Description for the general public

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The major challenge for ageing European Union societies in the coming decades will be the problem of shrinking labour resources. The proposed solution to the above problem may be to robotise certain areas of the economy. However, this requires the solution of many technological problems, such as enabling robots to be capable of carrying out tasks previously performed by people. As it is impossible to develop a single, universal robot for the multitude of possible tasks, specialized robots will be required. For this purpose, it is necessary to develop tools supporting the process of rapid and simple development and verification of robotic systems, which can be composed of several robots (not only a single robot). Tools that enable automatic generation of robotic system controllers shorten the time needed to specify the controller, generate its code, and validate it. This will lead to a reduction of costs required for prototyping a single robot, thus in consequence the cost of manufacturing such robots. As a result, robots will become available and affordable to all people. This will lead in particular to a significant development of robotics and first and foremost it will solve, partially or entirely, the problem of shrinking labour resources and support of the elderly.

The proposed research aims to identify the methods of designing robotic systems and thereby simplify and accelerate their creation and verification processes. For this purpose, the overall model of the robotic system should be defined as part of this research. It will be used to automatically generate robotic controller code. Based on the currently used specification methodology, which utilizes the concept of an embodied agent, transition functions, behaviours and finite state machine (FSM), the robot model will be extended by Petri net model that will solve the synchronization and communication problem for agents and agents subsystems. In our research we will develop tools based on Model Driven Engineering approach, which will be used to specify the robot model and automatically generate code of the robotic controller. We will develop the Robot Specification Language (RSL), a specific language facilitating modelling the robotic control system. This language will consist of keywords based on concepts derived from the embodied agent approach and current robot system modelling methodology. The robot model specified using the RSL language must be verified, thus compiler for the RSL language will be created. The compiler that will verify the robot model specified using the RSL language and automatically generate code of the robotic controller.

The correctness of the proposed generic model, usefulness and effectiveness of the RSL language and its compiler will be verified in practice. In our research two robots will be used: simple robotic collecting table-tennis balls and complex two-handed robot equipped with cameras, RGB-D, force and torque sensors. For each robot the formal specification will be expressed using the RSL language and based on the generic robot system design methodology. Automatically generated code of the robotic controller will be verified in a series of experiments in simulation and on the aforementioned robots.

Another goal is to confirm the hypothesis that it is economically justified to fully automatically generate the entire code of the robotic controller. In the research it may turn out that the cost of developing a robot system specification is comparable to the cost of manually generated controller. In above situation, research will be conducted to identify those parts of the robot system for which automatic code generation will be profitable.