Proceeding

The First International Seminar on Science and Technology

(ISSTEC 2009)

The Challenge of Sciences in a Global Warming Era: Issues and Opportunities for a Better Life

sciences go green

UNIVERSITI KEBANGSAAN MALAYSIA

UNIVERSITAS ISLAM INDONESIA

UNIVERSITI MALAYSIA TERENGGANU

Held from January 24 - 25, 2009

at Kahar Muzakkir Auditorium Universitas Islam Indonesia
Jogjakarta, Indonesia

ISBN : 978 – 979 – 19201 – 0 – 0

Welcoming Address by the Organizing Committee

Honorable Rector of Universitas Islam Indonesia
Honorable Vice Chancellor of Universiti Kebangsaan Malaysia
Honorable Vice Chancellor of Universiti Malaysia Terengganu
Distinguished invited speakers, participants, ladies and gentlemen,

Welcome you at the First International Seminar on Science and Technology (ISSTEC 2009) this morning here at the Auditorium Kahar Muzakkir Universitas Islam Indonesia, Jogjakarta, Indonesia. These seminars jointly organized are Faculty of Mathematics and Natural Sciences UII, Faculty of Science and Technology UKM and Faculty of Science and Technology UMT, Terengganu.

The international seminar is attended by more than 1000 participants, come from all over Indonesia, Malaysia, Iraq, Yemen, Japan and Australia. We invited 5 Indonesian invited and keynotes speakers and 3 invited speakers come from Malaysia. There are 300 papers to be presented orally and 47 papers presented by poster covering wide-variety subjects of sciences and technology like mathemati
Honorable Minister of Research and Technology of Indonesia
Honcs, statistics, chemistry, pharmacy, computer sciences, physics, biology and engineering.

We thank for organizing committee, especially for UKM and UMT. Finally, we would also like to thank Rector of Universitas Islam Indonesia, Vice Chancellor of Universiti Kebangsaan Malaysia and Vice Chancellor of Universiti Malaysia Terengganu for his support to this seminar.

We hope you will enjoy a pleasant and valuable seminar at Universitas Islam Indonesia.

Chairman,
Riyanto, Ph.D.

ISBN : 978 – 979 – 19201 – 0 – 0

Opening speech from the Rector of Universitas Islam Indonesia

Assalamu 'alaikum Wr.Wb.

The honorable Minister of Research and Technology of Indonesia
The distinguished invited speakers, and
All the participants of the ISSTEC 2009

Firstly, I would like to express my great appreciation to the Faculty of Mathematics and Natural Sciences UII as the organiser of this first International Seminar on Science and Technology (ISSTEC 2009) with the theme "The Challenge of Science in a Global Warming Era: Issues and Opportunities for a Better Life". I am proud that the first meeting of this interesting event is being organized and held in Yogyakarta.

As the biggest and the oldest private university in Yogyakarta, Universitas Islam Indonesia is committed to the excellence in research and teaching. Recently, we are preparing UII as one of the world class universities.

Knowing that committee has selected outstanding speakers from various prestigious institutions, I believe that all of the participants will enjoy the discussion of issues covered by the topic of this seminar. Scientists have shown that the earth's climate is changing dramatically, and human industrial activities and the burning of fossil fuels are largely to blame. Climate change is a crisis we caused together, therefore, a responsibility we all share together. We are deeply concerned with the issues and opportunities in the internationalisation of sciences for better life, sciences have to go green.

Finally, I would once again like to thank the organiser for organising this event, and to thank all the participants attending this ISSTEC 2009 event as well as delivering their scientific presentations. I do really hope that you can enjoy this seminar and have excellent stay in Yogyakarta.

Wassalamu 'alaikum Wr.Wb.

Yogyakarta, March 24, 2009

Prof. Dr. Edy Suandi Hamid, M.Ec.
Rector of Universitas Islam Indonesia

ISBN : 978 – 979 – 19201 – 0 – 0

Opening speech from the Vice Chancellor of Universiti Kebangsaan Malaysia

Assalamualaikum wbt. dan Salam Sejahtera

I would like to congratulate the Faculty of Science & Technology, which has taken the initiative in organizing the joint ISSTEC seminar with Universitas Islam Indonesia (UII), concurrent with FST's 10th Anniversary in 2009. This initiative parallels UKM's aspiration to promote academic research collaboration between UKM academic staffs and colleagues from various institutions at national, regional and international levels.

The seminar theme of "The Challenge of Sciences in a Global Warming Era: Issues and Opportunities for a Better Life" is consistent with a research niche of UKM in response to the problem of climate change. Climate change and its enormous impact on life should alert everybody, particularly scientists. The global warming issue has an across-dimension effect in life and its betterment. Thus, through this seminar, I believe collaboration, knowledge sharing and research experiences in this field will be benefited. I also believed this seminar will open up wider opportunities, while crossing academic, management and student borders.

It is hoped that UKM will start the collaboration work on this very day, and continue on to soon strengthen it with wider participation from academicians of various disciplines. This is due to knowledge approach to overcome recent demands unity and perspective from various disciplines. It is hoped that this seminar will fulfill its objectives, which have been outlined by the joint organizers, UKM & UII.

Sekian.

Prof. Dato' Dr. Sharifah Hapsah Syed Hasan Shahabudin
Vice Chancellor
Universiti Kebangsaan Malaysia

ISBN : 978 – 979 – 19201 – 0 – 0

Opening speech from the Vice Chancellor of Universiti Malaysia Terengganu

Firstly, I would like to express my utmost appreciation to the organizers and congratulate them for The First International Seminar on Science and Technology 2009. This seminar is the first activity after the signing of MOU on 7 August 2008. As citizens of today's modern world, we have to contribute to developments and the latest discoveries in knowledge and technology. Therefore we need to prepare ourselves to think and compete globally.

UMT has strived very hard to enhance its Key Performance Indicators (KPI) in order to face the challenges of globalization. Therefore UMT puts a lot of effort to alleviate research grants, increase journal publications, employ lecturers with PhD qualification, increase of international students intake, and also signing more MOUs with other universities. In 2008 alone, UMT had received 41 research grants valued at RM6.9 million as compared to only 37 research grants valued RM4.13 million in 2007. Recently, UMT researchers excelled in their achievements at the British Innovation Show 2008 (BIS). This indicates that UMT is now at par with the other well known universities in Malaysia.

To date, UMT has signed MOUs and MOAs with 18 foreign universities. University of Bergen, James Cook University, Kagoshima University, University of South Brittany France, Penn State University and Prince of Songkhla University just to name a few.

In August 2010, the Department of Mathematics UMT shall hold the 5th International Conference on Mathematics and Statistics with the collaboration of Moslem Mathematicians and Statisticians Society in South East Asia. It would be my great pleasure to invite all of you to come and join the conference. Your active participation is a prerequisite for the success of the upcoming conference.

Last but not least, I would like to thank the organizers for their hard work, the plenary speakers and participants for their valuable contributions.
I wish you all the best and enjoy the seminar!

Thank you.

Prof. Dato' Dr. Sulaiman bin Md Yassin

Vice Chancellor
Universiti Malaysia Terengganu

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ISBN : 978 – 979 – 19201 – 0 – 0

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ISBN : 978 – 979 – 19201 – 0 – 0

ISBN : 978 – 979 – 19201 – 0 – 0

ISSTEC 2009
The First International Seminar on Science and Technology
January 24, 2009

ISBN : 978 – 979 – 19201 – 0 – 0

Nash Equilibrium of Feedback Linear Quadratic Dynamic Game for Index One Descriptor System

Salmah

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Abstract

In this paper we present necessary and sufficient conditions for existence of Nash equilibrium of linear quadratic continuous non-zero-sum two player dynamic games for index one descriptor system. We assume that we give a linear feedback to the game. The connection of the game solution with solution of N couple Riccati equation will be studied**.**

Keywords: Nash equilibrium, feddback, linear quadratic dynamic game, descriptor system, index one

Introduction

In the last decade, there has been increasing interest to study the problem in economics with dynamic game approach. Particularly, in area of environmental economicc and macro-economics policy coordination, it is natural to model the problems as dynamic game[1], [7] and [24]. With this approach, the effect of the execution control strategy of the game to dynamic nof the model can be analyzed.([2], [5], [8], [9], and [10]). In applications one often encounters systems described by differential equations system subject to algebraic constraints. The descriptor systems, gives a realistic model for this systems ([3], [4], [11], [12], [13], [14], [15] and [16]).

In policy coordination problems, questions arise, are policies coordinated and which information do the parties have. One scenario is feedback Nash. According this, the parties can react to each other's policies, therefore it has large economic relevance.

In this paper we will consider a linear feedback dynamic game in which the player satisfy a linear descriptor system and minimize quadratic objective function. For finite horizon problem, solution of generalized Riccati differential equation is studied. If the planning horizon is extended to infinity the differential Riccati equation will become an algebraic Riccati equation. Particular attention will be given to computational aspect of the problem.

The purpose of this paper is to extend the investigation by Salmah et.al. in [18], [19], [20], [21], [22], [23] and Engwerda et.al in [16] where the scenario for the game is open-loop. In this paper we will include linear feedback strategy.

Until recently, exept for the work of the writer and colleaque, a study of differential game for descriptor system is lacking. Such first step studies have been carried out with assumption that the game is open loop. To study necessary and sufficient condition for existence of Nash solution of the game Hamiltonian method was used as in [18]. To find the optimal solution of the dynamic game for descriptor system with a finite planning horizon, the problem is related to the solution of differential Riccati equation. The differential Riccati equation is a generalization and combination of differential Riccati equation for linear quadratic dynamic game with 'ordinary system' and differential Riccati equation for linear quadratic optimal control for descriptor system in [19] and [20]. The work of linear quadratic dynamic game for descriptor system with infinite horizon case and studied algebraic Riccati equation for the game is in [21]. A simplifying assumption can be made, namely descriptor system with index one [6].

In those studies, the assumption for the game is open-loop. Open-loop game is a benchmark to study more complicated game. This strategy is based on assumption that the parties act non-cooperatively and the only information they have is it present state and the model structure. In this scenario the parties can not react each other. Therefore its economic relevance is limited.

In this paper we will study the game that including feedback nash, in which the parties can react to each other's policies. This sceanario has large economic relevance. An analysis is needed to study feedback Nash equilibrium of the game.

Preliminaries

Linear quadratic dynamic game can be considered as a combination of linear quadratic optimal control and game theory. In linear quadratic dynamic game, N parties (called players) try to minimize their individual quadratic objective

ISBN : 978 – 979 – 19201 – 0 – 0

function and give control to 'ordinary' state space system.

Although it has many applications, ordinary linear quadratic optimal control, often does not provide a physical meaning in controlling, because the state variable does not corresponds with variable that we want to control. Descriptor systems have great capacity for system modeling because they can preserve structure of physical system and can include nondynamic mode and impulsive mode. Therefore they have a potential applicability for a wide class of systems. Descriptor system described by a set of ordinary equations subject to some algebraic constraints.

In linear quadratic dynamic game for descriptor system we consider the problem of two players who like to optimize their quadratic cost function performance depending both on the state and control variables. The system is described by a set of differential and algebraic equations which is called a descriptor system. The game with two players can be expressed mathematically, that the players give control to descriptor system

$$E\dot{x} = Ax + B_1u_1 + B_2u_2,\ Ex(0) = Ex_0. \quad (2.1)$$

with

$E \in \Re^{nxn}, A \in \Re^{nxn}, B_1 \in \Re^{nxm_1}, B_2 \in \Re^{nxm_2}$, $x(t)$ descriptor vector n dimension. While $u_i(t)$, $i=1,\ldots,n$ are control vector m_i dimension which is done by i-th player, $i=1,\ldots,n$. Matrix E generally singular with rank $E = r < n$. The players minimizing objective functions in the Nash sense of the form

$$J_i(u_1,u_2) = \frac{1}{2}x(T)^T E^T K_{iT} Ex(T) + \frac{1}{2}\int_0^T \left(x(t)^T Q_i x(t) + u_1^T(t) R_{i1} u_1(t) + u_2^T R_{i2} u_2(t)\right)dt, \quad i=1,2 \quad (2.2)$$

with all matrices symmetric. Furthermore Q_i and K_{if} semi positive definite and R_{ij} positive definite.

In this paper we will consider a linear feedback strategy of the linear quadratic dynamic game for descriptor system. Below is definition of feedback strategy.

Definition 1.1: *The set of control actions* $F^* = (F_1^*, F_2^*)$ *is called a feedback Nash equilibrium if for all 1=1,2* $J_i(x_0, F^*) \le (x_0, F_{-1}^*(\alpha))$ *for every consistent* x_0 *and for each matrix* α *such that* $F_{-1}^*(\alpha) \in F_N$.

Under some assumptions such as regularity, impulse controllability and index one we will solve the game, both for finite and in finite planning horizon. To find solution of linear quadratic dynamic game for descriptor system with finite horizon case, a differential Riccati will be derived. The relationship between the existence of solution of differential Riccati equation and solution of the game will be considered. For infinite horizon case algebraic Riccati equation that associated with the game will be studied.

The Finite Planning Horizon

In this section we consider the game (2.1), (2.2) under the assumption that *T* is finite. In this section the differential Riccati equation

$$E^T\dot{K}_1 + (A - S_2K_2)^T K_1 + L_1(A - S_2K_2) - L_1S_1K_1 - K_2S_{21}K_2 + Q_1 = 0$$

$$E^T\dot{K}_2 + (A - S_1K_1)^T K_2 + L_2(A - S_1K_1) - L_2S_2K_2 - K_1S_{12}K_1 + Q_2 = 0$$

$$L_1E = E^TK_1,\ L_2E = E^TK_2, \quad (3.1)$$

with $S_1 = B_1R_{11}^{-1}B_1^T,\ S_2 = B_2R_{22}^{-1}B_2^T$, $S_{21} = B_2R_{22}^{-1}R_{12}R_{22}^{-1}B_2^T$, $S_{12} = B_1R_{11}^{-1}R_{21}R_{11}^{-1}B_1^T$, play a crucial role.

Theorem 3.1. *The two player linear quadratic differential game with descriptor system (2.1), (2.2) has, for every consistent initial state, a linear feedback Nash equilibrium if and only if the set of differenttial Riccati equation (3.1) has a set of symmetric solutions* K_1, K_2, L_1, L_2 *on [0,T].*

Proof:

Assume $u_i^*(t) = F_i^*(t)x(t),\ t \in [0,T],\ i = 1,2$, is a set of linear feedback equilibrium actions. Then according the definition of feedback equilibrium, the following linear quadratic regulator problem has a solution $u_1^*(t) = F_1^*(t)x(t)$, for all x_0, subject to the system

$$E\dot{x}_1 = (A + B_2F_2^*(t))^T x_1(t) + B_1u_1(t),$$
$$Ex(0) = Ex_0.$$

According to [12], this regulator problem has a solution if the Riccati differential equation

$$E^T\dot{K}_1 = (A - B_2F_2^*(t))^T K_1(t) + L_1(t)(A + B_2F_2^*(t)) - L_1(t)S_1K_1(t) - (Q_1 + F_2^{*T}(t)R_{12}F_2^*(t)) = 0$$

$$L_1(t)E = E^TK_1(t),$$

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has a symmetric solution $K_1(.)$ on [0,T]. Moreofer, the solution for this optimization problem is given by

$$u_1^*(t) = -R_{11}^{-1}B_1^T K_1(t)x_1(t).$$

For the second player the proof is analog.

Now we will proof the converse part of the theorem. Assume we choose the feedback strategy $F_1 = -R_{11}^{-1}B_1^T K_1(t)x(t)$, $F_2 = -R_{22}^{-1}B_2^T K_2(t)x(t)$, with $K_1(t)$ and $K_2(t)$ is solution of differential Riccati equation (3.1). Define

$$\gamma_1(t) = K_1(t)x(t),\ \gamma_2(t) = K_2(t)x(t).$$

Derive the equations to t we have

$$E^T\dot{\gamma}_1(t) = E^T\dot{K}_1(t)x(t) + E^T K_1(t)\dot{x}(t)$$
$$E^T\dot{\gamma}_2(t) = E^T\dot{K}_2(t)x(t) + E^T K_2(t)\dot{x}(t).$$

Based on equation of the system (2.1) we have

$$E\dot{x} = Ax(t) - B_1R_{11}^{-1}B_1^T K_1(t)x(t) - B_2R_{22}^{-1}B_2^T K_2(t)x(t)$$

or

$$E\dot{x} = (A - B_1R_{11}^{-1}B_1^T K_1(t) - B_2R_{22}^{-1}B_2^T K_2(t))x(t)$$

Based on Riccati differential equation (3.1) we have

$$E^T\dot{K}_1 = -(A - S_2K_2)^T K_1 - L_1(A - S_2K_2)$$
$$- Q_1 + L_1S_1K_1 + K_2S_{21}K_2$$
$$E^T\dot{K}_2 = -(A - S_1K_1)^T K_2 - L_2(A - S_1K_1)$$
$$- Q_2 + L_2S_2K_2 + K_1S_{12}K_1.$$

Therefore we have

$$E^T\dot{\gamma}_1(t) = -(A - S_2K_2(t))^T K_1x(t) - Q_1x(t) + K_2(t)S_{21}K_2(t)x(t)$$

Based on [23] and the definition of feddback Nash equilibrium it complete the proof.

The Infinite Planning Horizon

In this section we consider the game that the player satisfy (2.1) and they try to minimize the cost function

$$J_i(u_1,u_2) = \frac{1}{2}\int_0^\infty \left(x(t)^T Q_i x(t) + u_1^T(t)R_{i1}u_1(t) + u_2^T R_{i2}u_2(t)\right)dt,$$

(4.1)

with all matrices symmetric. Furthermore Q_i and K_{if} semi positive definite and R_{ij} positive definite.

In infinite planning horizon case it can be proove that the differential Riccati equation become an algebraic Riccati equation, the solution become constant, and the differentiwsal term become zero. Therefore now we consider the algebraic Riccati equation

$$(A - S_2K_2)^T K_1 + L_1(A - S_2K_2) - L_1S_1K_1 - K_2S_{21}K_2 + Q_1 = 0$$
$$(A - S_1K_1)^T K_2 + L_2(A - S_1K_1) - L_2S_2K_2 - K_1S_{12}K_1 + Q_2 = 0$$
$$L_1E = E^T K_1, L_2E = E^T K_2,$$

(4.2)

with $S_1 = B_1R_{11}^{-1}B_1^T$, $S_2 = B_2R_{22}^{-1}B_2^T$, $S_{21} = B_2R_{22}^{-1}R_{12}R_{22}^{-1}B_2^T$, $S_{12} = B_1R_{11}^{-1}R_{21}R_{11}^{-1}B_1^T$.

Theorem 3.1 also can be applied for infinite horizon case. Based on [12] we can find solution of the algebraic Riccati equation by defining generalized eigenvalue problem that need further investigation.

Conclusion

This paper consider *2* player non-zero-sum linear quadratic dynamic game with descriptor systems for finite horizon and infinite horizon case with linear feedback Nash equilibrium. The paper consider *2* couple Riccati-type differential equation for finite horizon case and algebraic Riccati equation for infinite horizon case. We derive theorem that consider relationship between solution ofr the Riccati equation and solution of the game.

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