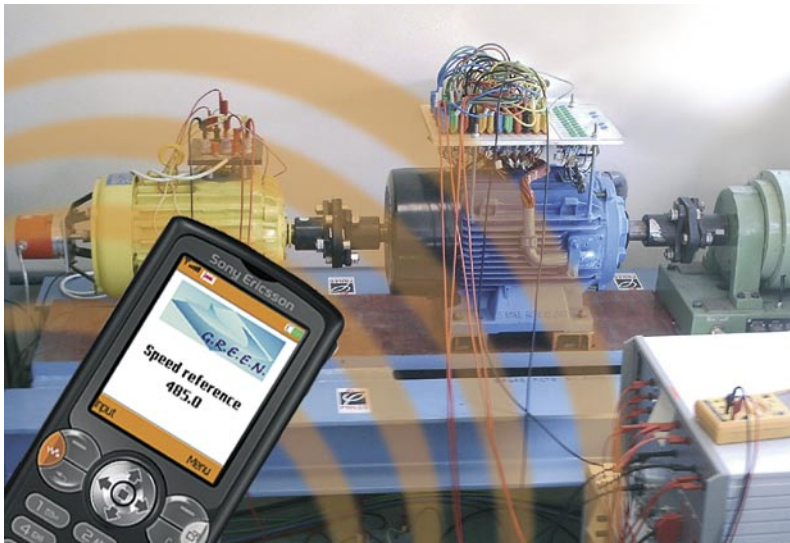# Wireless Vector Control of Induction Motor

- **Extending a DS1104 controller board with a Bluetooth module**

- **Implementing C code on the dSPACE hardware**

- **Developing control software for mobile devices**

The 'Groupe de Recherche en Electrotechnique et Electronique de Nancy (GREEN)', France, performs research in the field of electrical machines. Using an experimental setup based on a dSPACE DS1104 R&D Controller Board and a Bluetooth module, a wireless control of an induction motor is achieved. The project serves as an example of how control algorithms created with the C programming language can be implemented on the dSPACE hardware. The complete code is available online.

The implementation of control algorithms into digital signal processor (DSP) systems can be a challenging task for electrical and control engineers. While their daily business is in the area of applying control methods and modelling control systems, they are often not used to translating the models into

▲ *5.5 kW experimental bench with the double star induction motor controlled by a mobile device.*

code lines to be compiled for a digital signal processor (DSP). We from GREEN know that dSPACE successfully puts a lot of energy into fulfilling the requirement of easy implementation processes. dSPACE provides dedicated Simulink® blocks linked in Real-Time Interface (RTI) to the hardware of dSPACE's processor boards. Compiling the model and code generation is then transparent to the user.

While this satisfies most users, it may be insufficient for cutting-edge, highly demanding end-users.
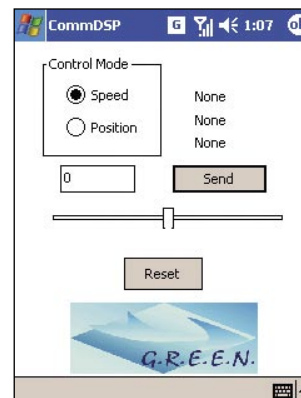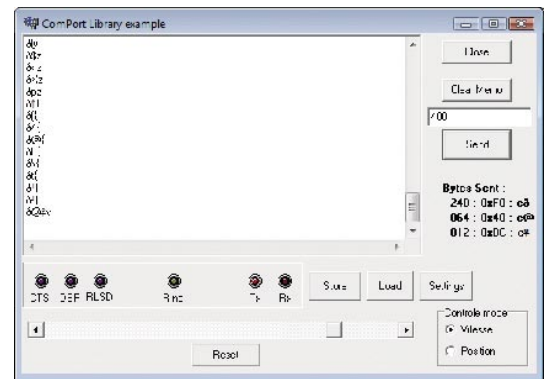
Register Programming

For special demands, dSPACE provides the Real-Time Library (RTLib), a C runtime library that is a sublayer of RTI. This allows users to write the control code directly in C language and call the RTLib functions to access the DSP board hardware. This way, the user has the ability to fully control the run of his/her program that is executed on the floating point PowerPC. dSPACE also added a library feature to change the firmware that is factory flashed into the slave DSP (the fixed point

▲ *CommDSP: the Windows PC version of the remote control software ...*

◄ *... the Pocket PC version.*

TMS 320F240), resulting in a completely flexible and customized code. We performed some development there and chose to present a method of generating 6 fully independent Pulse Wide Modulation (PWM) controls for double-star induction motors, thanks to the "user function" feature.

Bluetooth
Bluetooth Interface

RS232 Connection

DS1104 R&D Controller Board
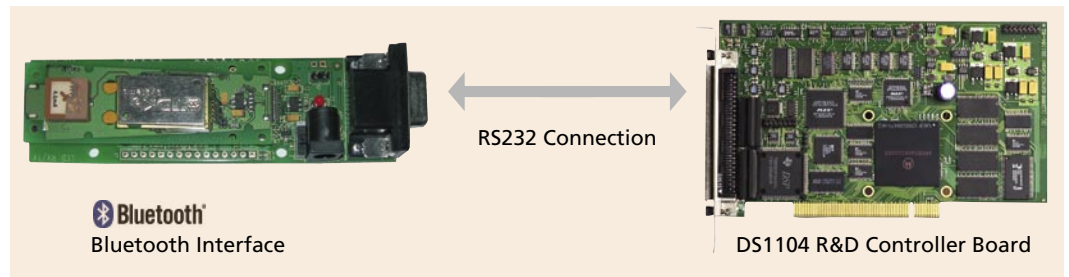
Getting Wireless

We also developed software that uses the Universal Asynchronous Receiver Transmitter (UART) serial port of the DS1104 to allow remote control of the program being run on the DSP board. In fact, the program listens to commands coming from the UART and interprets them as changes in the motor speed and position references. Simply by adding a Bluetooth® interface to the UART, we obtain wireless control.

Remote Control Software

For wireless remote control, one has to write the part of the software for the remote device. In our case this is a program called CommDSP. We developed a Windows® operating PC application, PDA (PocketPC)

> "Due to the open interfaces we could easily extend the dSPACE hardware with a Bluetooth device to realize wireless control."
> **Lotfi Baghli, Nancy Université**

Full Wireless Control

Bluetooth is suitable for data exchange in such high electromagnetic disturbed environments because of its high carrier frequency and communication protocol and layers. Authentification and pairing of Bluetooth devices are welcomed security features. Our code implements a full vector control (IRFO) of an induction motor with IP/Fuzzy controllers. It permits current, speed and position control and flux weakening for high-speed operating. This code, which runs on the dSPACE PowerPC, listens to the remote device commands, and also to commands coming from the conventional dSPACE ControlDesk platform. The code developed for this profect is available on our web site:

http://www.baghli.com/dspace.php

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▲ *The Bluetooth module is connected via RS232 serial bus to the UART of the dSPACE DS1104 controller board.*

application and Midlet application for Java enabled mobile phones. The PC and PDA CommDSP programs are written in C language. For mobile phones, the most common language is Java with a special SUN edition for resource limited systems called Java ME (Mobile Edition). The code developed uses the MIDP 2 profile which is the standard for mobile phones nowadays. In our case, we used the Eclipse 3.0 Integrated Development Environment (IDE), an Eclipse ME plug-in and the Sony Ericsson Software Development Kit (SDK) to generate the jar files of the Midlet. These tools are free and very powerful. CommDSP, running on the PDA or on the phone, establishes a Bluetooth connection to the device that is wired to the DSP UART. The information can be sent from the PDA or the phone to the control board. The 5.5 kW induction motor of our test bench is then at fingertip control with the mobile phone keys.
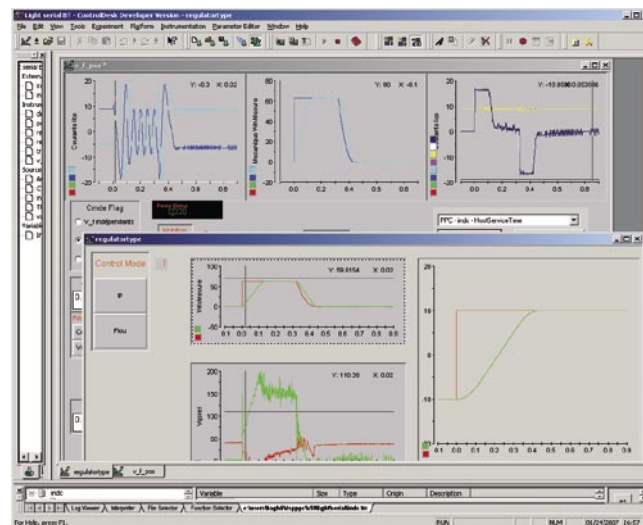

▲ *ControlDesk view of program variables showing a 20 rad position step of a 5.5 kW induction motor under vector control.*