

## Chapter 18

# Towards the Development of Smart Spaces–Based Socio–Cyber–Medicine Systems

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### ABSTRACT

*The concept of Cyber-Medicine System (CMS) is applied to research and development of medical information systems where the Internet is used to integrate medical devices and healthcare services into the system and to connect patients and medical professionals. In this paper, the authors generalize the concept to Socio-CMS, where the social world is added to the fusion of physical and cyber worlds. The social world affects the end-user activity and provides opportunities for collaborative work. A semantic layer is introduced to integrate all system and domain objects from the three digitalized worlds into a smart space: multi-source data, ongoing processes, situation attributes, reasoning rules, and human activity. All objects are dynamically related, leading to such a knowledge-rich structure as a semantic network. Data mining and analytics apply semantic algorithms for this network, including the Big Data case. The derived knowledge feeds construction of advanced healthcare services for supporting medical professionals and for assisting patients.*

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## INTRODUCTION

The traditional style of health care — visiting physician, either at hospital or outpatient clinic — is becoming inefficient due to the observed problem scale growth as well as a new service level that people expect from medical personnel and systems. Connection of a remote patient with a personalized continuous monitoring system for further semantic analysis of the complex dynamic set of acquired data would have been regarded as perspective to improve health care. This perspective drives development of many new proposals and approaches (Islam et al., 2015; Balandina et al., 2015; Majedi, Naeem, & Anpalagan, 2016; Korzun, 2017).

In this paper, we open a discussion on the concept of Socio-Cyber-Medicine System (Socio-CMS). The research question is how such a system could be implemented on the basis of semantic approach. What kind of a smart environment a Socio-CMS is forming as well as what kind of big data and their processing appear. In the general case of smart environments (Korzun, 2014), Socio-CMS is characterized by presence of the semantic network layer, in which system domains and virtual objects interact: multisource data, ongoing processes, situation attributes, reasoning rules, and human activity. The objects form a semantic network in consequence of dynamic links thus organizing a knowledge-rich structure. Semantic algorithms are used for data mining in this network. The obtained knowledge allows achieving such basic goals as supporting medical professionals, and assisting remote patients. We assume that the above mentioned smart spaces-based approach (Balandin, Waris, 2009; Honkola et al., 2010) would have been helpful to design such a semantic layer.

Several concepts drove emergence and further development of Socio-CMS. First, the Cyber-Physical System (CPS) combines computation and communication capabilities with the physical and (virtual, informational) cyberworlds. Any CPS integrates physical devices, such as sensors and cameras, with cybercomponents in order to form an analytical system that intelligently responds to dynamic changes in the real-world scenarios. Services for various domains can be constructed, which comprise of eight different perspectives, or elements: (1) application, (2) architecture, (3) sensing, (4) data management, (5) computation, (6) communication, (7) security, and (8) control/actuation (Haque et al, 2014). Second, CPS has essential components in the medical, or health care, domain. This allows transforming the CPS to the Cyber-Medicine System (CMS). The physical component is not mentioned, because medical devices, sensors interact with their representation in cyberspace by means of IoT environments. Existing research prototypes showed promising impact on the healthcare service industry (Islam et al., 2015; Balandina et al., 2015; Majedi, Naeem, & Anpalagan, 2016).

In the CMS, the Internet helps organizing remote delivery process of medical consultations, diagnosis, and prescriptions. Such health care services allow medical professionals online advising and prescribing treatment to end-users (patients). As any Cyber-Physical system, the CMS is comprised of many physical and virtual entities, and their compositions. Remote users play significant role in promotion of mobility (Demirkan, 2013; Alemdar, Ersoy, 2010).

Third, the Cyber-Physical-Social System (CPSS) concept has recently emerged (Xiong et al., 2015) to be specifically used in social and natural environments of humans. Thus, the CPSS links together three indivisible aspects: the cyber, physical, and social one. Social network integrates social system and its cybersystem, and further then the physical and social system can be mapped equivalently to their cybersystems. On that basis, the physical and social system and their cybersystems can communicate. The CPSS models social systems, like people's behavior and mind, weather and environment, etc. and

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