

Introduction to Curves, Vector Products, and Geometric Algebra

Engineering disciplines evolved around relatively simple mathematical concepts, probably due to their strong focus on practical applications. However, as the complexity of man-made systems is constantly growing, the existing mathematical frameworks used in engineering so far that are based on manipulating functions in a small number of dimensions, and working with numerical values arranged in vectors and matrices, are no longer sufficient. This concerns not only mathematical analyses, but also building mathematical models of complex systems, which can be effectively simulated is no longer trivial. At the same time, in mathematics, a number of concepts were developed to manipulate and analyze more complicated mathematical objects beyond functions and matrices. These concepts may be well known to graduate students in mathematics, but they are unknown to most engineers. In order to overcome such a knowledge divide, and bring the key concepts from mathematics into engineering, this talk will outline basic ideas about curves, vector products and geometric algebra, which can become very useful, for example, when designing advanced machine learning architectures for AI systems.

Pavel Loskot joined the ZJU-UIUC Institute in January 2021 as an Associate Professor after nearly 14 years at Swansea University, UK where he was a Senior Lecturer in Engineering. He received his PhD degree in Wireless Communications from the University of Alberta in Canada, and the MSc and BSc degrees in Radioelectronics and Biomedical Electronics, respectively, from the Czech Technical University of Prague in the Czech Republic. He is a Senior Member of the IEEE, Member of the Signal Processing and Life Sciences Societies, a Fellow of the Higher Education Academy in the UK, and a Recognized Research Supervisor of the UK Council for Graduate Education. He received 5 Best Paper awards from international conferences, and delivered tutorials and keynotes in nearly 60 international conferences.

In the past 25 years, he participated in and led numerous industrial and academic collaborative projects involving large and small institutions in the Czech Republic, Finland, Canada, UK, Turkey and China, and had consultancy contracts with several SMEs as well as larger companies. In 2014/2015, he was a visiting researcher in Computational Science Research Center of the Chinese Academy of Engineering in Beijing. China. In 2010-2012, he was the Digital Economy Adviser for the Welsh Government, and the Swansea University representative in Mobile Virtual Centre of Excellence in Mobile Communications in the UK. In 1999 to 2001, he was a Research Scientist in the Centre for Wireless Communications in Oulu, Finland, where he received the Nokia Research Award for his innovative work on adaptive transmission systems. He was involved in design, implementation and standardization efforts of the 2G, 3G and 4G mobile cellular networks and the early versions of WiFi and Bluetooth systems. In the past 8 years, he diversified his research interests and became directly involved in projects concerning computational molecular biology, air transport management, and renewable energy systems. This experience allowed him to truly understand the principles of interdisciplinary working, and crossing the disciplines boundaries. His current research focuses on the problems involving statistical signal processing and importing methods from Telecommunication Engineering and Computer Science to other disciplines in order to improve the efficiency and the information power of system modeling and analysis.