From the Editor's Desk

Advances in Transportation Cyber-Physical System (T-CPS)

Saraju P. Mohanty
University of North Texas

I WELCOME THE readers to the fourth issue of year 2020, the July 2020 issue, of the IEEE Consumer Electronics Magazine (MCE). The current issue is dedicated to Transportation Cyber-Physical System (T-CPS). The issue presents many articles covering various key aspects of T-CPS.

STATE OF THE ART OF THE T-CPS

We may recall that MCE has covered the concept of smart cities and related technologies in many articles and thematic issues. An example is my "Everything You Wanted to Know About Smart Cities" article published in July 2016. Smart cities can be visualized as a system of systems. Each system is individually smart, such as smart healthcare, smart agriculture, smart transportation, smart infrastructure, smart governance, and smart energy. A specific smart system is a cyber-physical system (CPS) which is built by deploying Internet-of-Things (IoT) to a physical system. It may be noted that Industry 4.0 (which belongs to fourth industrial revolution) may or may not be covered under smart cities framework. But, Industry 4.0 is also a CPS which is made smart through industrial IoT. At a system or CPS level, artificial intelligence (AI) is part of various CPS like smart cars (part of transportation CPS or T-CPS), smart healthcare (healthcare CPS or H-CPS), agriculture CPE (A-CPS), smart energy (energy CPS or E-CPS), and smart grid (also part of E-CPS).

T-CPS that makes smart transportation or intelligent transportation is evolving to meet the need of high urban population density in terms of services like traffic management, toll collection, ridesharing, smart parking, safe pedestrian crossing, and autonomous driving. For simplicity of understanding, we can visualize the T-CPS as four layers: data layer (deals with data streams), batch layer (store and process massive amount of data), analysis layer (performs analytics), and service layer (provides various services). T-CPS is complex because of various forms and sources of data such as, real-time data, static data, autonomous vehicle sensors, vehicles communications, traffic, and real-time decisions associated with it. T-CPS can cover a variety of vehicles and transportation systems including ground transportation (such as connected vehicles, electric vehicle, smart vehicles, road transport, hyperloop, and railway transportation), overwater transportation, underwater transportation, and autonomous aerial vehicles (UAV).

A variety of sensors make T-CPS possible. The individual autonomous vehicles have sensors for various actions including pressure sensor, gas level sensor, auto-braking sensor, cameras, accelerometer, gyroscope, GPS, radio detection and ranging, light detection and ranging, infrared sensors, ultrasonic sensors, and

Digital Object Identifier 10.1109/MCE.2020.2986517
Date of current version 8 June 2020.

Published by the IEEE Consumer Electronics Society

vision sensors. Various types of sensors can be part of vehicles to monitor health of the drivers and/or passengers. T-CPS can include other sensors such as RF-ID, road-condition sensor, environmental sensors, acoustic-array sensors, and piezoelectric sensors, in the overall T-CPS infrastructure. Various forms of communications technologies and protocol are needed in T-CPS for vehicle-to-vehicle, vehicle-to-infrastructure, or vehicle-to-everything communications. For the features like high-bandwidth, low-latency, and low-energy requirements, 5G is evolving as a choice in smart transportation domain.

T-CPS has multiple challenges for its design and operation. I discussed many of these in my editorials in various issues, such as the September 2018 issue under the title "Consumer Electronics is the Driver of Smart Cars" and the November 2019 issue under the title "Security-Smart is of Paramount Importance for Autonomous Vehicles." The challenges of T-CPS include bigdata analytics, AI training, AI execution/inferences, charging infrastructure, battery life, real-time communications, security, and cost. T-CPS is a heterogenous system that handles multiple emerging data sources, such as geospatial data, traffic network data, and connected vehicle data. AI training from large datasets is very resource, energy, and time consuming. However, AI model training can be performed through cloud resources. However, AI model execution/inference has to be performed in real time using hardware resource available on the on-vehicle server. This makes level 5 autonomous vehicle that can perform all safety-critical functions in all environments and scenarios, still difficult. However, research to develop edge-AI hardware is in full-swing in various parts of the globe using various forms of hardware such as graphics processing unit, neuromorphic computing, custom AI hardware accelerators (like tensor processing unit), and field programmable system-on-a-chip. Security and privacy issues in T-CPS are in various forms. The various forms of T-CPS security issues eavesdropping, data tampering, impersonation, man-in-the-middle, denial of service, and AI model attack. AI models can be defeated by various ways including model extraction, model inversion, model poisoning, and model evasion, which can lead to serious consequences in smart vehicles. The privacy issues in T-CPS include system privacy, location privacy, and privacy of the driver and passengers. System privacy of T-CPS which involves having knowledge of components of the smart vehicle other than the owner can exploited for security breaches. Research and development are in full swing from both industry and academia to solve the security and privacy problem of T-CPS.

FEATURE ARTICLES

Approximate LSTMs for Time-Constrained Inference: Enabling Fast Reaction in Self-Driving Cars: This article presents a method for fast yet accurate approximation computation in autonomous cars with limited computational resources.

S3A: Smart Station Search Assistance for Electric Vehicle—A Step Towards Smart City: This article presents a method to automatically locate charging stations for electric vehicles.

Secure and Resilient Swarms: Autonomous Decentralized Lightweight UAVs to the Rescue: This article presents a protocol which is secure and autonomous and considers heterogeneity and rotational knowledge for managing swarms of UAVs.

WeDoShare: A Ridesharing Framework in Transportation Cyber-Physical System for Sustainable Mobility in Smart Cities: This article presents an IoT-based real-time ride sharing framework with built-in automatic inventive approach.

Adversarial Attack: A New Threat to Smart Devices and How to Defend It: This article discusses a method for defense against adversarial attacks which is a problem for smart devices and is of serious concern for autonomous vehicles.

A Blockchain-Based P2P Transaction Method and Sensitive Data Encoding for E-Commerce Transactions: This article discusses a peer-to-peer transactions methods using blockchain technology.

Mobile Application Processors: Techniques for Software Power-Performance Optimization: This article presents a method for software power optimization during compilation time to ensure heterogenous multiprocessors of consumer electronic systems run in an efficient manner.

Towards an ICT Based Service Oriented Health Care Paradigm: This article presents information and communication technology (ICT) based healthcare paradigm with various service examples such as monitoring of activities of daily life.

COLUMNS

Bits Vs. Electrons—Relationships Among Devices: IoT → RaD: This article discusses relationship among devices in Internet and IoTs.

The Art of Storage—Memory for a New Game Platform: This article discusses memory requirements in the perspective of gaming platforms.

SPECIAL SECTION

A special section on intelligent cars which is a subset of T-CPS presents a selected article to cover the scope. I would like to thank the guest editor, Gordana Velikic, for all her hard work for this strong special section which will be an excellent read for the CE community as well as other researchers around the globe.

LOOKING FORWARD

I hope the current issue dedicated to T-CPS becomes a good read for a wider set of the CE community to advance their knowledge. MCE will continue the trend of covering more themes for our enthusiastic readers in future issues on the latest hot topics with the active support of the editorial board, active reviewers, and authors, around the globe.

Saraju P. Mohanty is currently the Editor-in-Chief of the IEEE Consumer Electronics Magazine and a Professor with the Department of Computer Science and Engineering, University of North Texas, Denton, TX, USA. Contact him at saraju.mohanty@unt.edu.