# Invited Session Proposal "New Results in Systems and Control"

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**Organizers:**

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The purpose of this invited session titled "New Results in Systems and Control" is to provide a forum for researchers and practicing engineers, and in particular students, to learn new developments in the field of Systems and Control, and exchange ideas and results among themselves. Over the last few years, the field has undergone rapid progress both at the levels of theory and practice, and has found wide applications in emerging engineering applications arising from communications, signal processing, networks, unmanned vehicles, multi-agent cyber-physical systems, and biology. We are pleased to have invited six leading and active researchers in the field and to report on their latest research results in systems and control.

The titles and abstracts of these six papers are listed below:

**Paper 1:**

**Title**: Sensor fault identification based on error-correcting output codes method

**Authors:** Rui Zhou, Jie Chen, Fang Deng; Beijing Institute of Technology, China

**Abstract**: In this paper, we proposed a method within the framework of Error-Correcting Output Codes (ECOC) to solve sensor fault feature extraction and online identification problem. Time and frequency domain signal features are selected as the initial fault characteristics, and we enhance the separability of initial characteristics by a nonlinear transformation based on the probabilistic confidence of the first ECOC outputs. Then construct the second ECOC to classify the fault state taking the feature extracted from the first ECOC as the input. We compared the accuracy and efficiency with this method between different ECOC coding strategies. The results indicate that some certain coding combination show better results on efficiency and accuracy, being able to meet the demand of sensor on-line fault identification. And generalization experiment on UCI Machine Learning Repository show that this method can also be promoted to other problems.

**Paper 2:**

**Title:** Value iteration and adaptive optimal control for linear continuous-time systems

**Authors:** T. Bian and Z. P. Jiang, New York University, U.S.A.

**Abstract:** In this paper, a new non-model-based optimal control design is proposed for linear continuous-time systems. First, a continuous-time value iteration (VI) algorithm is presented.

Then, an adaptive dynamic programming (ADP) method based on the obtained VI algorithm is developed to solve the optimal control problem for linear continuous-time systems. Different from existing results, the a priori knowledge of an initial admissible control policy is no longer required. The convergence of the proposed method is investigated. A practical example is presented to illustrate the obtained results.

**Paper 3:**
**Title:** Drones for cooperative search and rescue in post-disaster situation
**Authors:** Jinqiang Cui, Swee King Phang, Z. Y. Kevin Ang, Fei Wang, Xiangxu Dong, Yijie Ke, Shupeng Lai, Kun Li, Xiang Li, Feng Lin, Jing Lin, Peidong Liu, Tao Pang, Biao Wang, Kangli Wang, Zhaolin Yang, and Ben M. Chen, National University of Singapore, Singapore.
***Abstract:*** In this work, we report our solutions to the problems given in the 2014 International Micro Aerial Vehicle Competition, held in Delft, the Netherlands, August 2014, which involves using micro air vehicles in urban post-disaster search and rescue missions. Solutions to all four mission elements of the competition, including real-time map stitching, low altitude navigation, indoor navigation and roof-top perching, are documented and highlighted in this manuscript. The proposed solutions are tested and realized in the competition with actual flights.

**Paper 4:**
**Title:** The leader-following consensus for multiple uncertain Euler-Lagrange systems with a distributed adaptive observer
**Authors:** He Cai and Jie Huang, The Chinese University of Hong Kong, Hong Kong, China.
**Abstract:** The leader-following consensus problem of multiple uncertain Euler-Lagrange systems under switching network topology was studied using the distributed observer approach in one of our recent papers. However, the distributed observer in that paper assumed that all the followers know the system matrix of the leader system. In this note, we first propose a distributed adaptive observer which only assumes those followers who are the children of the leader know the system matrix of the leader system. Then, we further develop a distributive adaptive controller utilizing this distributed adaptive observer to solve the same problem as studied in our previous paper. As a result, we have removed the assumption that all the followers need to know the system matrix of the leader system.

**Paper 5:**
**Title:** Observability of dynamic control games
**Authors:** Hongsheng Qi, and Daizhan Cheng, Chinese Academy of Sciences, China.
**Abstract:** Consider a controlled evolutionary game (CEG), where $n$ players, $x_i, i = 1, \cdots, n,$ are considered as machines and $m$ players, $u_i, i = 1, \ldots, m,$ are considered as human players. Assume the machines strategy updating rules are known, and their payoffs $y_i, i = 1, \ldots, n,$ are also known. Then the dynamic model can be described as

$$\begin{cases} x_1(t+1) = f_1(x_1, \cdots, x_n, u_1, \cdots, u_m) \\ \vdots \\ x_n(t+1) = f_n(x_1, \cdots, x_n, u_1, \cdots, u_m) \end{cases}$$
$$y_j(t) = c_j(x_1, \cdots, x_n, u_1, \cdots, u_m), \qquad j = 1, \cdots, n,$$

where $x_p \in \mathcal{D}_k, p = 1, \ldots, n$ and $u_q \in \mathcal{D}_k, q = 1, \ldots, m$ are $k$ -valued logical variables, $f_i: \mathcal{D}_k^{n+m} \to \mathcal{D}_k, i = 1, \ldots, n$ are logical functions, and $c_j: \mathcal{D}_k^{n+m} \to \mathbb{R}, j = 1, \ldots, n$ are pseudo-logical functions.

First, we give a necessary and sufficient condition to judge whether a CEG is observable. That is, for any two initial states $x_0 \neq \bar{x}$ can we find a control sequence $u_0, u_1, \dots, u_s, s < \infty$, such that the outputs

$$y(x_0, u_0, \cdots, u_s) \neq y(\bar{x}_0, u_0, \cdots, u_s)?$$

Secondly, we prove that if a CEG is observable, then we can find a control sequence $u_0, u_1, \dots, u_s, s < \infty$, such that the initial state $x_0$ is identifiable. An algorithm is provided to calculate it.

The importance of this work is: Though the strategies $x_i(t)$ may completely unknown, it can be recognized via observed payoffs. And then the optimal control and all other control goals can be realized.

**Paper 6:**

**Title:** Distributed output tracking of multi-agent systems with stochastic nonlinear dynamics and multiple leaders

**Authors:** Wuquan Li, Lu Liu and Gang Feng, City University of Hong Kong, Hong Kong, China.

**Abstract:** The distributed output tracking problem is studied for multi-agent systems with stochastic nonlinear dynamics and multiple leaders. For the case where the graph topology is directed and the leaders set is the neighbor of only a small portion of followers, distributed tracking controllers are designed to ensure that the followers' outputs will exponentially converge to the convex hull spanned by the dynamic leaders' outputs with tunable tracking errors while all the states of the closed-loop system remain bounded in probability. The efficiency of the tracking controllers is demonstrated by a simulation example.