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Opracowanie efektywnej metodologii dopasowywania struktury sprzętowej oraz optymalizacja zasobów systemu PRET do wymagań czasowych zadań

Rozprawa doktorska napisana pod kierunkiem

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Gliwice 2022

Development of an effective methodology for adjusting the hardware structure and optimizing PRET system resources to the time requirements of tasks

The main objective of the PhD dissertation was to develop a methodology for adjusting the amount and type of resources (hardware) to the tasks and the time requirements in which they are to be executed. This method demonstrates a novel approach to the problem of task scheduling in real-time systems, since, assuming correct software, it ensures that each scheduled task will be completed on time. Such methodology will be of great help in the design of small embedded systems on which human safety and health depend. Such time-predictable (PRET) systems can be applied in medical equipment, systems used in communication systems (autonomous vehicles, aviation, railroads), in emergency shutdown systems for machinery in industry, in IoT end devices available to the public, supervising the operation of a domestic boiler and in many other devices. The design of PRET systems can be very complicated. The simple RTOS systems that are often used in such applications are fraught with inaccuracy and they lack repeatability, which is inconsistent with the idea of safety. Therefore, the proposed dissertation is intended to simplify the process of architecture design and task scheduling in the PRET system.

As part of his research, the author designed a synthesizable model of the PRET system. Next, the system was implemented in the FPGA programmable device. The model includes a specific method for exchanging data between tasks based on the thread-interleaving technique. A task scheduling methodology was also proposed and described in detail. The final chapters of the dissertation describe and analyze numerous experiments that were run to validate the effectiveness of the proposed solution. The validation appeared successful. In addition to the absolute time predictability of the system (each task was always completed before its scheduled execution time), the author also proposed methods to reduce the system's energy and resource consumptions. Based on his experience in working on time-predictable systems, the PhD student formulated a set of recommendations for future PRET system developers.