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Automated Radionuclide Identification on Compact Devices

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Abstract

Handheld and portable systems for special nuclear material (SNM) detection and identification have benefited substantially from recent advancements in hardware components including mechanical cryogenic coolers, gain-stabilized multi-channel analyzers (MCAs), and low-power compact computer processors. However, software applications for radionuclide identification deployed on these compact devices lag behind the state-of-the-art analysis algorithms. Sandia National Laboratories has identified an efficient approach for porting radionuclide identification algorithms from the GADRAS application to ARM processors, which are common in portable radiation sensors. Our evaluation has shown that by developing a suitable compiler, minimal modifications to the existing code should be required. A vendor has been identified who is able to develop the compiler at a reasonable cost and a purchase order is being prepared to procure the compiler.

1. Introduction

The hardware components of portable radiation sensors have undergone significant technical advancements in recent years including the development of gain-stabilized MCAs and, in the case of HPGe-based systems, mechanical cryogenic coolers. These sensors have also been able to leverage recent advancements in low-power embedded computing processors such as the ARM and XScale CPUs. For example, the Ortec Detective series of portable, mechanically cooled HPGe systems employs a commercial personal digital assistant (PDA) to control the sensor's operation, analyze the data acquired by the sensor, and interface with the operator. Although radionuclide identification algorithms employed by portable sensors have also improved, they are still relatively primitive when compared to state-of-the-art algorithms that have been developed at the National Laboratories.

Sandia National Laboratories has developed the Windows application Gamma Detector Response and Analysis Software (GADRAS), which is an advanced spectroscopic analysis application that is used by many Reachback analysts. In addition to operating in an interactive way, the application also contains fully automated algorithms that are written in FORTRAN. However, FORTRAN compilers do not currently exist that create applications for embedded devices. Rewriting the analysis algorithms in the C language is one approach for porting the algorithms. However, translating the massive amount of code that is included in GADRAS is impractical; code that is ported in this way would not be upgradeable for compatibility with the Windows version of the application; and the translated code would not inherit the quality assurance associated with the Windows version.

The goal of this project is to recommend a method for porting advanced spectroscopic analysis algorithms to embedded processors. The task entails identification of compatible processors, operating systems, software development environments, and communication protocols.

2. Porting DHSIsotopeID to Sensors and Portable Devices

2.1 Compiler/Toolchain Concerns

Although it would be desirable to port advanced analysis algorithms to portable sensors such as the SAIC GR-135, Ortec Detective, Thermo Scientific Identifinder, etc., the problem with this concept is that each detector has different hardware platforms and operating systems. Installation of software to these platforms would require multiple forks of the code, and could possibly require a different compiler for each device. While compilers (such as the GNU Compiler Collection, “GCC”) exist for various operating systems (e.g., Microsoft Windows XP, Linux) and hardware platforms (e.g., x86, ARM), there is no FORTRAN compiler for any embedded system.

Maintenance of multiple development environments and software versions targeted for specific hardware platforms and operating systems increases maintenance costs and undermines the reliability of analysis algorithms. Therefore, the objective of porting analysis algorithms to portable sensors can be achieved most effectively by supporting a small number of hardware and software platforms that can support a large number of sensors, and by avoiding software translations (e.g., from FORTRAN to C) and platform-specific code modifications.

2.2 A Consistent Development Environment

Employing a modern software development environment that is suitable for both the Windows version of the application and for embedded processors is desirable. The Microsoft .NET framework and the C# language have been selected for development of a revised GADRAS graphic user interface (GUI). The .NET framework also includes an embedded development option using C#. Because of the .NET support for Windows Mobile, we have decided that this is the most suitable operating system for deployment of advanced spectroscopic analysis capabilities on mobile sensors. A suitable system would be a ruggedized PDA, such as the TDS Nomad, which has an XScale processor and runs Windows Mobile 6.0. This system will be able to interface with a multitude of sensors that already have the capability of interfacing with PCs (e.g., the Identifinder, Detective EX-100, GR-135, etc.)

While there are no available FORTRAN compilers for embedded processors, GCC now includes the GNU Fortran compiler. The GNU FORTRAN compiler is currently FORTRAN95 compliant, and is steadily incorporating updates/enhancements to the FORTRAN language. GCC provides the option for building cross compilers, which are compilers that create executable code for a specific hardware platform and operating system on a development host that may use different hardware or a different operating system. Therefore, a desktop computer can be used to create applications for embedded hardware platforms such as the ARM processors, which are used on many portable devices (such as PDAs) and even some radiation sensors.

In order to deploy advanced spectroscopic capabilities to mobile systems, without a translation of the FitToDB algorithms to another language, the most important near-term goal of this project is obtaining a FORTRAN cross compiler for embedded devices. With a FORTRAN cross compiler, it will be possible to immediately deploy analysis algorithms directly to devices with the Windows Mobile operating system. This also opens the possibility of targeting other mobile devices as well.

We are in the process of releasing a purchase order to the code development shop CodeSourcery LLC, which has expertise in development of the GNU Toolchain that is customized for embedded devices. CodeSourcery is the exclusive external provider of GNU Toolchain (collection of GNU tools including GCC) services for ARM processors. CodeSourcery will deliver a validated GNU Toolchain which will contain a FORTRAN 90 cross compiler that is optimized for the XScale processor and Windows Mobile 6.0. The compiler will provide a means for achieving the near-term goal of porting spectral analysis algorithms to a specific mobile platform and the compiler will be compatible with Windows Mobile for ARM processors versions 4 through 7. The GNU Toolchain is highly flexible, and it will be a much smaller task to modify the Toolchain for other devices as needed.

3. Conclusions

An efficient path forward has been identified for deployment of advanced spectroscopic algorithms on mobile platforms. The approach is to target applications for Windows Mobile using an XScale processor, which are used in many handheld devices such as PDAs. The processor can interface with a variety of radiation sensors. While a cross compiler for FORTRAN does not currently exist, we are in the process of releasing a purchase order to CodeSourcery to modify and optimize the GNU Toolchain to support FORTRAN 90 for Windows Mobile and XScale processors.