Future Resilient Systems

Enhancing the resilience of urban systems by combining engineering, design and social research

Why Resilience?

The urban environment is a complex system made up of interconnected socio-technical systems, such as transport, energy, and financial systems, as well as human and community networks. Rapid urbanisation and densification of population and infrastructure have led to the emergence of high-density urban systems, which tend to be vulnerable to disruptions and cascading failure.

Meanwhile, digitalisation has led to the evolution of infrastructure systems into cyber-physical systems. These physical systems have integrated data acquisition, analysis, and intelligent advisory abilities that interact with users and operators. This calls for new approaches to make these systems more resilient.

At the same time, to improve social resilience, we need to improve our sense-making capabilities and understand how humans and organisations interact. The development of mobile sensors and data science has made distributed cognition possible by acquiring data from human and technical systems in real time.

Research Modules

Cyber-Physical Systems (CPS) Resilience

1.1 Resilience-Driven Design of CPS
1.2 Control, Detection, and Recovery of Resilient CPS
1.3 Data Network Resilience in CPS
1.4 Digital Twin-Enabled System Resilience

Resilience of High-Density Urban Systems (HD-US)

2.1 Resilience Analysis of HD-US
2.2 Energy Resilience in HD-US
2.3 Climate Resilience in High-Density Cities
2.4 Financial Systems Regulation and Networks

Distributed Cognition for Social Resilience

3.1 Measuring, Modelling and Enhancing Social Resilience
3.2 Dynamic Mobile Sensing Platform
3.3 Automated Hazard Detection for Social Resilience
3.4 Spatiotemporal Analysis for Weak Signals Detection
3.5 Interactions with New Technologies and Financial Systems

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Our Approach

The Future Resilient Systems programme provides a cross-disciplinary and cross-cultural environment, bringing together researchers from engineering, social sciences, and design and planning disciplines from ETH Zurich, Nanyang Technological University, National University of Singapore, and the University of Illinois Urbana-Champaign.

Researchers will develop approaches and models to be applied to real-world cases, such as a digital twin to analyse the resilience of energy systems. Network models of supply and demand as well as input-output flows will improve our understanding of interdependencies of infrastructure systems.

Tapping on the availability of sensors and development of data science analytics, researchers will develop ways to improve sensemaking and social resilience. Outcomes include a dynamic mobile sensing platform to support decision making by transport operators and a software that detects weak signals in mobility and social media data.

ETH zürich · Nanyang Technological University Singapore · NUS National University of Singapore · ILLINOIS

Programme Director

Prof. Christoph Hoelscher is professor at the Chair of Cognitive Science at ETH Zurich and leads the Cognition, Perception and Behaviour in Urban Environment project at the Future Cities Laboratory.

Programme Co-Director

With a background in environmental management and disaster risk management, Dr Jonas Joerin was involved in research on resilient urban communities and food value chains in the Climate Policy group and Sustainable Agroecosystems group at ETH Zurich.

The Singapore-ETH Centre

Future Resilient Systems is the second programme of the Singapore-ETH Centre, established by ETH Zurich – the Swiss Federal Institute of Technology Zurich and Singapore's National Research Foundation (NRF), as part of the NRF's Campus for Research Excellence and Technological Enterprise (CREATE).

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