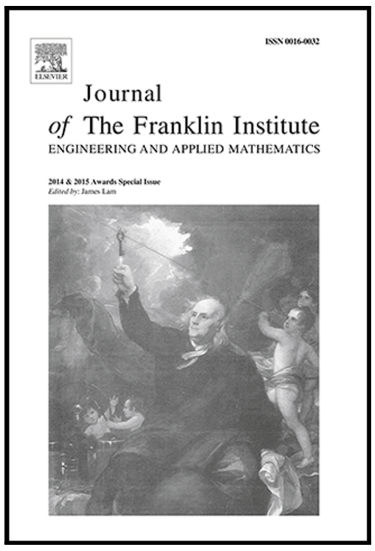

A Katz-centrality-based Protocol Design for Leader-Following Formation of Discrete-Time Multi-Agent Systems with Communication Delays

M.J. Park, O.M. Kwon, J.H. Ryu

PII: S0016-0032(18)30431-9
DOI: 10.1016/j.jfranklin.2018.06.022
Reference: FI 3523

To appear in: *Journal of the Franklin Institute*

Received date: 20 August 2017
Revised date: 16 April 2018
Accepted date: 16 June 2018

Please cite this article as: M.J. Park, O.M. Kwon, J.H. Ryu, A Katz-centrality-based Protocol Design for Leader-Following Formation of Discrete-Time Multi-Agent Systems with Communication Delays, *Journal of the Franklin Institute* (2018), doi: 10.1016/j.jfranklin.2018.06.022

A *Katz*-centrality-based Protocol Design for Leader-Following Formation of Discrete-Time Multi-Agent Systems with Communication Delays

M.J. Park[a], O.M. Kwon[b,1], J.H. Ryu[c,1]

[a] *Center for Global Converging Humanities, Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, Yongin 17104, Republic of Korea*
[b] *School of Electrical Engineering, Chungbuk National University, 1 Chungdae-ro, Seowon-gu, Cheongju 28644, Republic of Korea*
[c] *Electronics and Telecommunications Research Institute, 176-11 Cheomdan Gwagi-ro, Buk-gu, Gwangju 61012, Republic of Korea.*

Abstract. This paper aims at constructing an improved structure for the consensus protocol in discrete-time multi-agent systems. A consensus protocol is proposed by using the centrality measure for agent which is determined by the information flow through multi-agent systems. In analyzing multi-agent systems, a graph representation is used. The concept of centrality measure which was introduced in the field of social network analysis is attempted to find the most central node within the graph. This work is intended to observe the *Katz*-centrality that is one of centrality measures. Here, the advantage of *Katz*-centrality is that a node's centrality depends not only on how many others the node is connected to (its degree), but also on their centrality. The alternative consensus protocol will be applied to the leader-following formation problems for discrete-time multi-agent systems with second-order dynamics and time-varying communication delay. To achieve this, sufficient conditions for the aforementioned problems will be established in terms of linear matrix inequality by utilizing the Lyapunov method and some mathematical techniques. Finally, the discrete-time multi-agent systems modeled with a point-mass dynamics of motion for aircraft and its simulation results are given to illustrate the advantages of the alternative consensus protocol in point of the robustness on time delay and $\mathcal{H}_\infty$ performance.

Keywords: Multi-agent Systems, Time-delay, *Katz*-centrality, Formation, Lyapunov method.

[1]Corresponding authors. Email address: madwind@chungbuk.ac.kr (O.M. Kwon), jihyoung@etri.re.kr (J.H. Ryu)