# Applying Enterprise Architecture to business networks

A THESIS SUBMITTED TO
THE SCIENCE AND ENGINEERING FACULTY
OF QUEENSLAND UNIVERSITY OF TECHNOLOGY
IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

**Mohammad Adel Rostamzadeh Bakhtiyari**

Science and Engineering Faculty
Queensland University of Technology

March 2016

**Copyright in Relation to This Thesis**

**Statement of Original Authorship**

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

**Signature:**

**Date:**

*To my family*

# Abstract

---

A LaTeX style file, named qutthesis.sty, is developed, for writing PhD or Research Masters thesis. Developed by Associate Professor Yu-Chu Tian (Glen), it tries to fulfill QUT's Thesis requirements but it is unofficial.

Copyright (C) 2010 by Yu-Chu Tian (Glen)

This style file is provided "as is" without express or implied warranty. Permission is granted to PhD and Research Masters students for personal use on any computer systems, subject to the following restrictions:

1. The author is not responsible for the consequences of use of this style file.
2. Modification is allowed to this style file provided the modified version is marked as such.
3. This notice is to remain intact.

The 'qutthesis' option should be used as a package with the document class 'report'. It defines many new commands and environments for easy use to the end users though many of those definitions are transparent to the end users. Also, it refines many existing commands and environments, such as chapter, section, subsection, table, table*, figure, figure*, etc., for better presentation. Again, many of such refinements are transparent to the end users.

LaTeX beginners may simply follow the sample files provided to prepare their theses. For advanced LaTeX users, this style file would be a good start point for further refinement of the thesis presentation.

While all users are welcome to send me comments and suggestions for further improvement of the style file, feedback and technical support may not be expected from me due to limited resources.

# Keywords

---

Thesis, QUT, LaTeX, Template, Sample File

# Acknowledgments

---

Here is the acknowledgment section.

# Preface

Here is the preface.

# Table of Contents

---

# Nomenclature

---

**Abbreviations**

| | |
|---|---|
| CAN | Controller Area Network |
| DM | Deadline-Monotonic (Scheduling) |
| EDF | Earliest-Deadline-First (Scheduling) |
| FP | Fixed Priority |
| IAE | Integral of Absolute Error |
| IP | Internet Protocol |
| ITAE | Integral of Time Absolute Error |
| LCT | Least-Compute-Time (Scheduling) |
| QoC | Quality of Control |
| QoS | Quality of Service |
| PD | Proportional plus derivative (Control/Controller) |
| PD2 | Proportional plus up to the Second-Order Derivative (Compensation) |
| PD3 | Proportional plus up to the Third-Order Derivative (Compensation) |
| PI | Proportional-Integral (Control/Controller) |
| PID | Proportional-Integral-Derivative (Control/Controller) |
| RM | Rate-Monotonic (Scheduling) |
| NCS | Networked Control System/s |
| SSE | Sum of Square Error |
| TCP | Transport Control Protocol |
| WCCD | Worst-Case Communication Delay |

| **Symbols** | | **Chapter** |
|---|---|---|
| A1 $\sim$ Am | Smart actuators | Ch8,9 |
| C1 $\sim$ C5 | Control computers | Ch8,9 |
| $c$ | Worst case computation time | Ch5,6,7 |
| $d$ | Deadline | Ch5,6,7 |
| $e$ | Control error, $e = r - y_d$ | Ch1 |
| $f(\cdot)$ | Function | Ch10 |
| $G$ | Controller or its transfer function | Ch6,7 |
| $G_c$ | Controller or its transfer function | Ch3,4,10 |
| $G_L$ | Process transfer function in disturbance path | Ch3,4 |
| $G_p$ | Process transfer function in manipulation path | Ch3,4,10 |
| $K$ | Gain | Ch6,7 |
| $K_c$ | Controller gain | Ch3,4,10 |
| $K_p$ | Process gain | Ch3,4,10 |
| $k$ | Present sampling instant | Ch3,4 |
| | Integer | Ch8 |
| | Integer representing the $k$th control period | Ch10 |
| $lr$ | Loss rate | Ch10 |
| M1 $\sim$ M5 | Management computers | Ch8,9 |
| $m$ | Integer variable, or the number of smart actuators | Ch8,9 |
| $N$ | Number of requests for scaling down periods | Ch6,7 |
| $n$ | Total number of tasks | Ch5,6,7 |
| | The number of data, or the number of smart sensors | Ch8,9 |
| | Integer | Ch10 |
| $p$ | Period | Ch5,6,7 |
| $Q_1$ | Queue to store one control packet | Ch9,10,11 |

| | | |
|---|---|---|
| $Q_2$ | First-in-first-out (FIFO) queue of past control packets | Ch9,10 |
| $R$ | Set-point | Ch3,4 |
| $r$ | Set-point of the plant output | Ch1 |
| $r_1 \sim r_3$ | Parameters for prediction of the controlled variable | Ch3,4 |
| S1 $\sim$ Sn | Smart sensors | Ch8,9 |
| $s$ | Laplace transform operator | 6,7,10 |
| $T$ | Process time constant | Ch3,4 |
| | Task | Ch5,6,7 |
| | Control period | Ch9,10,11 |
| $T_C$ | Time instant to deal with control packet dropout | Ch9,11 |
| $T_c$ | Control integral time | Ch6,7 |
| $T_D$ | Time instant to dequeue $Q_1$ | Ch9,10,11 |
| $T_E$ | Earliest time instant to receive control packet | Ch9 |
| $T_i$ | Controller integral time (min) | Ch3,4,10 |
| $T_O$ | Time instant at which a control period commences | Ch9 |
| $T_L$ | Latest time instant to accept control packet | Ch9,10 |
| $T_p$ | Time constant for plant | Ch6,7,10 |
| $T_s$ | Sampling period (min) | Ch3,4 |
| $T_t$ | Time series | Ch8 |
| $t$ | Integer, $t = 1, 2, \cdots, N$ | Ch8 |
| | Time variable | Ch10 |
| $t_{ca}$ | Controller-to-actuator delay | Ch9 |
| $t_{ctr}$ | Control computation time | Ch9 |
| $t_j$ | Sum of sensor-to-controller-to-actuator jitters | Ch9 |
| $t_{sc}$ | Sensor-to-controller delay | Ch9 |
| $U$ | CPU utilization | Ch5,6,7 |
| $U^I$ | Workload of the subtask $T^I$ | Ch6,7 |

| | | |
|---|---|---|
| $U^{II}$ | workload of the subtask $T^{II}$ | Ch6,7 |
| $u$ | Manipulated variable | Ch1,3,4,10 |
| | Integer | Ch8 |
| $\hat{u}$ | The estimate of the control signal $u$ | Ch10 |
| $u_d$ | The digitised form of $u$ | Ch1 |
| $wrt$ | Worst response time | Ch5 |
| $y$ | Controlled variable (e.g., stage 7 temperature) | Ch1,3,4,6,7,10 |
| $\hat{y}$ | $d$ steps ahead prediction of $y$ | Ch3,4 |
| $\tilde{y}$ | Control error | Ch6,7 |
| $y_m$ | Measurement of the plant output $y$ | Ch1 |
| $y_d$ | The digitised form of the measurement $y_m$ | Ch1 |
| $y_r$ | Set-point of the controlled variable $y$ | Ch10 |

### Greek Letters

| | | |
|---|---|---|
| $\beta_i$ | Degree of fulfilment for the *i*th rule | Ch3,4 |
| $\Delta_H$ | QoC upper bound | Ch6,7 |
| $\Delta_L$ | Dead zone around $\delta\tilde{y}$. $\Delta_L < \Delta_H$ | Ch6,7 |
| $\Delta y_j$ | Control error $(= y_r - y_j)$ | Ch10 |
| $\Delta\hat{y}$ | $d$ steps ahead prediction of the $y$ deviation | Ch3,4 |
| $\delta\tilde{y}$ | One-step difference of $tildey$ | Ch6,7 |
| $\epsilon$ | Small and positive threshold in $S_2$ | Ch3,4 |
| | Forgetting factor | Ch6,7 |
| | Side length of a non-empty box | Ch8 |
| $\mu$ | Membership function | Ch3,4 |
| | A measure on interval $[0, 1]$ | Ch8 |
| $\tau$ | Time delay | Ch6,7 |
| | Scaling exponent | Ch8 |

| | | |
|---|---|---|
| $\tau_c$ | Sum of network delay and control computation delay | Ch10 |
| $\tau_p$ | Process time delay | Ch10 |
| $\theta$ | Process time delay (min) | Ch3,4 |

**Superscripts**

| | | |
|---|---|---|
| (i) | The first-, second, or third-order derivative ($i = 1, 2$, or $3$) | Ch10 |
| $max$ | Maximum value or upper bound (for $p$, $p_i$ and $N$) | Ch6,7 |
| $min$ | Minimum value or lower bound (for $p$ and $p_i$) | Ch6,7 |

**Subscripts**

| | | |
|---|---|---|
| $c$ | Controller | Ch6,7 |
| $i$ | The first or sole subscript to some variables ($c$, $d$, $O$, $p$, $T$, $wrt$) to indicate the $i$th task | Ch5,6,7 |
| $j$ | The second subscript to some variables ($c$, $d$, $O$, $T$, $wrt$) to indicate the $j$th subtask decomposed from a task | Ch5,6,7 |
| | Integers representing the $j$th control period | Ch10 |
| $k$ | Integers representing the $k$th control period | Ch10 |
| $p$ | Plant | Ch6,7 |
| $rq$ | Requests (for $N$) | Ch6,7 |
| $sp$ | Set-point for $U$ and $y$ | Ch6,7 |

# List of Figures

---

# List of Tables

# Chapter 1

# Introduction

---

This is the introduction of the sample thesis template file. It shows how to use LaTeX pacage qutthesys.sty for writing a thesis at QUT.

## 1.1 Overview

A LaTeX style file, named qutthesis.sty, is developed, for writing PhD or Research Masters thesis. Developed by Associate Professor Yu-Chu Tian (Glen), it tries to fulfill QUT's Thesis requirements but it is unofficial.

Copyright (C) 2010 by Yu-Chu Tian (Glen)

This style file is provided "as is" without express or implied warranty. Permission is granted to PhD and Research Masters students for personal use on any computer systems, subject to the following restrictions:

1. The author is not responsible for the consequences of use of this style file.
2. Modification is allowed to this style file provided the modified version is marked as such.
3. This notice is to remain intact.

The 'qutthesis' option should be used as a package with the document class 'report'. It defines many new commands and environments for easy use to the end users though many of those definitions are transparent to the end users. Also, it refines many existing commands and environments, such as chapter, section, subsection, table, table*, figure, figure*, etc., for better presentation. Again, many of such refinements are transparent to the end users.

LaTeX beginners may simply follow the sample files provided to prepare their theses. For advanced LaTeX users, this style file would be a good start point for further refinement of the thesis presentation.

While all users are welcome to send me comments and suggestions for further improvement of the style file, feedback and technical support may not be expected from me due to limited resources.

## 1.2 Illustration of References and Citations

References and citations are best handled in a consistent way by using BibTeX. In this method, you supply all the relevant information about references in a ".bib file" without regard to ordering or style. Then you let BibTeX format all citations and reference entries according to the chosen bibliographic style, and you don't have to sweat all the font and punctuation and ordering details yourself.

There are two basic types of citation styles: numerical and author-year. I personally prefer the author-year style in writing thesis because this style allowing us keep reading the text without having to frequently turn to the reference pages.

There are several author-year bibliography styles that have been popularly used. I used to use "named" package. This package is simple and easy to use. However, it does not now how to break a line for a long citation involving several references and thus often generate bad boxes when you typeset the documents. Actually, what I did before was to ignore such bad boxes in draft version, and to manually remove such boxes and refine the layout before generating the final version.

A more complicated author-year bibliography style is "natbib". There are many discussions on how to use this package. I do not intend to discuss how to use this package here; instead, I merely provide some examples of using this package.

Here is a citation example [Tian et al., 2007]; this paper was published by Tian et al. in 2007.

Another citation example is shown here [Peng et al., 2009]. Tian et al. [2007] showed that a system can be well stabilised using a new method proposed from the fuzzy logic perspective.

These two papers [Peng et al., 2009, Tian et al., 2007] are only two examples taken from our long list of publications. Many more examples are here [Peng and Tian, 2006, 2007, 2008, Tian and Levy, 2008a]. And even more are here [Tian and Gao, 1998, 1999, Tian and Levy, 2008a,b, Tian et al., 2003].

Our latest publication is [Peng et al., 2011].

## 1.3 Cross-Referencing of Appendices

Now the updated qutthesis.sty style file supports cross-referencing of appendices. This is an illustration of Appendix A to show you how to cross-reference an appendix. A similar example is shown in Appendix B with detailed explanations.

We are also be able to cross-reference equations and tables in appendices. For example, both Eq. (A.1) and Table A.1 are from Appendix A. From Appendix B, we can find Eq. (B.1) and Table B.1.

# Chapter 2

# Literature Review

---

Real-time systems are those in which timeliness is as important as logic correctness. Missing a deadline will result in a degradation of system performance for soft real-time systems or a system failure for hard real-time systems. The requirements for real-time system design have been extensively described in a large number of papers as well as in many books.

As a class of real-time systems, real-time and embedded control systems have been increasingly deployed in various applications. As outlined in Chapter 1, with the focus on dynamics analysis and integrated design, this thesis will address three related areas of real-time control:

- Control design for controllers: Well designed control strategies are essential for real-time control systems to provide the desired functionality. For complex processes that cannot be well handled using either simple Proportional-Integral-Derivative (PID) control or advanced model-based control, integrated design of model-free and intelligent control is an attractive way for process operation.

- Control implementation on controllers in multi-tasking environments: Real-time control systems are typically deployed in hardware platforms with limited resources, e.g., uni-processor, resulting in various constraints in computing and scheduling of real-time control tasks of the systems. While schedulability has been the focus of conventional scheduling theory, it is not enough for real-time control systems. We need good control performance as well! In order to meet the requirements of both control performance and multi-tasking schedulability, well-designed scheduling of multiple real-time control tasks becomes critical for these systems.

- Control design and its implementation on controllers in networked environments: Challenges exist when a real-time control system in implemented over networks. A better understanding of the dynamics of networked control is necessary for further improvement of system performance. As separate designs of control, scheduling, and networks do not provide optimal solutions to a networked control system (NCS), an integrated design of various system components is thus crucial for maximising the system performance.

Real-time systems are a vast field, so are control systems. Computer networks, which are essential for networked control, are also a very broad area. This marks the interdisciplinary nature of this research.

# Chapter 3

# Math Equations

---

This chapter shows you how to typeset math equations. We are not going to give a comprehensive description on this topic; but merely demonstrate this through some examples.

Several sections of this chapter are directly taken from our paper [Tian et al., 2007]. We are not going to cite this paper everywhere in this chapter. However, keep in mind that the majority of the materials shown below come from this paper.

## 3.1 Theoretical Background of Time Series Analysis

### 3.1.1 R/S Analysis

Denote the dynamics of the network traffic shown in Figure 3.1 as $x = \{x_k\}_{k=1}^{N}$, where $N$ is the length of the sequence. This sequence can be treated as fractal records in time. Hurst invented the $R/S$ analysis method to study such sequences. Later, Mandelbrot and Feder further developed this method in fractal theory.

For any fractal records in time $x = \{x_k\}_{k=1}^{N}$ and any $2 \leq n \leq N$, define

$$< x >_n = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{3.1}$$

$$X(i,n) = \sum_{u=1}^{i} [x_u - < x >_n] \tag{3.2}$$

$$R(n) = \max_{1 \leq i \leq n} X(i,n) - \min_{1 \leq i \leq n} X(i,n) \tag{3.3}$$

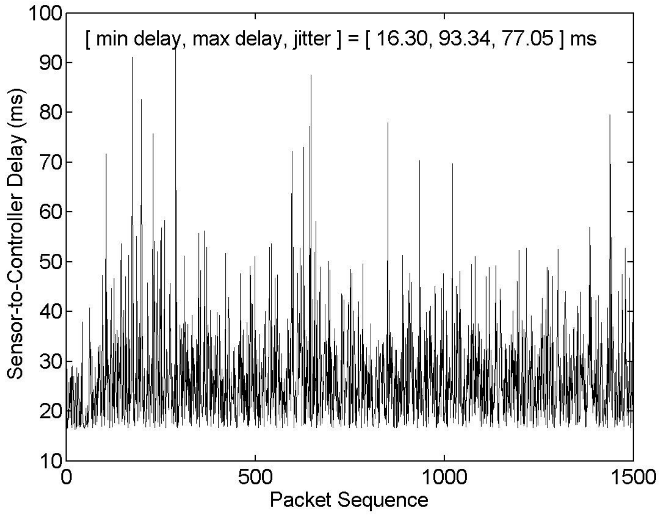

**Figure 3.1**: Sensor-to-controller delay.

$$S(n) = [\frac{1}{n}\sum_{i=1}^{n}(x_i - < x >_n)^2]^{1/2} \tag{3.4}$$

Hurst found that

$$R(n)/S(n) \ \sim \ (\frac{n}{2})^H \tag{3.5}$$

where $H$ is called the *Hurst exponent*.

As $n$ changes from $m$ to $N$, we obtain $N - m + 1$ points in $\ln(n)$ v.s. $\frac{\ln(R(n)}{S(n))}$ plane. Then, we can calculate the Hurst exponent for the time series using the least-square linear fit.

The Hurst exponent is usually used as a measure of complexity. The trajectory of the record is a curve with a fractal dimension $D = 2 - H$. Hence a smaller $H$ means a more complex system. When applied to fractional Brownian motion, if $H > \frac{1}{2}$, the system is said to be *persistent*, which means that if for a given time period $t$ the motion is along one direction, then in the time succeeding $t$ it is more likely that the motion will follow the same direction. For a system with $H < \frac{1}{2}$, the opposite holds, that is, the system is *antipersistent*. But when $H = \frac{1}{2}$ the system produces Brownian motion, which is random.

# Chapter 4

# Demonstration of Tables

---

This is Chapter 4. We will demonstrate how to present results in tables. It is not difficult but need to practice.

The materials shown below is taken from my own PhD thesis. For simplicity, I do not cite any reference here.

## 4.1 Task Decomposition with Fixed Control Periods

To employ the hierarchical feedback scheduling proposed in this work, we first develop a new task model in which each of the original six control tasks is decomposed into two subtasks: data acquisition and QoC evaluation, and control computation and output. Without loss of the generality, the settings of the decomposed tasks and their priorities are shown in Table 4.1.

**Table 4.1**: Task model in the case studies. Top level scheduler task $T_0$. Sampling and control task set $T_i = T_{i1} \bigcup T_{i2}$, $i = 1, 2, \cdots, 6$. Control periods are the same as those in Table ...(omitted...). Priority levels are valid only for FP scheduling.

| Settings | $G_1(s)$ | $G_2(s)$ | $G_3(s)$ | $G_4(s)$ | $G_5(s)$ | $G_6(s)$ |
|---|---|---|---|---|---|---|
| | $T_{11}, T_{12}$ | $T_{21}, T_{22}$ | $T_{31}, T_{32}$ | $T_{41}, T_{42}$ | $T_{51}, T_{52}$ | $T_{61}, T_{62}$ |
| Priority | 2, 8 | 3, 9 | 4, 10 | 5, 11 | 6, 12 | 7, 13 |
| Period (ms) | 0.8 - 2.0 | 1.0 - 2.5 | 1.0 - 2.5 | 1.2 - 3.0 | 1.2 - 3.0 | 1.5 - 3.8 |
| Top level scheduler task $T_0$ with the highest priority of 1. | | | | | | |
| Execution times $c_0 = 10\mu$s; $c_{i1} = 50\mu$s and $c_{i2} = 250\mu$s, $i = 1, 2, \cdots, 6$. | | | | | | |
| Deadlines $d_0 =$ 1ms; $d_{i1}$ and $d_{i2}$, $i = 1, 2, \cdots, 6$, are calculated using Eqn. (...omitted...). | | | | | | |
| Other Settings: $\Delta_H = 0.05; \Delta_L = 0.01, \epsilon = 0.9, U_{sp} = 0.92, N_{rqsp} = 5$. | | | | | | |

We have tested the new task model, in which the original six tasks are decomposed into twelve subtasks, under fixed task periods and FP.

## 4.2 More Results

More results are omitted here......

# Chapter 5

# Compensation for Control Packet Dropout in Networked Control Systems

---

Like time-varying network induced delay that have been investigated in the last two chapters, data packet dropout is another challenging problem in real-time networked control systems. Applying the real-time queuing protocol that we developed in the last chapter, we are able to limit the sum of the network induced communication delay and the control computation delay to within a control period. This one-period delay is further guaranteed by improved **integrated design of real-time networked control** through embedding packet dropout compensation into the queuing protocol.

This chapter proposes to compensate for the control packet dropout at the actuator using past control signals. Three model-free strategies for control packet dropout compensation, namely, PD (proportional plus derivative), PD2 (Proportional plus up to the second-order derivative), and PD3 (proportional plus up to the third-order derivative) are developed. They are suitable for a large number of NCS without the need to tune the compensator parameters. The proposed dropout compensation schemes are demonstrated through numerical examples.

The core content of this work has been published in two papers Tian and Levy [2008a,b].

## 5.1 Philosophy for Control Packet Dropout Compensation

A queuing protocol has been developed in the last chapter for NCSs. Control packet dropout refers to the situation where, in a control period, no control packet is received by the actuator before the latest time instant to enqueue a control packet to queue $Q_1$.

From the timelines in Figure (...... omitted ......) for the queuing protocol, it is seen that $T_L$ is the latest *possible* time instant to receive control packets without packet dropout. After this time instant, some control packets may not be delivered successfully. $T_L$ is also the cut-off, i.e., latest *allowable*, time instant for $Q_1$ to accept control packets in a control period. Even if some control packets can reach the actuator after this time instant, they are purposely dropped.

Before developing strategies to deal with control packet dropout, we would like to clarify the following two aspects, which are crucial for our development:

1) How much computing power and other resources are available for calculations of packet dropout compensation? and
2) How much chance will various packet dropout scenarios likely occur?

...... More discussions are omitted here ......

## 5.2 Mechanism for Control Packet Dropout Compensation

For real-time networked control, having the mechanism to output control signals at a fixed time instant in the real-time queuing protocol leads to more predictive timing behaviour of the NCS. This compensates for time-varying network delay, but does not solve the problem of control packet dropout. What will happen if a control packet is not received by the actuator by the time instant $T_L$? In this case, $Q_1$ is empty and no control signal can be output to the plant. We need to “make” a control signal! This is what we will investigate in detail in the next few sections.

...... More discussions are omitted here ......

# Chapter 6

# Conclusions and Recommendations

## 6.1 Summary of the Research

This “qutthesis.sty” LaTeX package is easy to use. Thus, it is recommended to you to make your thesis writing much easier. In particular, you do not need to worry about the format and layout of your thesis; this package will look after all those aspects for you.

## 6.2 Recommendations

This package may not always be compatible with other packages. But I do not have time to make a comprehensive testing. Therefore, when using any other packages, check if there is any problem. Keep in mind that we have some declarations in “Abstract”. Please do have a look at those declarations.

# Appendix A

# Example I without Detailed Explanations

---

This is the first appendix.

## A.1 Problem Formulation

The problem can be described using the following state space model

$$\dot{x(t)} = Ax(t) + Bu(t) + Gw(t) \tag{A.1}$$

where $x$ is the system state.

## A.2 Solving the Problem

To solve this problem, a new method is proposed. .....

The simulation results are shown in Table A.1.

**Table A.1**: Simulation results.

| Time $t$ | Output $y(t)$ |
|---|---|
| 1 | 10 |
| 2 | 12 |
| 3 | 15 |

# Appendix B

# Example II with Detailed Explanations

---

This is the 2nd appendix.

## B.1 System Output Model

The model to describe the system output dynamics is given by

$$y(t) = Cx(t) + Hv(t) \tag{B.1}$$

## B.2 Simulation for System Output

Simulation results of the system dynamic model are given Table B.1.

**Table B.1**: Simulation results of the system output model.

| Time $t$ | State $x(t)$ |
|---|---|
| 1 | 10 |
| 2 | 12 |
| 3 | 15 |

# Literature Cited

Peng, C. and Tian, Y.-C. (2006). Robust $H_\infty$ control of networked control systems with parameter uncertainty and state-delay. *European Journal of Control*, 12(5):471–480.

Peng, C. and Tian, Y.-C. (2007). Networked $H_\infty$ control of linear systems with state quantization. *Information Sciences*, 177(24):5763–5774.

Peng, C. and Tian, Y.-C. (2008). Delay distribution based NCS stability analysis. *Applied Mathematics Letters*, Submitted.

Peng, C., Tian, Y.-C., and Yue, D. (2011). Network QoS constrained output feedback control of discrete-time systems in networked environments. *IEEE Transactions on Systems, Man and Cybernetics, Part A*, 41(1):185–190.

Peng, C., Yue, D., and Tian, Y.-C. (2009). New approach on robust delay-dependent $H_\infty$ control for uncertain T-S fuzzy systems with interval time-varying delay. *IEEE Transactions on Fuzzy Systems*, 17(4):890–900.

Tian, Y.-C. and Gao, F. (1998). Adaptive control of chaotic continuous-time systems with delay. *Physica D*, 117(1-4):1–12.

Tian, Y.-C. and Gao, F. (1999). Control of integrator processes with dominant time delay. *Industrial and Engineering Chemistry Research*, 38(8):2979–2983.

Tian, Y.-C. and Levy, D. (2008a). Compensation for control packet dropout in networked control systems. *Information Sciences*, 178(5):1263–1278.

Tian, Y.-C. and Levy, D. (2008b). Dealing with network complexity in real-time networked control. *International Journal of Computer Mathematics*, 85(8):1235–1253.

Tian, Y.-C., Yu, Z.-G., and Fidge, C. (2007). Multifractal nature of network induced time delay in networked control systems. *Physics Letters A*, 361(1-2):103–107.

Tian, Y.-C., Zhao, F., Bisowarno, B. H., and Tadé, M. O. (2003). Pattern-based predictive control for ETBE reactive distillation. *Journal of Process Control*, 13(1):57–67.