Workshop Proposal

- Title:
  Intelligent Vehicle Meets Urban: Safe and Certifiable Navigation and Control for Intelligent Vehicles in Complex Urban Scenarios (2nd Workshop)

- Contents:
  - Motivation and objectives.
    Intelligent vehicles (IV) are well recognized to be the remedy of improving traffic efficiency, alleviating unexpected traffic accidents, and finally accelerating the arrival of smart cities. In the past decades, the key functions of IV systems had witnessed incredible development, such as localization, perception, and control. Satisfactory performance can be provided using those existing technologies in constrained or open areas, with limited participants. However, those functions are significantly challenged in complex urban scenarios with dense traffic congestions and complex environmental structures. For example, the existing localization solution using multi-sensor fusion via GNSS/IMU/LiDAR/HD Map is degraded. Specifically, the performance of the GNSS is degraded due to the tall building structures, leading to the multipath effects and the non-line-of-sight (NLOS) receptions. As a result, the GNSS positioning error can reach more than 10 meters which is not acceptable for the ADV. The LiDAR-based positioning is challenged by the dynamic objects. Moreover, the perception function is also degraded by unexpected blockage and dense surrounding objects. At the same time, today's widely used AI algorithms for object detection are beginning to face fundamental limits and practical shortcomings. Many AI algorithms developed recently do not specifically quantify uncertainty; they do not assess the risks that uncertainty imposes on system safety and success; they do not guarantee the uncertainty bounds on this risk and these assessments in real-time are needed. Unsatisfactory performance both from localization and perception can lead to additional challenges to the control functions. In short, those functions rely heavily on each other and how to guarantee the performance of the existing functions in complex urban scenarios is still an open question. More importantly, the reliability of those key functions is important to the IV systems. Any unreliable solutions from localization, perception, and control can lead to the expected system catastrophic failure. Therefore, how to verify the correctness, and risk of the derived solutions is one of the key issues for the massive deployment of IV systems.

In this workshop, we wish to raise the awareness of the academic and industry on the challenges of the complex urban scenarios on the existing key functions of the IV systems to develop the solutions for safe and certifiable navigation and control for intelligent vehicles in complex urban scenarios. Those solutions are expected to account for uncertainty and risk of failure during their online execution, their capabilities for proactively...
quantifying and mitigating risks against task goals and safety constraints, and their ability
to offer formal guarantees, such as bounds on the risk of failure. This workshop will include
both invited speakers from academia and industry and presentations from paper
submissions. More importantly, this workshop will also invite the interdisciplinary topic
from safety, correctness certification, and integrity monitoring in the aviation fields.

- Relevance to the ITS community.
This workshop aims to investigate the safety-certifiable navigation and control methods for
intelligent vehicles in challenging urban scenarios which are essential but still an open
question. Such exploration would significantly facilitate the massive deployment of
intelligent vehicles in life-critical applications in urban areas. As the key component of the
intelligent transportation system, the development of intelligent vehicles benefits the
improvement of the whole system.

- Topics of interest:
This workshop will include but is not limited to the following topics:
1. Certifiable Multi-sensor fusion for IV systems localization, including GNSS, IMU, LiDAR,
   Camera, and High-Definition Map.
2. Certifiable and risk-aware perception, control, localization, and mapping.
3. Formal methods for monitoring and verifying uncertain systems.
4. Robust control of intelligent systems.
5. System-level monitoring and risk quantification.
6. System integrity monitoring and verification.

- Dedicated website.
https://sites.google.com/view/ivurban2023itsc

- Format:
Full day. Half day for invited speakers making presentation. Half day for author
presentations of the accepted paper, and discussion on topics collected from the audience.

- Organizers:
Organizer 1:
Weisong Wen, Hong Kong Polytechnic University, welson.wen@polyu.edu.hk,
https://www.polyu.edu.hk/aae/people/academic-staff/dr-weisong-wen/
Dr. Wen received a Ph.D. degree in Mechanical Engineering from The Hong Kong Polytechnic
University (PolyU), in 2020. He was also a visiting Ph.D. student with the Faculty of
Engineering, University of California, Berkeley (UC Berkeley) in 2018. In 2021, he won the
TechConnect World Innovation Conference and Expo, Innovation Award, U.S., and the Best
Presentation Award from the Institute of Navigation (ION). Before joining PolyU as a
Research Assistant Professor, he was a senior research fellow at AAE of PolyU. He is
currently the associate director of the Intelligent Positioning and Navigation Laboratory (IPN Lab) at PolyU. He was the session chair of the PolyU-TUM workshop in 2021, ION GNSS+
2022, and ICGNC 2022. Meanwhile, Dr. Wen served as the Young Editor Board Member and
Leading Guest Editor of several journals. He published more than 20 SCI journal papers and
24 academic conference papers in the fields of navigation and autonomous driving.

Organizer 2:
Jiachen Zhang, Hong Kong Polytechnic University, jiachen.zhang@polyu.edu.hk
Dr. Zhang is currently a postdoc fellow at the Department of Aeronautical and Aviation
Engineering, The Hong Kong Polytechnic University. She is working in the IPN Lab with Dr.Li-
Ta Hsu and Dr. Weisong Wen. She obtained her bachelor’s degree and Ph.D. degree in 2016 and 2022 respectively from Tianjin University, China. Her research topics focus on LiDAR SLAM in challenging urban canyons, and safety-certifiable LiDAR localization for life-critical unmanned applications.

Organizer 3:
Jin Wu, Hong Kong University of Science and Technology, jin_wu_uestc@hotmail.com
Jin Wu currently serves as a Ph.D. student in the Robotics and Multi-Perception Lab (RAM-LAB), Department of Electronic and Computer Engineering, Hong Kong University of Science and Technology under the supervision of Prof. Ming Liu. He is currently also an engineer with Unity Drive Inc., Shenzhen, China. He obtained his bachelor’s degree from the University of Electronic Science and Technology of China, supervised by Prof. Zebo Zhou and Prof. Rui Li, co-supervised by Prof. Bin Gao and Prof. Yuhua Cheng. In 2013, He was a visiting student with Groep T, Katholieke Universiteit Leuven (KU Leuven). He worked as a shareholder of several companies of unmanned aerial vehicle (UAV) services since 2012. Previously, he worked as an engineer at Tencent Robotics X, under the administration of Dr. Zhengyou Zhang. He worked as an active educator of open-source UAV systems like PX4 and ArduPilot on embedded programming and optimization in China from 2015 to 2018. His research topics include Integrated Navigation and Multi-sensor Fusion, Machine Vision and 3D Reconstruction, Rigid-body Dynamics and Robotic Calibration, Structural Chemistry, and Hybridization Theory, etc. Till now, his related research works have been reported in over 120 journal and conference papers, which include top-tier publications, such as IEEE Transactions on Robotics, IEEE Transactions on Cybernetics, IEEE Transactions on Aerospace and Electronic Systems, AIAA Journal of Guidance Control and Dynamics, and Automatica.

Organizer 4:
Tim Pfeifer, the Chemnitz University of Technology, tim.pfeifer@etit.tu-chemnitz.de, https://www.tu-chemnitz.de/etit/proaut/en/team/timPfeifer.html
Dr. Tim Pfeifer received his Ph.D. degree from the Chemnitz University of Technology, Germany, where he currently works as research assistant. His research interests include factor graphs, robust estimation techniques, and Gaussian mixture models for robot localization. He focuses on methods to make autonomous systems robust against unforeseen sensor events.

Organizer 5:
Yulong Huang, Harbin Engineering University, heuedu@163.com, http://homepage.hrbeu.edu.cn/web/huangyulong
He received a Ph.D. degree in control science and engineering from the College of Automation, Harbin Engineering University, Harbin, China, in 2018. His current research interests include state estimation, intelligent information fusion, and their applications in navigation technology, such as inertial navigation, integrated navigation, intelligent navigation, and cooperative navigation. He was selected for the sixth Young Elite Scientists Sponsorship Program by China Association for Science and Technology in 2020. He serves as an Associate Editor for the IEEE Transactions on Aerospace and Electronic Systems and for the IEEE Sensors Journal, a Youth Editor for the IEEE/CAA Journal of Automatica Sinica (JAS), for the Journal of Marine Science and Application, and for the Unmanned Systems Technology.
Organizer 6:
Haoming Zhang, RWTH Aachen University, h.zhang@irt.rwth-aachen.de,
He received a bachelor's and master's degree in mechatronics from the University of Duisburg-Essen, Duisburg, Germany, in 2017. He is now with the Institute of Automatic Control at the RWTH Aachen University, Aachen, Germany. His research interests include graph-optimization-based state estimation, multi-sensor fusion, and learning-based inference methods for online noise distribution estimation. In addition, he works on research projects to enable robust vehicle/vessel localization in complex and large-scale environments.

Organizer 7:
Xiwei Bai, The Hong Kong Polytechnic University, xiwei.bai@connect.polyu.hk
Xiwei Bai received her Ph.D degree in Department of Aeronautical and Aviation Engineering (AAE) from The Hong Kong Polytechnic University (PolyU), in 2023. She will work as a postdoctoral researcher in AAE PolyU in the near future. She received a bachelor's degree in Mechanical Engineering and Automation from Beijing Information science and Technology University, China, in 2016 and the master's degree in Mechanical and electronics in China Agricultural University, China, in 2018. Her research interests including visual SLAM and Visual-aided GNSS positioning for autonomous vehicle localization.

- Contact details of the proposers (email, postal address, etc):

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