English Summary

AGENT-BASED ANALYSIS AND SUPPORT OF HUMAN FUNCTIONING IN COMPLEX SOCIO-TECHNICAL SYSTEMS: Applications in Safety and Healthcare

Have you ever thought about the complexity of the world in which we live and about the complexity of ourselves? And this world is becoming even more complex with the rapid development of information technology. Millions or billions of information processing stages are going on in our brain before we perform an action. Thousands of operations and many human and technical agents are involved while you for instance purchase a pizza via Internet or while you are travelling by plane. Understanding behavior of complex systems, for example complex socio-technical systems where humans interact with computers, is not a trivial task while it is crucial for improving human well-being and quality of life and work conditions. We need to understand socio-technical systems in order to predict and control their behaviour and in order to design better systems in future. The current research has an aim to analyze the complexity of human behavior at different levels in two socio-technical domains: the *computerized health behavior support domain* such as computerized therapy, mobile lifestyle support and *safety critical domains* such as air traffic management and naval warfare. The former represents an example of human functioning in private life and the latter is an example of human functioning in critical and highly dynamic work environments. Both domains address human functioning in abnormal contexts: in the case of healthcare it concerns the life of chronic patients and in the case of safety critical domains it involves functioning of humans in highly demanding and dynamic circumstances.

Complex systems can be described and analysed at different levels: starting from very low levels, such as biological cells, atoms and even electrons, to higher levels, such as living organisms, populations, mechanical units and machines. However, the problem of connectivity between different types of descriptions and the challenge of bridging the levels still exist. A classical mind-body problem can be an example of this challenge. For instance, we know how neurons in a human brain work, but we don not know exactly how the mental properties of the brain emerge from the functioning of neurons at a low abstraction level.
In this thesis methods for agent-based analysis and support of human functioning in complex socio-technical systems have been addressed. The methods are in accordance with a three-dimensional framework for classification of agent-based models, and enable the modeler to develop models at different abstraction levels, and to establish interlevel relations between those models. Models of human functioning were created and analyzed in safety and healthcare domains with the aim to provide support and recommendations both at the level of the whole system and at an individual level.

The main contribution of the research described in the present thesis is that more insight was obtained in complex systems' behavior and behavior and roles of humans in socio-technical systems. The main conclusion of the current research is that agent-based modeling proved to be a good approach for the analysis of systems in safety and healthcare domains where either complex dynamic relations are present

or where cognitively complex human agents interact with technical systems in a complex manner. This type of modeling allows for the analysis of a system's behavior at different levels of abstraction, both at a global and at a local level across the three dimensions.

Many models described in this thesis can be potentially developed into real life ambient support applications that provide support to humans during their functioning in abnormal contexts, e.g. in highly dynamic environments such as aviation and modern warfare or in the disease management and healthcare domain.