Chapter 26
Cyber-Physical Systems in Vehicular Communications

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ABSTRACT

Like the other emerging technologies such as computer evolution and embedded machines, the Vehicular Ad Hoc Networks (VANETs) have also gained much attention from various manufactures and academia. Moreover, we have several on board sensors installed inside the vehicles, responsible for sensing different activities within the vehicle and surrounding such as temperature, intruder detection and so on. Recently, those sensors/actuator systems became responsive to the physical world by enabling real time control emanating from conventional embedded systems, thus emerging a new research paradigm named Cyber-Physical System (CPS). Likewise, other applications for CPS, we have Vehicular Cyber-Physical System (VCPS) that is not a new concept. For now, VCPS may refer to a wide range of transportation management system that is integrated strongly and should be highly accurate, real-time, and efficient. This chapter provides readers with the details of the term "VCPS" followed by the historical overview of this new emerging field including research challenges and future aspects of the VCPS.

INTRODUCTION

According to the recent report by Transportation Research Board (Washington, DC, 2013), the world has been facing a lot of challenges related to the transportation system. The system is neither reliable nor robust. As the result of which significant expiries and injuries are faced by the world. It also influences energy, environment and climate. For example, in US over 37000 people die annually due to the

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road crashes. Similarly, traffic congestion drain off $87.2 billion of the US economy, with 4.2 billion hours and 2.8 billion of fuel spent sitting in traffic (Broy, Kruger, Pretschner & Salzmann, 2007). Hence, there is an urgent petition is required to revise transportation system and introduce resiliency, in order to reduce injuries; improve unmanageable environmental impacts and mortalities. The most desirable issues in transportation can efficiently be sorted out by means of cyber physical systems (CPS). The following sections enlighten that how CPSs are modeled.

The most important use of computer and software is to process the raw data and efficiently convert into information, in order to take a decision. The large ranges of computers in use, however, are less visible, they might be used in engines, seatbelts, airbags, brake system, steering systems in a car. They might be used in cell phone for digitally encoding your voice, convert into radio signals and then send it from the cell phone to the base station. They derive washing machine, deep freezer, dishwasher, and printers. They operate robots, power plants, and traffic lights, find for microorganisms in genetic models, draws images of the inside of a human body. They fetch life to toys by enabling them to respond to human sound, and touch. They derive planes and trains. Now-a-days, they are part of almost all the fields of life. These less noticeable computers are termed as embedded Systems, whereas the software they are using is entitled as embedded software.

Despite of the effect, they have widespread occurrences in almost all the fields of lives, but they are only viewed as an information processing source, just like an ordinary computer system.

Recently, researchers have recognized that these systems require distinct engineering techniques for analysis and design these systems. Though, the field of embedded system has been in use since the 1970s, but they are only considered as small computers. The primary engineering issue was considered to be the one have limited resources (small memory, limited processing, and limited energy, etc.). It was concluded that engineering problem was to improve the design, since optimization can be achieved by achieved by improving the design, therefore the discipline was not different from computer science in any aspect. It just had to be more destructive to apply the same optimization techniques.

Recently, researchers pointed out that the major challenge in embedded system stems their interaction with other physical processes, and from their limited resources. Hence, the field Cyber-Physical Systems (CPS) came into existence shown in Figure 1. The term CPS was invented to be the key area of research, by Hylen Gill. Starting in late 2006, the National Science Foundation in the U.S. referred to the amalgamation of computation with physical processes. Unlike traditional embedded systems, a full-fledged CPS is intended as a network of interconnecting components with physical input and output as impartial device. Ongoing improvements in the field of science and technology will increase the link between computation and physical elements by using intelligent mechanisms. Moreover, it will increase adaptability, reliability, functionality, security, independence, and usability of CPS.

CPS can be viewed as the following two perspectives: formation and function. According to the perspective of formation, it consists of embedded system and network components, whereas from the perspective of function, it utilizes feedback tool to control the physical environment.

Modern cars consist of over 100 electronic control units, which communicate with each other using FlexRay and CAN bus, establishing a network environment.

Vehicles of today support a large number of control functions: the most important control is engine control, including speed and throttle control. The second important control is body control, including the control of air conditioning, mirror, and lock control. The third one is chassis control. The last but not least is safety features, including adaptive, warning of lane patrol control etc. Most functions are associated with physical devices, sensors and controllers. Moreover, they use the closed round feedback