

MICROPROCESSOR DEVELOPMENT SYSTEMS FOR THE CREATION OF REAL-TIME INTELLIGENT AUTOMATION APPLICATIONS

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ABSTRACT:

The paper describes functions and requirements for microprocessor development systems focused on the creation of object-oriented applications for the management of control processes working in real time. The Processor Expert product is characterised shortly, and the conclusion includes the definition of expected development trends in this sphere.

KEY WORDS:

software design, real-time management, Processor Expert, microprocessor development systems

1. Persistence of RT Applications Development on the Structured Paradigm

Most of the contemporary programmes used for microprocessor applications are developed using classical structured methods. This is confirmed by presentations held at a series of specialised conferences OBJEKTY, which are organised by the staff of Czech Agricultural University Prague [6]. They mostly describe object-oriented applications from the sphere of classical processing of mass data or scientific and technical calculations [12].

Contemporary publications on programming microprocessor applications also present the classical structured method, be it the development environment for PIC microcontrollers [1], ATMEL microcontrollers – development environment KEIL μ Vision [2], or microprocessor 8051 – environment Micro Scope Professional/Standard by Promis [3].

The reason is the need of the shortest possible response time and the necessity of economic working with the operation memory capacity.

2. The Need of Object-oriented Approach

The performance of contemporary microprocessors is constantly growing, as well as the capacity of their operation memory. This is why none of these things is a critical factor for microprocessor applications anymore, as the previous paragraph states. In the past it was the great consumption of operation memory capacity as well as complicated computations that accompanied the use of object-oriented applications and they were the reasons why real-time control programmes in the old microprocessors (of low performance and low memory capacity) were developed in the classical structured way.

Another thing is that currently there are two requirements that expect a shift to the object-oriented paradigm:

- More and more applications today contain functions that are related to the solution problems in real time (e.g. drawing cash from on-line vending machines). For methodical reasons it is better that both cases are done with object-oriented methods.
- Control of complicated, extensive, and hierarchically organised systems requires complicated control algorithms, especially if functions employing artificial intelligence are required as well (mechatronic systems, robotic systems), which is impossible to design with simple development systems [1,2,3].

All this aims for the using of object-oriented approach, even in applications that relate to real-time control.

3. Product Processor Expert

The Processor Expert™¹ product by UNIS (further referred to as PE) represents a progressive, object-oriented microprocessor development system. First version of Processor Expert was implemented in 1993 and presented in 1994.

Processor Expert (PE) is advanced, component oriented, open Rapid Application Development environment for embedded systems, based on original methodology of embedded system decomposition to HW and SW elements. Processor Expert provides Delphi-like style component application building for 8/16/32bit microcontrollers with a high level of generated application code portability, component reusability and inheritance, and a short learning curve using expert knowledge system assistance. Code is generated from components to source code C and ASM. Generated code supports event driven architecture. PE provides system level code-design of hardware and software with design consistency checks. PE offers multi-target and multi-language designs including hardware descriptive languages.

Processor Expert is based on the Embedded Beans specification. Embedded Beans encapsulate the functionality of basic elements of embedded systems, including CPU core, CPU on-chip peripherals, standalone peripherals, virtual devices, programmable arrays, and pure software algorithms and express these facilities using properties, methods, and events (like objects in OOP). Beans Wizard handles creation and modification of the user's Embedded Beans.

Web Processor Expert is a platform-independent, Web-based software development tools for embedded systems. The Web Processor Expert is a complete development environment for design, implementation, verification, and optimization of embedded applications. This tool includes Graphical IDE, Classic IDE, Simulator and File Manager. This high productivity development platform efficiently uses the microcontrollers and their peripherals, allows building of portable solutions, and saves development time and cost. The Web Processor Expert may be run from any computer connected to the Internet that has an Internet browser with Java support installed.

The expert knowledge system of Processor Expert keeps a comprehensive information database of all encapsulated microprocessors, which reduces the necessity for users to spend excessive time learning details about microprocessors. The expert knowledge system works in

¹ Processor Expert™ is a trade mark of UNIS spol. s r.o.

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PE can operate with any processor from 8bit up to 64 bit and DSP in connection with existing tools for their support. A microprocessor or any other part can be exchanged at any design phase very quickly without the necessity of making changes in the previous code. It will be easy to find the optimal target solution variant for the given application. PE provides an electronic CAD-like view of the real microprocessor.

Supported Microprocessors:

- Fujitsu 16LX
- National Semiconductor COP8
- Freescale HC08 and HCS12
- MPC5500
- 56800

PE provides extensive content help (more than 250 pages) throughout the design time and provides access to the CPU/MCU vendor documentation. Syntax highlight for the supported languages improves readability of the generated and written code.

PE supports team work, user component creation, inheritance and exchange.

PE speeds up radically application design using:

- easy to use portable component library
- design-time assistance of expert knowledge base for component settings
- optimized source code generation from components settings
- elimination of debug effort - design time verification
- easy maintenance of user and generated sources
- graphical interactive representation of the CPU package and structure
- low-level peripheral initialization and control access
- user component creation with Beans Wizard
- concurrent support of ASM, C, EC++, VHDL, EDIF, ...
- several debuggers with Open Source target kernels
- cooperation with third party IDE, compilers, debuggers, emulators.

Reasons of using PE may be presented as follows:

- Designer of application usually starts with decision, which microprocessor could be used to fulfill current known requirements. His software colleague should give him feedback (after some time of course) if proposed hardware is sufficient for implementation of desired tasks. Unfortunately requirements to application functionality can vary. They depends on many agents: component cost, designers experience with the given hardware platform, user floating requirements, delivery terms, package variants and others. Application development process has usually one fixed point: deadline and the development cost.
- To be more flexible in application development one should be flexible in design changes in both hardware and software side. The reason why codesign of hardware and software becomes so important is his ability to shorten application development time and provide more safety thanks to closer relationship between hardware and software entities.
- Embedded software programmer cannot use in the most cases the same tools and object oriented technologies which are usual on PC - Microsoft Visual Basic, Borland Delphi and others, which are called Rapid Application Development tools. Instead, he or she must go deeply into hardware manuals to study various chip features, find out correct setups, and be able to solve various limitations using combination of hardware and software methods.
- We designed Processor Expert for both hardware and software people to work together much closer and make their interface much clearer and more flexible. All work around the core of the application - microprocessor itself and its behaviour is now configuration process, which can be changed at any time. It is a process, where change in hardware is reflected in application software configuration, and where change in peripheral settings is immediately transformed to application source code. The built-in knowledge about possible hardware settings decrease learning time curve together with number of required good and wrong decisions.

One great advantage is that UNIS develops also a tool for modelling of object-oriented analysis of the design [10], as such support allows for substantial improvement of the developed product and enables for a better documentation of the product and the development process, allowing for an efficient communication within the development team.

UNIS was the first Eastern European company to win the prestigious prize award for PE (The European Information Technology Prize 2001).

In competition with innovative technology from 207 applicants in 26 countries, UNIS, the software developer of Processor Expert technology, was recognized for developing one of the winning technologies.

4. Conclusions for the research of intelligent control systems management

Successful popularisation of PE is also caused by the fact that UNIS co-operates with many research institutions in order to refine its functions.

The Institute of Information Theory and Automation of the Czech Academy of Sciences is working on the integration of PE into the environment of MATLAB/Simulink by MathWorks,

which nowadays represents a standard tool for the solution of complicated control systems [7]. The staff of the Faculty of Information Technologies of Brno University of Technology use PE in the doctoral research at the faculty [8, 9].

The research project “Intelligent Systems in Automation” also carried out at the Brno University of Technology will solve problems related to the extension of PE functions in order to use it for the design of software for real-time application of intelligent automation. These are mainly problems related to:

- Improvement of the support of testing the generated code and verification of its design in order to improve the quality of the application.
- Extension of functions supporting the accumulation and intensification of knowledge on the design of microprocessor applications.
- Possibilities of supporting the co-ordination of work in large team of programmers when developing applications.
- Extension of functions for control and project monitoring.

The solution of the mentioned problems is required by the contemporary complicated systems of large sets control, and these problems also react to expected trends in the development of microprocessor development systems.

By working on these design proposals, together with other added functions, which UNIS plans to apply in the following versions, PE may become an important supporting tool in the development of control applications for intelligent automation.

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