New modelling methodology for large-scale dynamic networks

September 8 2021

Shengling Shi defended his PhD on the use of graph theory to improve insight into complex networks, such as power grids and social networks. Credit: Eindhoven University of Technology

Engineering systems, such as power grids and transportation systems, are

becoming increasingly complex and encompass numerous sub-systems that are spatially interconnected. Modeling of these 'dynamic networks' is an important task for designing, analyzing, and controlling these systems. By exploiting graph theory, Shengling Shi developed novel modeling methods that consider the interconnection structure of dynamic networks and thus allow for more flexible locations of actuators and sensors in the network for data collection and data-driven modeling.

Due to current advances in machine learning and artificial intelligence of complex dynamic systems, the data-driven modeling of dynamic networks has attracted an extraordinary amount of research attention. The challenge of this modeling task is mainly caused by the complex interconnection of sub-systems in large-scale dynamic networks. This makes the classical approaches for data-driven modeling, originally designed for small-scale systems, inadequate for modeling large-scale dynamic networks.

Shengling Shi addressed in his Ph.D. research the shortcomings of the classical approaches for modeling dynamic networks by embracing graph theory. By graphically representing the interconnection structure of a dynamic network, Shi developed graphical tools and algorithms to allocate sensors and actuators such that the model of the dynamic network can be identified. He also developed efficient approaches to estimate the interconnection structure of dynamic networks from sensor data.

The developed modeling methodology has important applications, e.g., in biological networks, power grids, and social networks. Shi applied it to the inference of brain connectivity from fMRI data, to investigate the effect of intensively listening to Mozart's music on human cognition, a topic that is of interest in neuroscience. His study demonstrates the effectiveness of the developed modeling methodology and its potential applications in various domains.

More information: Topological Aspects of Linear Dynamic Networks: Identifiability and Identification. research.tue.nl/en/publication … s-identifiability-an