Smart Communication Data Fusion by White Learning for Enhanced UAV Applications

Speaker:

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Synopsis:

Kalman filter is one of the greatest engineering breakthroughs in the history of trajectory estimation and data fusion theory in the 20th century. It is directly applied to control complex dynamic systems, such as autonomous navigation for swarms of nanobots, unmanned aerial vehicles to ballistic missiles.

Dynamically modelling and fine-tuning the Kalman filter in real-time for optimal performance can be very challenging. In this keynote, we will review some systematic methods and strategies that use some of the latest machine learning techniques to optimize the performance of Kalman filters in modern applications.

For example, we relax probability distributions using updateable fuzzy clustering to better express uncertainty in a probabilistic way. Bayesian modelling is used in combination with deep learning, which is known as white learning methodology is used as an explainable AI to infer the relations between errors and influencing factors. We will start with the classic fusing methods of measuring multiple sensors, each operating at a different sampling rate. We systematically describe how machine learning and metaheuristics help to optimally tune a Kalman filter for reliable performance, how to simulate sensor errors in a Kalman filter, and how to fine tune a Kalman filter for best performance.

Our proposed machine learning model is also capable of detecting and analysing potential communication errors based on sensor measurements using explainable AI. As a result, our data fusion proposal is an advanced process of integrating multiple data sources to generate actionable information that is more consistent and more robust than the original data sources using machine learning and metaheuristic optimization. The combination of sensory measurements using machine learning and metaheuristic optimization has resulted in a fusion that provides more reliable and accurate estimates than measurements alone can provide. Thus, the UAV's trajectory will not only be smoother than that of the original, but also deviations and their severity can be predicted and interpreted in a causal way.

This report builds on our latest Guangdong provincial government-funded project to integrate BeiDou satellites denial data, 5G data, and IoT data for advanced communications applications. At the end of the workshop, our lab principal researcher, Dr. Gloria Li, will demonstrate a live demonstration of some intelligent fusion simulations in various capstone applications.

Biography:

Simon Fong graduated from La Trobe University, Australia, with a 1st Class Honours BEng. Computer Systems degree and a PhD. Computer Science degree in 1993 and 1998 respectively. Simon is now working as an Associate Professor at the Computer and Information Science Department of the University of Macau, as an Adjunct Professor at Faculty of Informatics, Durban University of Technology, South Africa. He is a co-founder of the Data Analytics and Collaborative Computing Research Group in the Faculty of Science and Technology. Prior to his academic career, Simon took up various managerial and technical posts, such as systems engineer, IT consultant and e-commerce director in Australia and Asia. Dr. Fong has published over 500 international conference and peer-reviewed journal papers, mostly in the areas of data mining, data stream mining, big data analytics, meta-heuristics optimization algorithms, and their applications. He serves on the editorial boards of the Journal of Network and Computer Applications of Elsevier, IEEE IT Professional Magazine, and various special issues of SCIE-indexed journals. Simon is also an active researcher with leading positions such as Vice-chair of IEEE Computational Intelligence Society (CIS) Task Force on "Business Intelligence & Knowledge Management", TC Chair of IEEE ComSoc e-Health SIG and Vice-director of International Consortium for Optimization and Modelling in Science and Industry (iCOMSI).

Gloria Li is currently a PhD candidate at the University of Macau. In 2017, Gloria graduated with BEng, major in • Electronic Communication Engineering, from Hebei University of Science & Technology, China. She graduated with a MSc degree on Computer Information Science in 2019. She is also the Head of Data Analytics and Collaborative Computing Laboratory, Zhuhai Institute of Advanced Technology, Chinese Academy of Science, Zhuhai, China. Ms Li is leading and managing the laboratory, in R&D as well as technological transfer and incubation. She is an entrepreneur with experiences in innovative I.T. contest, with her award-winning team in the Bank of China Million Dollar Cup competition. Her latest winning work includes the first unmanned supermarket in Macau enabled by the latest sensing technologies, face recognition and e-payment systems. She is also the founder of several Online2Offline dot.com companies in trading and retailing both online and offline. In 2021, Ms. Li has won a prize of 2nd runner-up of Global Management Challenge: WorldGMC (Macau region) by her analytics skills. Ms Li is also an active researcher, manager and chief-knowledge-officer in DACC laboratory at the faculty of science and technology, University of Macau.