilities as well as activating and sensing of communication capabilities. Usually, these type of devices are referred to intelligent agents, which is known as an independent unit and performances activity to provide the target requirements [2].

The intelligent agent's degree in specific domain leads to the capability of learning and reasoning which is required to have knowledge base access and interference engine to determine the performance of an agent in the sense which successfully grips novel responsibilities [3].

The intelligent agent's mobility has to move from the destination point to carry out the job responsibility and not restricted. This will have a certain degree of mobility in this case. Furthermore, the advantage of mobility conditions is

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to have representative's functionality after the position invented from the disconnected case. By mean of multi-Agent systems, the intelligent agents are capable of arranging all the agents in case of exit from the distributed way and communicate over networks by using two monitors with control environments. These type of systems have a challenge in agents capability which must be capable of perceiving, reasoning and evolving with their situation and collaborated with other nodes to realize widespread system purposes [4]. The Multi-Agent Systems are able to overcome the difficulties for individual agent, which provide suitable solutions in the old systems. To develop the Multi-Agent System, each one is respected as only node, which may consist of numerous instruments, decision maker and actuator. To make a decision and receive information freely, the data exchange process should cooperate with all nodes. The Multi-agent systems have to review a sensor and make a decision in the network and actuated too. The data collected from environments by the sensor and perform actions in the system actuators has been done normally with extremely mobility with energy resources processor and memory to provide the decision making [5]. The fast growth in internet field for voice and video applications is lead to finding an efficient construction in internet networks with efficient congestion control algorithms in order to provide more demand to the user nowadays [6]. Therefore, the suggested differentiated services were designed to carry the Quality of Services (QoS) in TCP/IP network [7]. In the networks, the congestion control still has a crisis, which needs to look for high-performance idea. Numerous efforts have been proposed to improve the congestion controller by using linear control scheme [8 - 12].

In spite of these efforts, the congestion controller architecture whose performance could be logically recognized and established in repetition is motionless interesting unsettled problematic [13]. In this paper, the design of a robust dynamic system called Modified Sliding Mode Controller (MSMC) has been used to provide high utilization, less delay, while the network fulfills with the demands of each traffic flow. Flexible MSMC theory is used to compensate the congestion controller in proposed design and implementation.

2. DYNAMIC NETWORK MODEL

This subdivision presents the equation of state space system for the *M / M/ 1* line. An extension to consider the delay in traffic includes uncertainty in the models. Subsequently, three groups of passing utilities have projected into the networks. Fig. (**1**) illustrates the model of fluid flow assuming that x (t) is a changeable condition representing the standard numeral of the set in the system illogically at matching period with the time (t). In addition, *fin* (t) and *fount* (t) let are composed of regular incoming and leaving flow of the system, individually.

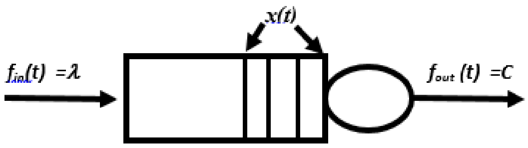


Fig. (1). Virtually block of model line.

The model formula of this model type is:

$$\dot{x}(t) = \frac{dx(t)}{dt} \tag{1}$$

$$\dot{x}(t) = f_{in}(t) - f_{out}(t)$$

In a queuing system if using equation 1, we can define the parameters of C and λ as expiration server ability and average coming rate. Assume the queue capacity is boundless, $f_{in}(t)$ is impartial the λ is arrival rate. The flow out of the system, $f_{out}(t)$, the ensemble normal employment can be related to the queue $\rho(t)$, by $f_{out}(t)=\rho(t)C$. The link of ρ that consumption can be expected by the estimated function $G(x(t))$ signifies together the normal link consumption at time t as a state variable function. Therefore, the queue model is represented by the following differential equation (nonlinear) [14].

$$\dot{x}(t) = -CG(x(t) + \lambda \tag{2}$$

The G(x(t)) function governs queuing organization. If arithmetical data is obtainable, a function G(x(t)) can be expressed empirically. Yet, it is not usually situation function of *G(x(t)) it* is typically resolute by the equivalent of the steady state queuing results equation (2). *M / M / 1* was implemented in several traffics of communication network. These prototypical rates of input and service mutually have PDF (Poisson Distribution Function) for the state space equation M/M/1 [15]:

$$\dot{x}(t) = -C\frac{x(t)}{x(t)+1} + \lambda \tag{3}$$

A number of researchers proved the model validity of equation (3) [16, 17].

3. CONTROLLER DESIGN AND STRUCTURE SYSTEM

Assume that a router produces three differentiated traffic classes. Collectively, out port, a controller has been explained to occupy different type's flow of traffic entering through the port. A new sliding mode controller shown in Fig. (**2**) explained the effect of sliding controller on output signal when the input node traffic contains dissimilar traffic node. When the input node is separated from every identifier tags, headlong packets to the suitable queue to each class are in line with their class identifier tags. Hence, the maximum rate of C server in the transmit packets is given as:

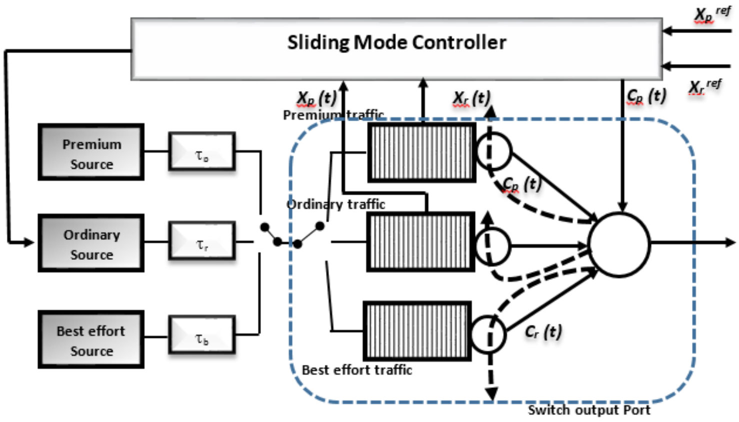


Fig. (2). The implementation of control approach.

4. PROPOSED CONTROL APPROACH

A guaranteed exacting to delivery in premium traffic flows is needed. Packet, delay, and jitter descents should be possibly close to a certain value. The dynamic model queue can be explained in the following equation:

$$\dot{x_p}(t) = -C_p(t)\frac{x_p(t)}{1+x_p(t)} + \lambda_p(t) \tag{4}$$

To determine $C_p(t)$ in control system network is the mean objective for whatsoever arrival rate $\lambda_p(t)$ and any in travel time in which the length queue, $x_p(t)$ is adjacent to a reference rate, $x_p^{ref}(t)$, quantified by the design of the system. In equation 4, $x_p(t)$ the system state can be tracked, the control signal $C_p(t)$ resolute by the congestion controller while the disturbance is λp(t).

In order to increase extra capacity, allocating a least probable ability for the best traffic is the mean objective in this design. For this reason, it is providing a proper QoS for premium flows.

$0 < C_p(t) < C_{server}$

Because of a capacity essential, the server capacity is always less than the maximum server capacity so that a design controller constraint is further tough.

5. STRATEGY OF ORDINARY CONTROLLER

There is no limitation on the delay of ordinary traffic flows, therefore an adjustment of the capacity rates due to block controller will be specified. Assuming that, the sources send ordinary packets through the network. The dynamic model of the queue is as follows:

$$\dot{x_o}(t) = \frac{x_o(t)}{1 + x_o(t)} C_o(t) + \lambda_o(t - \tau) \quad (5)$$

Consider two important things:

Co(t) is the residual capacity, C_o (t) = C_{server} - CP (t) it can be considered as disquiet to measure the premium queue in this case. In modified sliding controller, structure forces to segregate the effect of *Co(t)* on the variable state *xo(t).*
λo is maximum value limited *of λmax* and non-negative *λo* is acceptable *i.e.*

$$0 <= \lambda_o(t) <= \lambda_{max} <= C_{max}$$

6. TRAFFIC OPTIMIZATION

The traffic optimization has the lowest significance and thus, it is used only in the port capacity, otherwise will not be used by the best and normal traffic flows to highlight the results. This type of service cannot be controlled.

7. PROPOSED ROBUST CONGESTION CONTROL APPROACH

An architecture DiffServ based on time-delayed robustness of congestion control clarifications remains incompetent. This paper has proposed a new algorithm categorized for example:

1. The network backed congestion controller by using the queue buffer length as an information feedback.
2. The future controls in the vicinity the length queue of each buffer by acting on the server bandwidth.
3. Altogether it sends back to the Ordinary source to allow maximum rate. The model of the network illustrated in Fig. (**3**) shows the quality of its robustness.

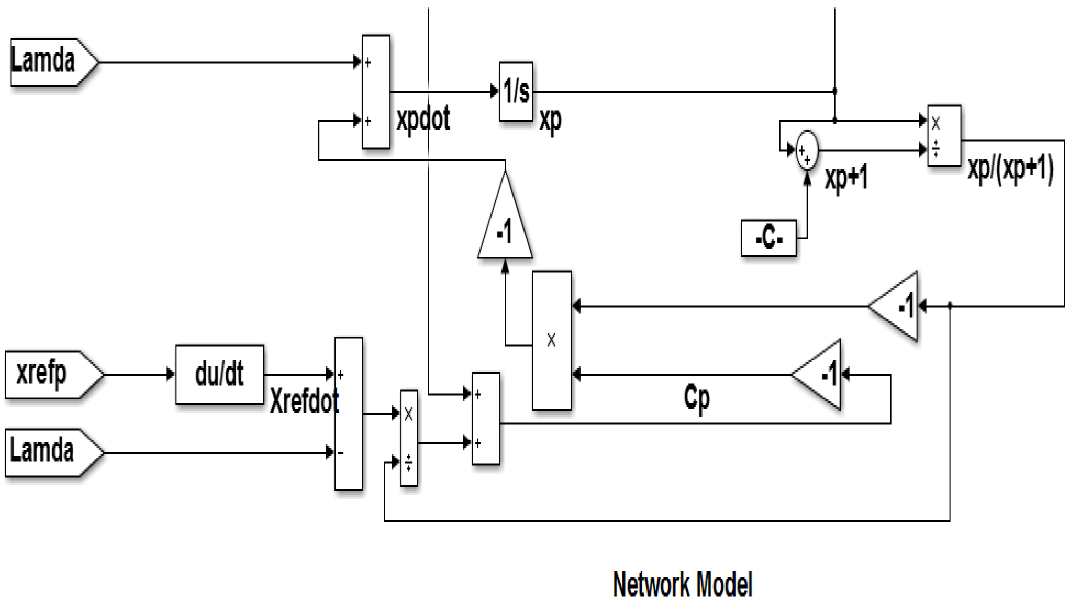


Fig. (3). The model of network.

The molds for controller design in this paper are used for the congestion control objective. Have made the following:

C_{max} = 3,00000 *Packets / Second*

λ_{max} = 15,00000 *Packets / Second*

There is no system delay (means τ =0). To get best and ordinary systems, two controllers are designed for both types and the sliding line of modified sliding mode controller assumes the following:

$$\sigma = x(t) - x_{ref}(t) \tag{6}$$

Fig. (**4**) illustrates the proposed MSMC system with (m) and (n) input and output, respectively. To develop the design of congestion control in suggested strategy, the service framework illuminate (m) from Fig. (**5**) is used. The sliding mode of congestion controller could be expressed as follows given by the following formula which was designed in the state space error by defining the variables error.

$$e_i = x_i - x_i^{ref} \quad \& \quad \dot{e}_i = \dot{x}_i - \dot{x}_i^{ref} \tag{7}$$

$$u(t) = -Kx_i(t)$$

Where K is a state feedback gain that can be evaluate in below gain Equation?

$$K = [0 \quad 0 \cdots \quad 1]P^{-1}\alpha(A) \tag{8}$$

$$K = [k_1 \quad k_2] \tag{9}$$

To combine the sliding mode criteria with state feedback gain Equation 6 needs to be reformulated as follows:

$$u(t) = -Kx_i(t)) \times sign(\sigma) \tag{10}$$

by substituting Equation 8 in Equation 9

$$u(t) = [-k_1 sign(\sigma) - k_2\, sign(\sigma)]x_i(t)$$
$$\dot{x}(t) = Ax(t) - BKx_i(t)) \times sign(\sigma) \tag{11}$$

$$\dot{x}(t) = ((A - BKsign(\sigma))x_i(t) \tag{12}$$

Substituting Equation 11 in Equation 12

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ \begin{cases} -x_1(a_1 + \alpha b_2 k_1) - x_2(a_2 + \alpha b_2 k_2)\ if\ \sigma_x > 0 \\ -x_1(a_1 + \beta b_2 k_1) - x_2(a_2 + \beta b_2 k_2)\ if\ \sigma_x < 0 \\ -x_2(a_2 + \alpha b_2 k_2) - x_1(a_1 + \beta b_2 k_1)\ if\ \sigma_x > 0 \wedge \sigma_x < 0 \end{cases} \end{bmatrix} \tag{13}$$

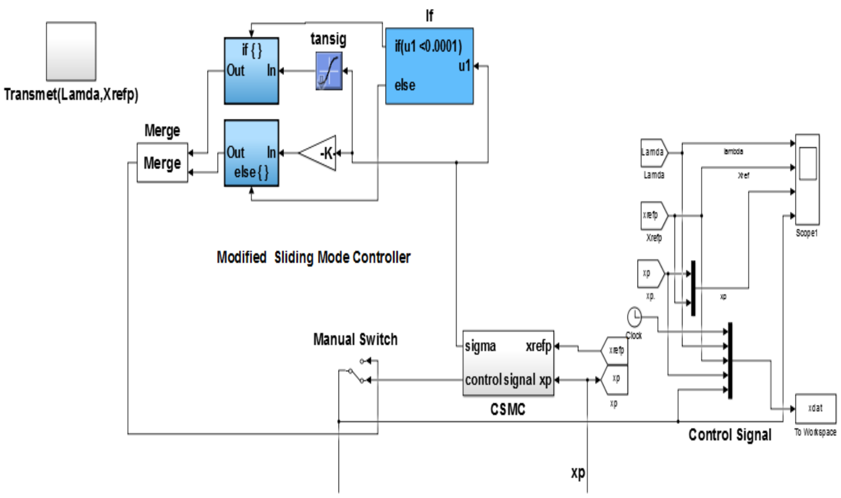


Fig. (4). Block diagram of the MSMC simulation.

Fig. (**5**) shows simulation results simulation results are illustrated for premium traffic and the new sliding mode controller. Figs. (**6a** and **b**) shows the input and output signals, the reference data and the output data. It is clear that the proposed new sliding mode controller technique minimizes chattering effect significantly due to the reduced oscillations. Fig. (**6b**) illustrates $x(t)$ and $x_{ref}(t)$ for best and proposed new sliding mode controller, respectively. To achieve better rising and settling time behavior of $x(t)$, this system has been suggested.

8. THE OUTPUT RESULTS

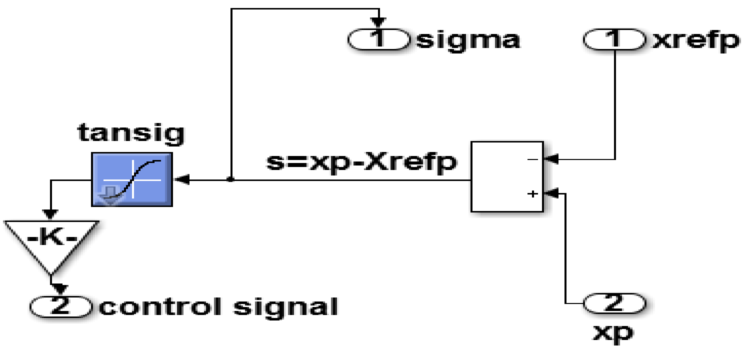
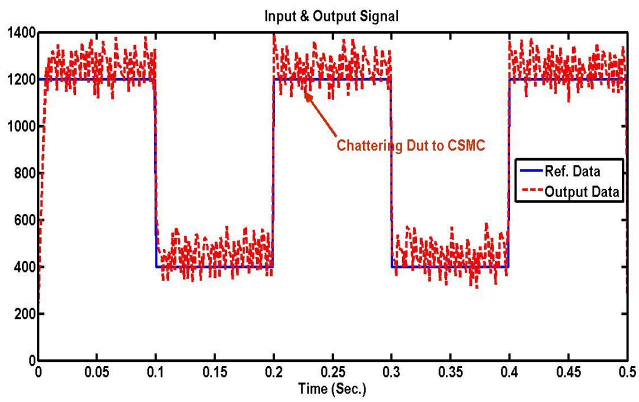


Fig. (5). Simulation of sliding mode controller.



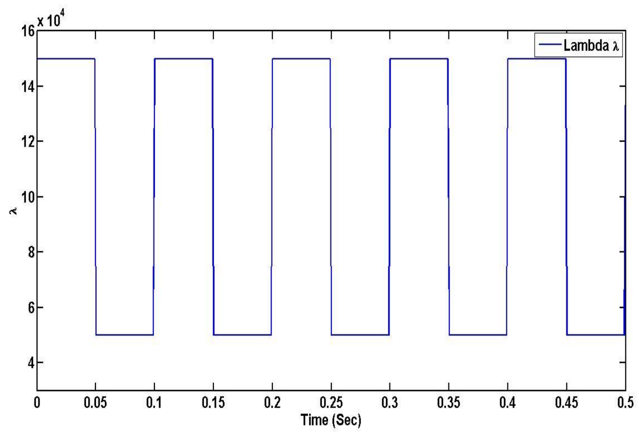


Fig. (6). $x_p^{ref}(t)$ and $x_p(t)$.

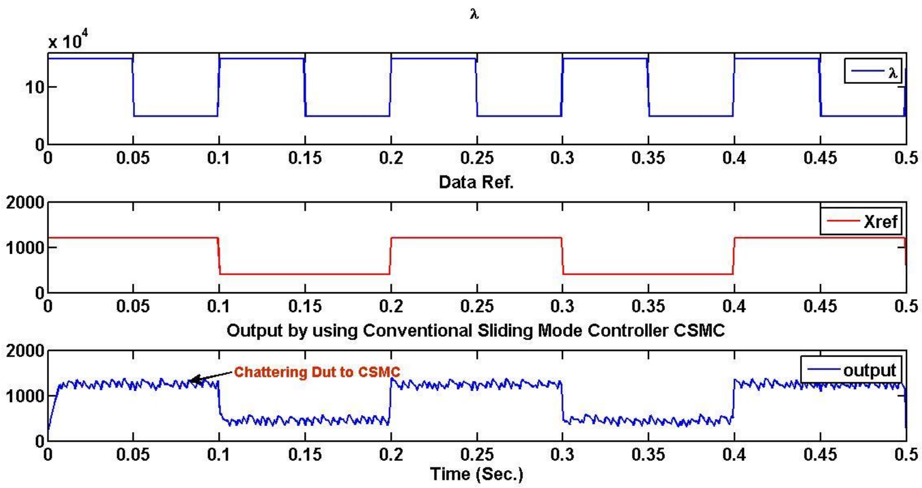


Fig. (7). Output rate of premium's buffer.

Fig. (**7**) shows the output rates for the conventional sliding mode controller CSMC buffers and the output rates of Premium buffer as well. Investigation of the robustness of the proposed new sliding mode controller is done by applying the uncertainty and the round trip time delay for the system.

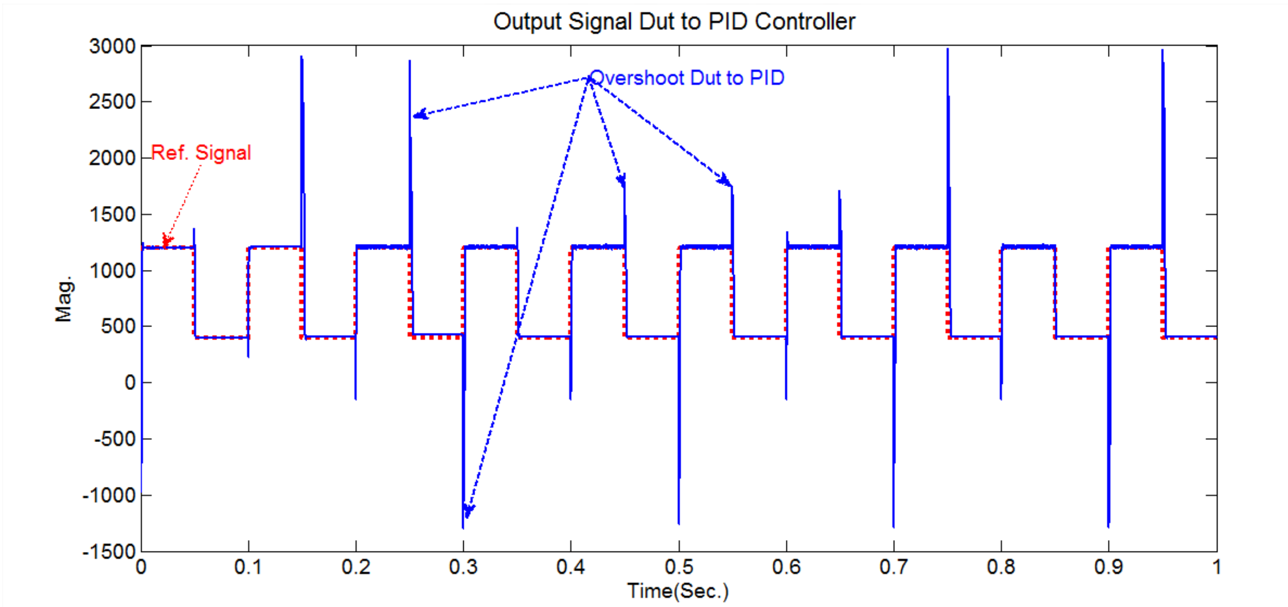


Fig. (8). $x_{pref}(t)$ and $x_p(t)$ with uncertainty and delay using PID controller.

Fig. (**8**) shows the tracking behavior set point of $x_p(t)$ and $x_{p.\ ref}(t)$ with delay time respectively according to a functional situation which is applied. Clearly, the observation is the distortion which is caused by the overshoots due to high gain in PID controller, distorted data does not match with the data sent, these distortions appear in the data received. Although the data is highly congruent, causing data change in logical data. The comparison results from three types of controller (Conventional SM New Sliding Mode Controller and PID) illustrated in Table **1**. The presentation of xp(t) in suggested sliding mode controller and the achievement of the controller does not vary changing and received dated effect as well as shown in Fig. (**9**). Consequently, the results indecision does not effect on the closed-loop system in current development. Thus, the xo(t) performance is somewhat inferior to the case of deprived delay indeed. Meaning that the suggested system has proved its robustness and significantly affected around the trip time compensating.

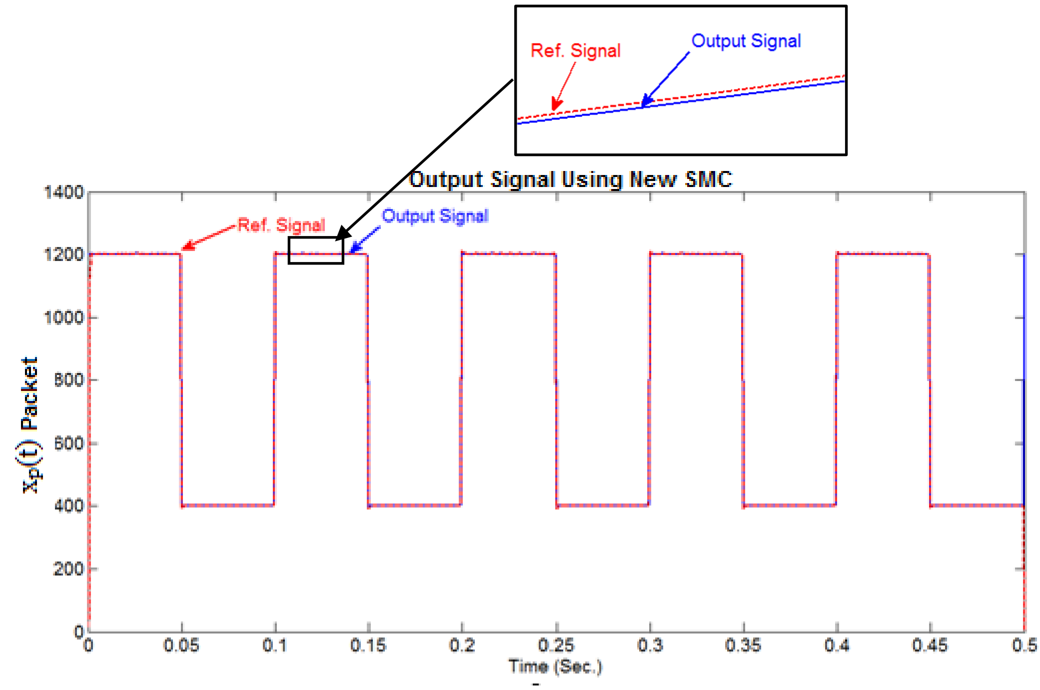


Fig. (9a). $x_{pref}(t)$ and $x_p(t)$ with uncertainty and delay using New SMC.

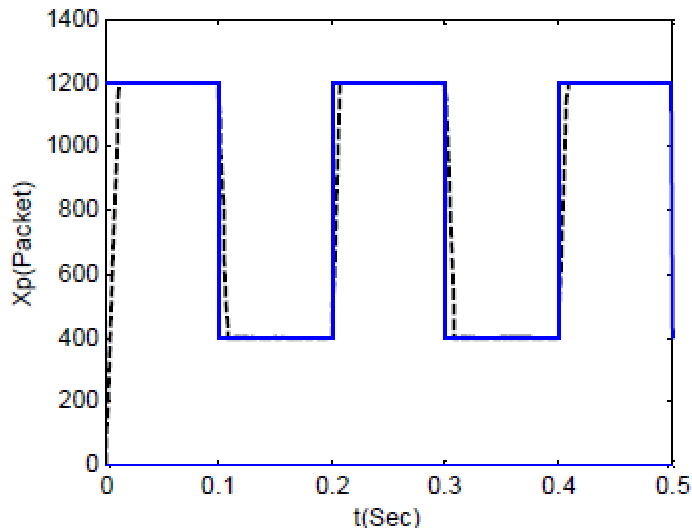


Fig. (9b). $x_{pref}(t)$ and $x_p(t)$ with uncertainty and delay using fuzzy with PID ref. [17].

Table 1. Comparision Table 1.

Controller	TS (Msec)	OVERSHOOT	DISTURABNCE REJECTION
Conventional SMC [17]	2	Nil	GOOD
New SMC	1.3	Nil	GOOD
PID [17]	2.5	Present	POOR

CONCLUSION

The present paper introduces new control of congestion networks by applying modified sliding mode Controller. A new sliding mode control system was proposed and Network system is modeled. The modeling of the proposed control system was based on mating between the state feedbacks controllers with sliding mode controller; it has been named MSMC. A mathematical model was derived to represent theoretical modeling in mathematical equation. The ideal model for controlling and available properties of the system state - convergence - is exploited to generate gain commensurate with the amount of error generated in the MSMC system. The differentiated-services network outline has been expected and the control approach was framed for three types of services in this paper like Premium Service and Ordinary Service as well as Best Effort Facility as a new idea. The analysis results of MSMC showed that the property and the nature of the currencies which achieved in the network system led to significantly reduce the disturbing phenomenon and delay time. These results need more tuning and developments as the future scope to minimize the delay as possible.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Decleared none.

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