Feedback Congestion Control Protocol for Wireless Sensor Networks: A Review

Surabhi Singh[1], **Kunal Gupta**[2]

[1, 2]Amity School of Engineering and Technology, Computer Science Department, Amity University, Noida, UP, India

Abstract: ***We have put forward some new ideas and congestion restriction algorithm for sensor networks based on feedback restriction, which will be known as Feedback Congestion Control (FBCC). This algo has been planned by making full use of linear discrete time control concept. A feedback control system is set up between parent and children node. The FBCC discover the beginning of congestion by using queue distance. An active steady control plan selects appropriate incoming traffic which is forced by the new active scheme. Encircled-loop stability of the proposed hop-by-hop congestion control is given by the Lyapunov-based approach. Simulation final conclusion show that the FBCC restricts congestion and makes better performance over Congestion Detection and Avoidance (CODA). The results of simulations proves FBCC can avoid and makes Congestion less severe and has fairly good effects of reliability, less energy consumption and high throughout.***

Keywords: Wireless Sensor Network, Feedback, Congestion Control, Sensor networks

1. Introduction

In wireless networks (WSNs), the multiple mode mutual interference of wireless connections, dynamic changes of system topology and the memory restrained characteristic of sensors, all make network highly affected to congestion. Since network system congestion may degrade the transmitting performance and network lifetime, it has become one of the most important technologies to decrease such impression and guarantee the systems quality of service (QoS). Because the energy provided, computational power and non wired communication capabilities of system nodes are all limited and the network scale is always very large, higher needs are forced on the congestion control technology and researches on congestion contrive and traffic release are more competitive.

1.1 WSN

A sensor network contains spatially spreaded autonomous sensors to observe environmental conditions like temperature, weather, noise, pressure, etc. and to forward their information through the network to a main place. The more modified networks are bi-directional, also allow control of sensing activity. The evolution of sensing nodes was motivated by military applications such as battlefield close observation; today such networks are helpful in many industrial and customer applications, like monitoring of industry, monitoring of machine life, and so on.

1.2 WSN CONGESTION

When large amount of packets are present then it lowers the performance. This is known as traffic . In any WSN, when too much of data traffic occurs at a particular sensor node then the network becomes slow or starts loosing information, it is known as congestion. It degrades quality of service and also can lead to delays or loss of facts.

2. Review

2.1 Design of WSN Congestion Control

IIn the domain of discrete-time, change in buffer occupancy in reference of incoming and outgoing traffic will be written in linear model like:

$$qi(k + 1) = Satq0\ (qi(k) + Tui(k) - xi(k)). \qquad (1)$$

where T denotes measurement interval, qi(k)= is buffer occupancy of node at K instant of time, ui(k) =is a regulated (incoming) traffic, xi(k) =represents an outgoing traffic, which is followed by the next hop node i+1,and is disrupted by change in state of channel, and Satq0=is the constant function that denotes the finite-size of queue.

The incoming congestion ui(k) is calculated and taken as a feedback to the sensing node i − 1 located in the path to the source, which is used to roughly calculate the outgoing traffic for upstream node xi(k). The active congestion control algorithms. We model the FBCC behavior using Stochastic Differential Equations. We consider a queue system in which a parent node has four children. For the father node, it has a capacity of transmission C and M the number of active connections crossing the path i. For the children node, it has a outgoing traffic given by x1(t), x2(t), x3(t), x4(t), respectively. Then, the dynamics of buffer i is written as follows:

$$dxi = (ui - xi)xi\_xi - q0 - q(t)T\_ - Cxi\ dt. \qquad (2)$$

The system in Eq.(2) was linearized at the operating point(u0, x0, qd), and we obtain

$$N = (\_xi) - 2(ui - 2xi)(\_xi - q0 - qdT - C) + (ui - xi)xi(4 - q0 - qdT - C);$$

$$M = x0\_x0 - q0 - qdT\_ - Cxi;$$

$$qd = C/M0$$

The saturation function prevents qi(k) from being negative or growing infinitely in the case of non-congested paths. C is the link capacity in packets/s and M is the number of active connections crossing the link i, the nonlinear model (2) could be expressed in the form of the following linear model:

$$\dot{z}(t) = Nz(t) + Mu(t). \qquad (3)$$

Then (3) is approximately discreted,

$$xi(k + 1) = (N + 1)xi(k) + Mui(k). \qquad (4)$$

Let Y (k+1) = (qi(k+1), qi(k), xi(k+1), xi(k))T ,
From (1) and using (4), we can obtain the dynamic equation as

$$Y (k + 1) = BY (k) + Au(k). \qquad (5)$$

$u(k) = (ui(k), ui(k - 1))T$

Let the state error be defined as

$$e(k + 1) = Y (k + 1) - Y (K) \qquad (6)$$

The objective of this study was to design controllers capable of achieving asymptotic stability of the desired operating point and the fairness congestion algorithm based on linear discrete model given in Eq.(5)was especially taken into accordence

2.2. Lyapunov- Krasovskii Stability Theorem

Theorem 1 The buffer occupancy feedback system is stabilized if satisfied the following limited conditions are as follows:

1)$TB + A = 0$;
2)$ui(k) =(T - BA)xi(k)/T2 + A2$

Proof Consider the following Lyapunov functional candidate

$V (k + 1) = eT (k + 1)e(k + 1)$

Taking the time instant derivative of V (k + 1) along the trajectory of the system in Eq. (6) yields

$V (k + 1) - V (k) = eT (k + 1)e(k + 1) - eT (k)e(k) =(-xi(k) + Tui(k))2 - (qj(k - 1) - qj(k -$

$2))2 + (Mxi(k) + Nui(k))2 - (xi(k - 1) - xi(k 2))2$

Substituting $TB + A = 0$; $ui(k) = (T-BA)xi(k) T2+A2$ into above formula, the following more compact form is obtained:

$$V (k + 1) - V (k) = -(qj(k - 1) - qj(k - 2))2 < 0 \qquad (7)$$

The negative inequality in Eq.(7) leads to derivative towards negativity of V (K + 1) along with negativity of the expression in Eq.(6). Therefore, from the theorem, we can conclude that the network in Eq. (5) has uniform asymptotic stability. Though, limiting condition of the theorem 1 is more careful, because of properties of WSN, we only appropriately make particular transport protocol based feedback control for character explicitly, objective definitely application. In this way, we can minimize risk by restricting congestion, and limited resource is used efficiently to the greater extent. A state feedback controller for the topology in Eq.(5) can be designed under the criteria that all of the states are available. This study implemented memory less state feedback controller expressed as

$$u(k) = -LY (k) \qquad (8)$$

Where L is the pattern gain matrix such that the answer of closed-loop system is asymptotically stable. Substituting Eq.(8) into Eq.(5) yields a system having closed-loop in the following form:

$$Y (k + 1) = (B + L)Y (k) \qquad (9)$$

In order to have a formal assurance the asymptotic stability of the system in Eq.(9) for any postpone in time, we apply the Lyapunov- Krasovskii functional scheme and the LMI approach to design a suitable feedback gain matrix L. The controller gain and fixed stability criterion is given by the following theorem:

Theorem 2 Assume the system in Eq.(5). Controller will stabilize this system Eq.(8), if there exist symmetric positivity definite matrices P, Q, which fulfill the following matrix inequality:

$$RT (P + Q)R -Q \ Q$$
$$Q -Q< 0 \qquad (10)$$

Where $R = B-AATP -I$. The state feedback gain is then given by

$$L = ATP \qquad (11)$$

Proof Consider the Lyapunov functional candidate

$$V (k + 1) = Y T (k + 1)PY (k + 1) + eT (k + 1)Qe(k + 1) \qquad (12)$$

The difference in time instant of this function along the trajectory of the system in Eq.(9) is given by

$$\Delta V (k + 1) = V (k + 1) - V (k) = eT (k + 1)e(k + 1)Y T (k + 1)PY (k + 1)+eT (k + 1)Qe(k + 1) -eT (k)e(k)Y T (k)PY (k) - eT (k)Qe(k) = Y T (k)(RT (P + Q)R - Q)Y (k) +Y T (k)QY (k - 1) + Y T (k - 1)QY (k)-Y T (k - 1)QY (k - 1)= (Y (k), Y (k - 1)) \times RT (P + Q)R -Q \ Q \ Q -Q \times(Y (k), Y (k - 1))T < 0 \qquad (13)$$

The negative inequality in Eq.(13) leads to negativity of the time difference of V , along with negativity of the expression in Eq.(9). Therefore, from the Lyapunov-Krasovskii stability theorem, the uniform asymptotic stability of the system in Eq.(9) is ensured.

3. Discussion

A packet level simulating program is presented to get the acquired performance evaluation results for FBCC and calculate the performance between ABPS and FBCC. We select parameters N0=50, C=300Mbps,q0=140, q d=120, u0=25, x1=42, x2=40, x3=35, x4=30, T=0.2s, We first done validation on our design, and then comparison is done on the scheme with ABPS in terms of the following performance criteria: length of queue, packets that are dropped, efficiency of energy, fairness. The controller of Feedback traffic regulates The congestion state isby keep on observing the buffer level x and keeps it at less gap by the threshold. By maintaining x at the level of 120 data packets, Figure 1 plots the averaged queue length of the FBCC and ABPS. Obviously, the FBCC scheme gets to possess higher throughput. The unbalance between coming and going flows due to congestion is not passed by the ABPS thus still resulting in overflow of buffer and a significant drop in facts packet. In Figure 2, we can discover that FBCC drops lesser number of packets than ABPS.

4. Conclusion

This paper presents a feedback traffic control scheme whereby the congestion is reduced by feedback control of all the nodes based on the current network conditions. On the given technique of the Lyapunov- Krasovskii idea and the LMI procedure, the explained congestion control laws and their criteria for stability is derived. The proposed scheme helps in mitigating traffic. Simulation and experimental information show that this scheme increases throughput, efficiency of network and energy conservation. With the addition of a scheduling algorithm, the technique guarantees desired quality of service (QoS).The simulating results confirm that the proposed ideas are feasible and open a new path for WSN.

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Author Profile

Surabhi Singh received the B.Tech and M.Tech degrees in Computer Science and Engineering from Guru Gobind Singh Indraprastha University and Amity University in 2013 and 2015(pursuing), respectively.