Workshop on High-speed Rail Operation for Safety and Reliability

Date: 25 November 2016
Time: 08:45 – 17:30
Venue: Connie Fan Multi-Media Conference Room

Organized by:
Department of Systems and Engineering and Engineering Management
City University of Hong Kong

Supporting Organizations:
State Key Laboratory of Rail Control and Safety, Beijing Jiaotong University
Advanced Public Transportation Research Center, National Taiwan University

Speakers

Prof. Jason SK Chang	National Taiwan University
Prof. Tao Tang	Beijing Jiaotong University
Prof. Tsung-Chung Kao	University of Illinois Urbana-Champaign
Prof. Shaoquan Ni	Southwest Jiaotong University
Prof. Yiqing Ni	The Hong Kong Polytechnic University
Prof. Jianhui Lin	Southwest Jiaotong University
Dr. Paul HF Lam	City University of Hong Kong
Dr. Rex YC Lai	National Taiwan University
Dr. Jason Ni	City University of Hong Kong
Mr. Tommy Jen	Taiwan High-speed Rail Corporation
Mr. Dennis Li	Asia Pacific Region, TÜV SÜD Hong Kong Ltd.

Organizing Committee

Co-chairs :

Prof. Kwok L Tsui	City University of Hong Kong
Prof. SM Lo	City University of Hong Kong
Prof. Richard Yuen	City University of Hong Kong

Members:

Prof. Tao Tang	Beijing Jiaotong University
Prof. Jason SK Chang	National Taiwan University
Prof. Jianjun Shi	Georgia Institute of Technology
Dr. KS Chin	City University of Hong Kong
Dr. Paul HF Lam	City University of Hong Kong
Dr. Eric Lee	City University of Hong Kong

Conference Schedule

Morning Session	
08:45 - 09:15	*Registration*
09:15 - 09:30	**Welcome Speech** - Prof. Hong Yan, Dean of College of Science and Engineering, City University of Hong Kong - Prof. Kwok L Tsui, Head of Department of Systems Engineering and Engineering Management, City University of Hong Kong
09:30 - 10:00	**Enhancement of Emergency Management for Taiwan High Speed Rail with Information and Communication Technologies** - Prof. Jason SK Chang, National Taiwan University
10:00 - 10:30	**The Security Issues of Train Control Systems** - Prof. Tao Tang, Beijing Jiaotong University
10:30 - 11:00	*Refreshment Break*
11: 00- 11:30	**Online and On-board Monitoring of High Speed Rail Systems for Enhancing Operation Safety** - Prof. Yiqing Ni, The Hong Kong Polytechnic University
11:30 - 12:00	**Key Technology of High-speed Train Operation Security Monitoring and Diagnosis** - Prof. Jianhui Lin, Southwest Jiaotong University
12:00 - 12:30	中國鐵路列車運行圖編制研究 - Prof. Shaoquan Ni, Southwest Jiaotong University
12:30 - 14:00	*Lunch at City Top Staff Lounge, 9/F Amenities Building*
Afternoon Session	
14:00 - 14:30	**Next Generation High Speed System** - Prof. Tsung-Chung Kao, University of Illinois Urbana-Champaign
14:30 - 15:00	**Evaluating Service Risk in Railway Capacity Utilization Using Expected Recovery Time** - Dr. Rex YC Lai, National Taiwan University
15:00 - 15:30	**Research of Railway Delay Events within Five Minutes** - Dr. Jason Ni , City University of Hong Kong
15:30 - 16:00	*Refreshment Break*
16:00 - 16:30	**Big Data in Taiwan High Speed Rail** - Mr. Tommy Jen, Taiwan High-speed Rail Corporation
16:30 - 17:00	**Measurement of Train-track Vibration and Its Possible Application in High-speed Rail Diagnosis** - Dr. Paul HF Lam, City University of Hong Kong
17:00 - 17:30	**Customer Service Considerations for High Speed Railways** - Mr. Dennis Li, Rail Consultancy, TÜV SÜD Hong Kong Ltd.
17:30 - 17:35	*Closing Remarks*

Prof. Jason SK Chang

Director & Professor
Advanced Public Transportation Research Center
Department of Civil Engineering
National Taiwan University

Presentation:
Enhancement of Emergency Management for Taiwan High Speed Rail with Information and Communication Technologies

With the unique geographical location, travel characteristics and living environment, Taiwan encounters various types of natural hazards, such as earthquakes, typhoons, floods and landslides. Hence, it is critical for Taiwan High Speed Rail Corporation (THSRC) to ensure its capability in emergency management. THSRC has combined a variety of information and communication technologies, to develop a comprehensive platform that could enhance its interactive communications, emergency responses, decision-making processes and innovative services to increase passenger confidence by integrating GPS/GIS, image recognition techniques, location-based services, push messages, etc. This platform not only helps the monitoring of real-time system operation but also identifies the environmental danger along the line. The real-time train operation data are provided to both front-line staff and management level via smart phones and tablets. In addition, passenger information kiosks and "T Express" App are available to provide more accurate, real-time and customized made information for passengers. Therefore, with the application of information and communication technologies, it is aimed to enhance its overall capabilities in emergency management, decision-making quality, and improvement of productivity of THSRC. This paper presents the framework of the emergency management system and its main functions. Benefits for safety, reliability and passenger's satisfaction are also presented. It is concluded by summarizing crucial research and innovative subjects in further works.

Prof. Tao Tang

Director & Professor
State Key Laboratory of Rail Traffic Control and Safety
Beijing Jiaotong University

Presentation:
The Security Issues of Train Control Systems

With the development of information technology, the communication, control and computer technologies are widely applied in communication-based train control systems, which help the improvement of operation efficiency and the enhancement of railway capacity. However, the increase of automation and information bring the cyber security risks of CBTC systems. Based on the CBTC specific characteristics including safety-critical, fail-safe designs and failure-tolerance applications, the security issues of CBTC systems are discussed. As the existence safety guaranty mechanisms, some typical cyber security risks can be limited, which could cause some efficiency reduction incidents such as emergency braking. However, the cyber security risks cannot be eliminated due to the inherent features of CBTC systems, which can be triggered from the operation systems, the hardware platform, the communication channels. According to the architecture of CBTC systems, the potential attacks are summarized. In addition, the relationship among security, safety and efficiency is demonstrated.

According to the state of art on the cyber security of railways, some typical security protection solutions of Chinese railways are present. Based on our engineering experience, we raise several feasible research points for cyber security of CBTC systems including the situational awareness, the security risk assessment, the security risk monitor and response.

Prof. Yiqing Ni

Professor
National Engineering Research Centre on Rail Transit Electrification and Automation (Hong Kong Branch)
The Hong Kong Polytechnic University, Hong Kong

Presentation:
Online and On-board Monitoring of High Speed Rail Systems for Enhancing Operation Safety

Developing smarter rail systems by integrating sensing, communication, computing and information technologies is becoming an urgent need to meet the demands for increasing running speed and traffic density, large volumes of passengers and more efficient and safer services. In particular, the sensor-enabled smart rail system is destined to empower high speed rail (HSR) with higher intelligence and sustainability and therefore enhance the operational safety of HSR. Through online and on-board monitoring for mission critical rail components, the smart rail system incorporating appropriate analytic and predictive modelling tools not only provides real-time insight into the operational status of rail systems and early-stage diagnosis of damage in its incipiency, but also enables the trend prediction and timely prognosis of failure before it happens. This presentation is related to recent efforts on the following research topics: (i) instrumentation and online monitoring of rail tracks for the purpose of detecting wheel defects including wheel flats and wheel polygonization; (ii) instrumentation and on-board monitoring of HSR vehicles (including axle-box, bogie frame, gearbox, carriage, etc.) for the purposes of identifying the dynamic interaction among wheels, bogies and car-bodies, suppressing extremely large vibration, and evaluating the influence of wheel non-roundness on vehicle vibration level and ride comfort; and (iii) development of a HSR-enabled mobile sensing platform for air quality, health and climate investigations.

Prof. Jianhui Lin

Professor
State Key Laboratory of Traction Power
Southwest Jiaotong University

Presentation:
Key Technology of High-speed Train Operation Security Monitoring and Diagnosis

In time and space of high-speed train, service state and security state always in a state of change are led by the changes of vibration and environment, which brings great challenge to the safety and health maintenance of high-speed train. Based on the content of analysis of the high-speed train performance service, the test system of high-speed train service performance is proposed, which illustrates the construction contents and scheme and develop the test technique of high-speed train running track. Through years of testing and verification, the tracking test system has a significant effect on the service performance of high speed train.

Prof. Shaoquan Ni

Professor
School of Transportation and Logistics
Southwest Jiaotong University

Presentation:
中国铁路列车运行图编制研究

列车运行图是铁路行车组织的基础，在很大程度上决定了铁路运输质量和服务水平。分析中国铁路列车运行图编制管理技术现状，阐述我国铁路运输组织目前急需解决的关键问题，主要包括高速铁路列车运行图编制问题及基于运到时限的货物列车运行计划编制问题，并介绍基于群体协同的铁路列车运行图编制系统。

Prof. Tsung-Chung Kao

Director & Research Professor - HSR Systems
University of Illinois at Urbana - Champaign

Presentation:
Next Generation High Speed System

Across the world today, High Speed Rail (HSR) emerges as an attractive, highly competitive and environmentally friendly transportation system. The modern HSR have been in use for more than 50 years, it has been proven to be a high speed, high capacity, low pollution and high efficiency transportation tool. However, many emerging technological innovations in the 21st century are bring in a wealth of development that could alter the future of human life and therefore the future development of HSR. The following is a list of potential emerging innovations which could impact HSR development:

1. new HSR Systems: Faster trains, Maglev, Hyperloop,
2. new cars: Driverless car, Electric Car, Car-car communication
3. new business model: Uber
4. new IT technology: Virtual Reality Computation (VR) , Artificial Intelligence (AI), Apple pay
5. new energy source: Shale oil, Hydrogen car
6. next generation robotics, Drone technology, Distributed manufacturing

In his presentation, the speaker will firstly review the past development of HSR technology and then present the impacts of these newly emerging technologies to the future development of Next Generation HSR.

Dr. Rex YC Lai

Associate Professor
Railway Technology Research Center and Department of Civil Engineering
National Taiwan University

Presentation:
Evaluating Service Risk in Railway Capacity Utilization Using Expected Recovery Time

A successful railway service plan should be designed according to the balance between capacity utilization level and operational stability. Given the occurrence of potential system disruptions, railway planners need to incorporate an appropriate level of slack in the service plan to efficiently restore the system to a normal state. Insufficient slacks result in unacceptable operational stability, while surplus slacks incur unnecessary expense and waste. Previous capacity research usually focused on capacity measurement without evaluating the potential risk from the increase of the capacity utilization level. This research proposes a new concept, namely, risk in capacity utilization, by using expected recovery time to quantify the service risk in capacity utilization. A corresponding computational process was also developed to assess the expected time for the railway operation to recover after potential disruptions. Computational results from the case study demonstrate that the service risk in capacity utilization can be obtained and compared by using the proposed concept and process. A minor increase in the capacity utilization level at peak hours may incur a substantial risk to service reliability. Therefore, it is important to incorporate this evaluation procedure in service design process in order to provide reliable and robust railway services.

Dr. Jason Ni

Assistant Professor
Department of Architecture and Civil Engineering
City University of Hong Kong

Presentation:
Research of Railway Delay Events within Five Minutes

As for today, railway operators around the world mainly consider the delay of train arrived at the terminal as operational performance appraisal (i.e., KPI). Taipei MRT (Mass Rapid Transit) and Taiwan high speed rail cooperation (THSRC) both use five minutes as a threshold of "serious event", which needs to be reported to external supervising agencies. Delay events within five minutes are all supervised and controlled internally, thus being difficult for public to get related information.

However, according to Heinrich's law, the occurrence of serious accidents mostly has traces/reasons. And small issues, being accumulated for a while, can become a major problem. That is, even delay events within five minutes, can be an early sign of a major incident. If rail operators can take this research opportunity to review their operation and find out the root cause of the system, several potential risks can be avoided (or prevented). The safety and reliability of the railway system can be improved significantly.

Considering the quality management, safety, reliability and resources, current international KPI on five-minute threshold is reasonable. Nevertheless, we proposed to analyze those "minor" events causing delay between 4~5 minutes. There are several objectives in this proposed research: [1] to form some "standardized data format" for minor delay events. [2] to construct a data-mining model; [3] to develop data visualization scheme. Above three objectives (if reached) can help rail operators to find out the systematic reason of operation failure, and lead to improvement strategy with cost efficiency.

Mr. Tommy Jen

Manager, Operation Control Center
Taiwan High-speed Rail Corporation

Presentation:
Big Data in Taiwan High Speed Rail

Taiwan High Speed Rail line covers a distance of about 350 km with 12 stations and 4 maintenance depots. The daily ridership is over 150,000 passengers in 2016. THSRC has combined a variety of information and communication technologies, to build a comprehensive platform to collect large scales data which run through the period of construction, operation, maintenance, forming as a solid foundation of Big Data and further analytics:

- Strengthening data collection and networks to ensure information on current traffic conditions, incidents and events is accurate and reliable
- Increasing the ease and speed in which information about high speed train traffic conditions can be shared with travelers and other agencies
- Enhancing condition monitoring system in ensuring proper coordination of operation and maintenance management activities

Therefore, how to analyze and extract useful information from the big data to achieve the optimization in many aspects efficiently, reliably are important research topics.

In this presentation, we describe the current progress of data collection, data analytics and management enhancement, and also expected benefits in Taiwan High Speed Rail. Finally, we summarize the challenges and opportunities with Big Data in Taiwan High Speed Rail to improve reliability and safety. The future works in research and innovative collaboration are also concluded.

Dr. Paul HF Lam

Associate Professor
Department of Architecture and Civil Engineering
City University of Hong Kong

Presentation:
Measurement of Train-track Vibration and Its Possible Application in High-speed Rail Diagnosis

This paper reports a comprehensive field test for measuring the vibration of both the train (mainly at the wheel axle of a vehicle) and the track (at the rails and sleepers). The main purpose of the test is to obtain vibration data for studying the train-train interaction. This paper first focuses on the planning and configuration of the field test. Two measurement teams (i.e., the train and the track teams) were formed to ensure the measurement can be completed within a limited time frame without affecting the normal operations of the train services.

The measured train data can be used to study the characteristics of the suspension systems (important in the modeling of train-track interaction), while the measured track vibration is important for modeling the rail-sleeper-ballast system. This paper puts forward for the first time the use of track vibration data in identifying the nonlinear ballast stiffness, which can be applied in the damage detection of railway ballast. To explicitly handle the uncertainties in the model updating process, the Markov chain Monte Carlo (MCMC) based Bayesian model updating method was adopted for generating samples for the approximation of the posterior probability density function (PDF) of uncertain model parameters.

Mr. Dennis Li

Director, MetroSolutions Limited
Senior Advisor, TÜV-SÜD AG

Presentation:
Customer Service Considerations for High Speed Railways

Al Hopper defined customer service as "the assistance and advice provided by a company to those people who buy or use its products or services." In a competitive world, the support and assistance rendered to customers is a great value differentiator between a company and its competitors.

In transportation, customer service goes beyond the traditional view of providing safe, reliable and convenient movement from origin to destination. While these attributes are important, they are often taken for granted by the customers. Nowadays, it is important to look into the expectations of the customers, including both stated and implied expectations.

This paper attempts to look into some of the positive experience in transportation operations in different parts of the world and see how these examples can be applied to the high speed railway customers.

Note

Website:
http://www.cityu.edu.hk/csie/TBRS/

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