Chapter 7
Ambient Assisted Living At–Home Laboratory for Motor Status Diagnostics in Parkinson's Disease Patients and Aged People

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ABSTRACT

The chapter summarizes the authors' development on the concept of "at-home lab" (AHL). The concept employs the methods of artificial intelligence (AI), smart internet of things (IoT) technologies, and data mining techniques. The aim is at support for patients with Parkinson's disease and aged people to continuously monitor and evaluate their motor and cognitive status using own smartphone (in particular, IMU as wearable sensor, apps for testing cognitive status, camera for motor tracking). In addition, other devices in the IoT environment can participate in creating the information assistance support for people. This chapter presents and discuss the AHL concept as a further development step of AI in respect with human evolution (NeoNeoCortex). The focus is on evolutionary, environmental, and biological aspects of AI.

INTRODUCTION

In the past decade, several global problems have emerged: 1) acceleration of mankind's aging, 2) "silver economy" phenomenon, and 3) swift development in the sphere of the artificial intelligence (AI), both technologies and economy. Very much likely, these three phenomena do not just correlate or coincide, but rather have causal interlinks. We posit that emergence of AI may well have been provoked by the global aging of population for the sake of compensation for natural intelligence decrease, which happens with aging. Within this paradigm, varied modern technologies suggested to help older people, such as Ambient Assisted Living (AAL), Internet of Things (IoT) environments, and Ambient Intelligence (AmI), can be regarded as a kind of evolutionary response to the challenges raised by the environment in a form of global aging.

This chapter considers our study on evolutionary aspects of AI in respect to the information and communication technology (ICT) progress (Korzun, Nikolaevskiy, & Gurtov, 2016; Meigal, Prokhorov, Gerasimova-Meigal, Bazhenov, & Korzun 2017; Zavyalova, Korzun, Meigal, & Borodin, 2017; Meigal, Korzun, Gerasimova-Meigal, Borodin, & Zavialova, 2019; Reginya, Meigal, Gerasimova-Meigal, Prokhorov, & Moschevikin, 2019). We argue that biological aspects of environment, e.g., aging and neurodegenerative disease, do play critical role for AI emergence and development. This is in good line with the work of (Augusto, Nakashima, & Aghajan, 2009) who regarded the environment and the intelligent system as equal parts of the AI. Therefore, in this chapter we focus on evolutionary, environmental and biological aspects of AI, AmI and AAL.

Parkinson's disease (PD), as one of the neurodegenerative diseases, exerts profound multi-domain impact on either individual human's life or whole mankind living. In PD patients, such symptoms as tremor, akinesia, rigidity, balance disorder, depression, cognitive and autonomic dysfunction appear as major disabling factors. Even without PD, aged people often share these symptoms. Early detection of these symptoms and, hence diagnosis of PD, would have provided retardation of the PD progression. Existing methods of instrumented study of motor function (e.g., video capture, power tracks) are technically expensive and require specialized equipment and performance in professional (laboratory/hospital) conditions. These methods are not personalized, i.e. not adapted to the characteristics of the patient and to the conditions of his daily life, and are not used at home conditions by the patient or his relatives.

In this regard, accessible, informative and reliable methods for movement and cognition evaluation in PD patients have to be elaborated. In this paper we propose to address this problem with help of inertial measuring units (IMU) of a smartphone attached to the body of a human, either during standard neurological tests or free moving. Further, information collected with smartphones and other gadgets can be analyzed and conceived with help of Smart Space and Big Data technologies (Bazhenov, Korzun, & Balandin, 2018). In several studies, the idea of a kind of at-hand laboratory which provides values of numerous parameters of gait and postural reactions is already proposed (Mancini et al., 2011). Also, varied batteries of instrumented tests and clinical scales are used to better extract data on motion and cognition during neurological pathologies (Muller & Muhlack, 2010). To the moment, the mobile-based batteries of motor-cognitive tests are under development and testing (Arora et al., 2015).

We discuss our own concept of NeoNeoCortex or the Fourth Brain, which opens additional layer for human brain (Meigal, Korzun, Gerasimova-Meigal, Borodin, & Zavialova, 2019). We consider the concept of At-Home Laboratory (AHL) as a step towards implementation of the NeoNeoCortex. The concepts support building AAL systems for comfortable assistance in patient's daily life conditions. Socio-cyber-medicine, which altogether would have allowed Additionally, besides pure technological

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