Do-it-yourself robotics

Embedded software allows users to program their own robot application

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The year 2005 saw more orders being placed for ABB robots than ever before. The IRC5, ABB's 5th generation robot controller, established itself on the world market and its sales are outstripping that of its predecessor, the S4CPlus. The IRC5 represents a landmark in robotics: its powerful MultiMove® feature sets new standards for motion control. It enables complex, coordinated patterns, in which as many as four robots (up to 36 axes) are controlled in independent or synchronized movements by a single controller module.

But it's not just the controller that breaks new ground! State-of-the-art embedded software in the new hand-held operator unit, the IRC5 FlexPendant, now allows IRC5 users to realize the benefits of customized interfaces.

Ease-of-use and flexibility are key concepts in the IRC5. The FlexPendant is central to this user-centred philosophy and represents a significant breakthrough in both concept and technology. It is an integral part of the IRC5, yet a complete computer in itself, developed with Microsoft's latest technology for embedded systems, Windows CE.NET. It has an innovative ergonomic design and fits naturally into either hand, leaving the other free. An eye-catching feature is the unique, ABB three-way joystick for intuitive jogging of the robot. There are only eight hard buttons, used for fast access to crucial functions, such as starting and stopping robot programs, and of course an emergency stop. Other buttons needed for operation appear on the graphical touch screen when needed, eg, a soft keyboard for entering text. This is a significant improvement on the more complex key-based systems of competing devices. As the FlexPendant is subject to continuous operation in harsh industrial environments, the touch screen is easy to clean and resistant to water, chemicals and even accidental welding splashes.

Usability issues have guided the development of the FlexPendant through all its phases. The use of the one-finger touch screen is fast and natural, and the Windows-like interface, with internationally recognizable icons, is familiar to most end-users and therefore minimizes operator training. As its name suggests, the FlexPendant can be adapted to end-users' specific needs. Currently, it can be operated in 14 different languages, including Asian character-based languages such as Japanese and Chinese. Left-handed operators can adapt the device from its default setting by simply rotating the display through 180 degrees 1. Moreover, four of the hard keys are programmable, ie, their function can be assigned by the end-user.

"The ABB FlexPendant team is very astute and has made demanding requests for new functionality and bug fixes in our platform. They have definitely helped us to continue to improve the .NET Compact Framework platform."
Richard Greenberg[1)]

Development of the FlexPendant

Development of the IRC5 FlexPendant began in earnest in late 2001. The technical requirements of the device were well suited to Microsoft's embedded operating system, Windows CE 4.0, which was specifically designed for intelligent hand-held devices. While the choice of operating system was clear, it was more difficult to decide on the most suitable programming model. One possibility considered was to use COM/ATL as component technology with MFC to create the user interface. The main concern was the complexity of the programming model. The FlexPendant had to be on the market within a couple of years, and the chosen technology would later be required to provide a user-friendly software development kit, enabling third parties to add custom applications to the device.

It was readily understood that Microsoft's coming framework for embedded devices, .NET Compact Framework (.NET CF), would offer an improved programming model, less error prone and less time consuming. But adopting new technology is a risky business and unforeseen technical problems often cause delays in the time schedule. In this case, it would be necessary to use both alpha and beta releases from Microsoft. However, the benefits of using .NET, in terms of quality and productivity, made it a very attractive option. It would also allow ABB to realize the concept of operator-customization.

During the first year of development, ABB worked in close collaboration with Microsoft as a participant in their

Footnote

1) Richard Greenberg, Group Program Manager of the .NET Compact Framework team, Microsoft (April 2006).

1 The FlexPendant is easily adjusted to suit a left-handed user

2 Klöckner-Desma, Germany, was an early adopter of the FlexPendant SDK

Early Adopter Program (EAP) for .NET CF. Microsoft support was essential to the success of the project and approval for the EAP ensured the necessary commitment from Microsoft for the concurrent development of the FlexPendant and the software platform it would use. For their part, ABB, committed themselves to launch the FlexPendant soon after the planned release of .NET CF in 2003.

ABB was about the only EAP participant exploring .NET CF on Windows CE, as most others were using Pocket-PC as an operating system. Microsoft took a genuine interest in the development of the FlexPendant, and soon began to use ABB robots in their television commercials for .NET. From the start, the business relationship with Microsoft was characterized by commitment and technical expertise. The partnership led to ABB launching one of the very first advanced industry products built on Windows CE.NET. The amount of code developed for the FlexPendant is substantial; there are well over 180,000 executable lines of C# code, along with 25,000 lines of C++ code, providing the communication layer towards the robot controller.

Software Development Kit

The FlexPendant-SDK (Software development kit) was initiated in 2003, in parallel with further enhancement of the FlexPendant base software. An EAP for ABB customers was soon initiated, and Klöckner-Desma, a German company targeting the shoe manufacturing industry, realized innovative ideas on how to facilitate the task of supervising the soling process. The idea was to display the robot path, ie, the contour of the sole graphically, thus providing an easier way to tune robot positions 2. While robots are usually delivered with a general operator interface, a customized solution is clearly more desirable to the end-user. Tailored solutions are easier to operate and they optimize users' investment in automation. The FlexPendant-SDK has been part of the ABB software product Robot Application Builder (RAB) 3 since 2004. This allows an end-user or a third party to develop their own robot applications. These RAB applications are integrated with the basic functionality of the FlexPendant using the standard structured menu system. RAB represents an important advancement in robot technology and places ABB's products ahead of its competitors'.

> "The FlexPendant is one of the most sophisticated applications we have seen using the .NET Compact Framework on Windows CE."
> *Mike Zintel*[2)]

The embedded software platform chosen for the FlexPendant means ease-of-use for RAB users. Among programmers, .NET distinguishes itself by the programming model provided by the Microsoft .NET Framework. One feature is its programming language independence, leaving the choice to the RAB developer to use any language provided by the integrated development environment, Microsoft Visual Studio. Most prefer C# or Visual Basic, which offer safe, yet efficient, development. As the majority of programmers already know how to program Windows platforms using Visual Studio, they do not need extensive training when moving to RAB 4.

Advanced software products

To further speed up the development process for the customer, Virtual IRC5 is included in the Robot Application Builder package. Using Virtual Robot Technology, Virtual IRC5 literally puts a robot controller on the desktop, as it allows the IRC5 controller software to run on a PC. An important feature of the .NET Framework is that compiled .NET code can run on any supported platform. This has enabled the development of a virtual FlexPendant, now included in Virtual IRC5, in parallel with that of the real device. Custom applications can thus be developed and tested at the desktop. Debugging is easy, with either a virtual or a real FlexPendant. The user needs only attach the main process to Visual Studio, set a break point in the code and step through it while it is executing. Developing real-time applications for devices with limited process and memory resources is, nevertheless, more demanding than developing PC applications. Therefore, the user documentation emphasizes the skills of optimizing for performance and memory consumption.

RAB development in China and Sweden

Today, many customers benefit from using RAB. These include robot system integrators, automotive companies, and even ABB itself. In 2004, to further strengthen its position in China and the Far East, ABB established a software development team in Shanghai. Their first challenge was to use RAB to develop a software application for use in the plastics industry. The goal was to speed up the process of programming and operating ABB robots used in the injection molding process. RAB provided the team with a clean interface toward controller functionality and proved to be a real facilitator between teams working together from different corners

Footnote

[2)] Mike Zintel, Production Unit Manager of the .NET Compact Framework team, Microsoft (April 2006).

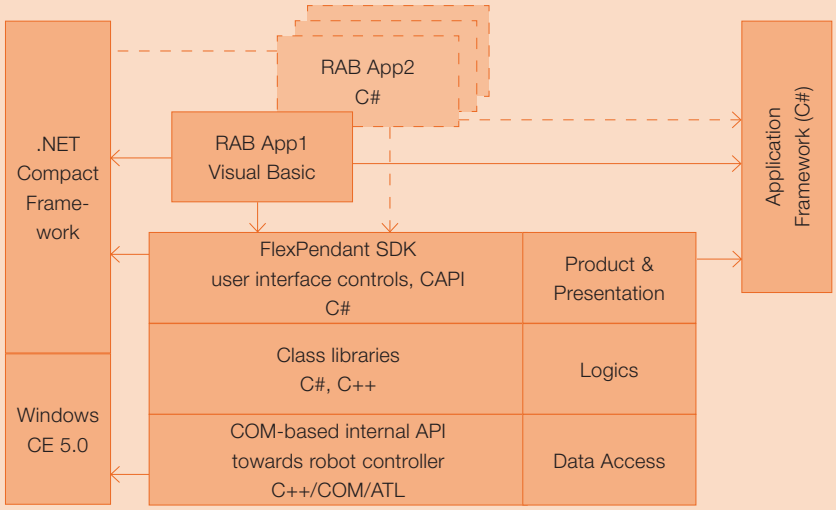
3 Robot application builder (RAB) enables customers to develop their own robot applications

of the world. The result, RobotWare Plastics, was successfully launched in 2005. Again, ease-of-use was a primary concern and end-users were closely involved from the early stages.

One of the first customers to be involved with RobotWare Plastics was the Swedish molding company, AD-Plast. This company was founded in 1963 as a tooling company, but later moved into injection molding, with automotive components as a key product segment. Robotization has allowed the company to achieve consistent quality levels throughout the process and to maintain competitive pricing. RobotWare Plastics has meant smoother and faster start-up for new production processes. Operators no longer need to be robot-programming experts, as the program wizard of the graphical user interface guides the operator through the entire programming process. Another helpful feature is the graphic cell overview 5.

RobotWare Dispense, a robot application enabling dispensing processes, such as gluing and sealing, has been part of the ABB product range for many years. In 2005, an operator interface, customized for the dispensing process was developed in Sweden. Again, a heavy emphasis was placed on ease-of-use and the desire to increase customer value. A well-designed user interface presents relevant information and functionality at the right time. This is much easier to achieve with a customized user interface 6 than with a general-purpose interface.

4 FlexPendant software architecture



RAB App – Application developed with Robot Application Builder, of which FlexPendant SDK is a part.
CAPI – Controller Application Programming Interface, public API offering robot controller services.
COM/ATL – Component Object Model, Microsoft component technology.
Active Template Libraries, set of template-based C++ classes that simplify the programming using COM.
*arrows show dependence

5 RobotWare Plastics is used to program and operate the ABB robot tending the injection molding machine. Pictures of equipment and produced items on the graphic cell overview make the interface intuitive and easy to use.

6 A RAB application for dispensing processes is tested at the desktop before it is downloaded to the real device. This is made feasible by Virtual IRC5.

The future

The embedded technology chosen by ABB for the new generation of smart devices for the robot industry has exceeded expectations. Advantages such as worldwide competence of platform, lasting commitment from Microsoft to the embedded market and continuous inspiration from the PC world, all contribute to making Windows CE.NET a long-term technology choice. Meanwhile, ABB's standing on the robot market will be strengthened as state-of-the-art technology, flexibility and ease-of-use combine to further enhance robot automation, giving ABB and its customers a competitive advantage.

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