Smart, Intuitive User Interfaces Move to Industrial Control

The next-generation control panel will be more intuitive through increased intelligence

Industrial applications, such as home and commercial building automation, data loggers, point-of-sale terminals and cash registers, in-house displays for energy metering, alarm systems and medical equipment are starting to join the “smart” revolution currently enjoyed by portable media player and smartphone markets. In addition to Internet connectivity being included everywhere, the way people will interface and interact with equipment is fundamentally changing. This is forcing hardware designers to increase the processor performance to several 100 MIPS, the peripheral data rates to tens of Mbps and on and off-chip bandwidth to Gbps. The memory size scales with the software to several Mbytes in cases of an RTOS-based implementation or tens of Mbytes for Linux or Microsoft Embedded CE.

The latest generation of smart phones and multimedia players are perfect examples of how user interfaces are rapidly evolving to take on some of the human psychology and physiology that makes the user interface work. The job of a user interface is to help the user interact with the end product. It provides input to the system and interprets output from it. A user interface can be as simple as a light switch or as complex as the control panel in a jumbo jet. The goal of the user interface should be to make end products effective, efficient, effortless and satisfying to use.

The current revolution in user interfaces is to shorten the human learning curve by making it easier for the user, while putting most of the burden on the end product. The two key concepts are cognition and intuition. Historically, people learn to use products cognitively from a user manual or from trial and error. Only after achieving these cognitive skills, does product use become intuitive. With intelligent user interfaces (iUI), this process is reversed. The product acquires the skills to become usable. Basically, it offloads the cognitive function from the end-user, so the human learning curve is minimal or non-existant and product use is entirely intuitive.

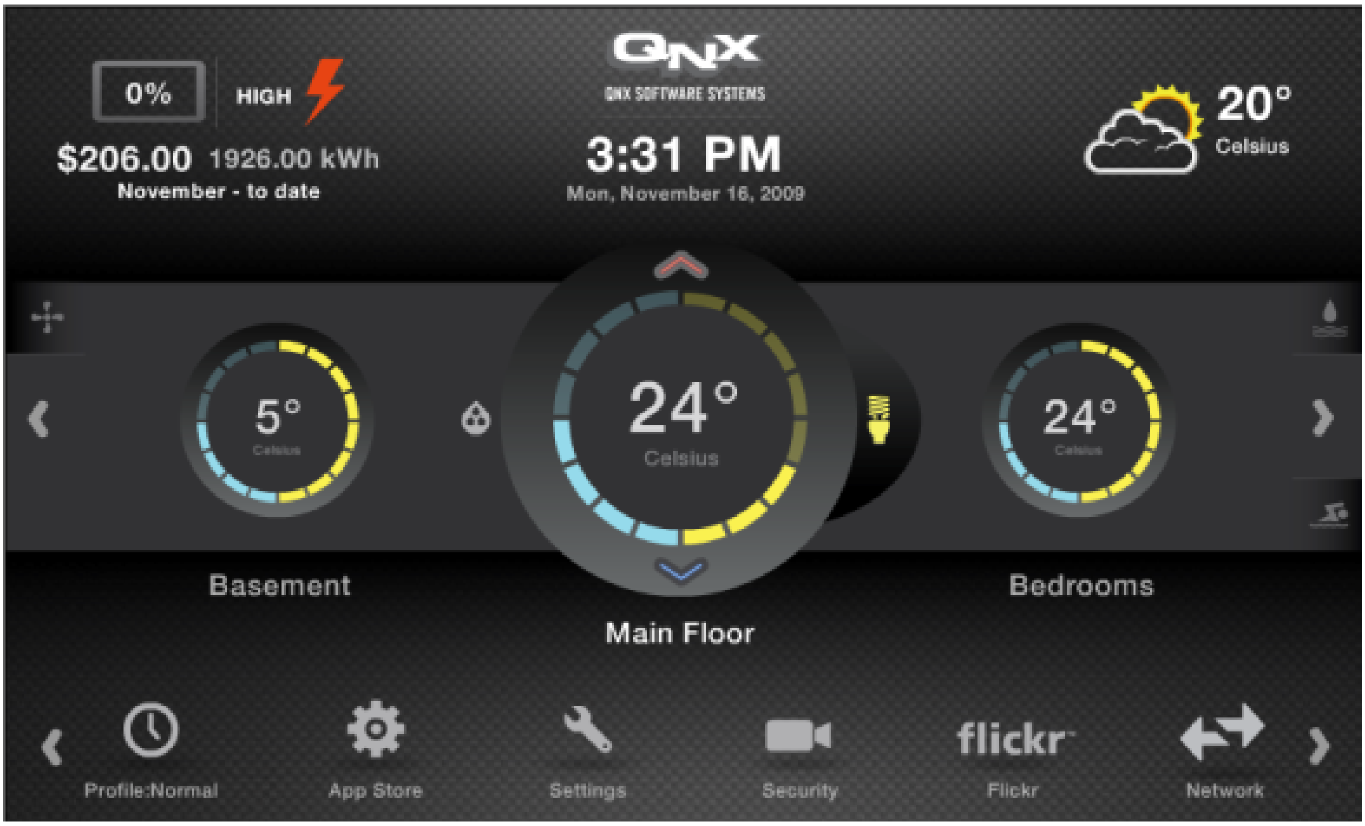

Figure 1. Smart Energy Control Panel Intelligent User Interface by QNX Software Systems.

Picture 1 shows a user interface developed by QNX for a multi-application in-house display controlling the heating, lights, security and shutters while feeding information on energy consumption. In addition to an improved visual representation of information, it is dynamically configured for each application. The control is intuitive and gesture-based through a touch screen. Real-time feedback on power consumption is provided to stimulate a more efficient and reduced usage of electricity.

Driven by the increased software overhead and performance needs for the intelligent User Interface (iUI), multiple wired and wireless connections; communications with in-house or remote servers; and multi-application support; the memory and processor used in the control panel evolves significantly. Mechanical buttons are replaced by touch screens and buttons, LED displays by LCDs, several MIPS flash microcontrollers by embedded MPUs and external DRAM. Industrial temperature range, 3.3 V IO support, and long product life are deeply entrenched in industrial applications but are incompatible with the processors and memories used in multimedia players and smartphones.

I/O Voltage Levels and Power-up Drive System BOM

Since iUI microprocessors were originally developed solely for cell-phones and PDAs, they are optimized for 1.8 V supply voltage. In order to implement iUI applications in industrial applications, which are typically 3.3 V systems, designers have been forced to add as many as 11 level shifter ICs that can cost as much as $13. On-chip power-up and reset control eliminate the need for expensive external power management ICs found on smartphones. This difference can reduce board size by a factor of two to four times, and reduce IC costs by $10 to $24. In addition, cell-phone application processors have a 0.65 mm ball pitch or less that can lead to more expensive printed circuit board fabrication.

DDR2 to Replace SDRAM in Embedded Applications
The vast majority of ARM9-based embedded MPUs support only SDRAM memories. The problem is that memory availability is driven by the high-volume PC market and SDRAM is basically obsolete for current generation PCs. DDR2 and DDR3 offer higher memory densities, higher performance, lower cost and lower power consumption than SDRAM.

While the minimum external bus of 300 MHz required for DDR3 is far too high for the majority of embedded MPUs, DDR2 is a good option for designers. DDR2 may become the memory of choice for the industrial embedded market.

The increased speed of the memory interfaces makes the PCB design more complex. Provisions to control the I/O drive by software, PCB design guidelines, and reference designs reduce the risk of PCB spins. Ultimately, selecting a commercial processor module can eliminate the complexity of high-speed designs completely.

DMA and Multilayer Bus Enable Parallel Data Transfer and Processing
Large amounts of data must be moved and processed and moved again in order to support an iUI. The fastest processor in the world will be useless if there is a bottleneck on the bus or the peripherals cannot communicate directly with the CPU or memories. Ideally an iUI MPU will have a multilayer bus matrix and Direct Memory Access (DMA) Controllers for each peripheral to ensure that all the data gets moved without delays or bus bottlenecks and CPU intervention.

Figure 2. Atmel's SAM9M10 400MHz ARM926-based embedded MPU reduces system cost in industrial control panels with on-chip high-quality video decoder, DDR2 support, 3.3V I/O and industrial temperature range.

Video Decoding and 2D Acceleration for intelligent User Interfaces (iUI)

Whether it's an alarm control panel showing a sequence taken from a surveillance camera or a connected tablet playing content from the Internet, today, iUIs can optionally support high-quality video playback. However, video decoding raises multiple issues in system design, the central one being the processing power required to handle the task. To solve the problems that a software solution causes, an on-chip high-performance hardware video decoder is recommended. The decoder should play resolutions up to D1 (720 x 576) or WVGA (800 x 480) at 30 fps and support multiple formats, H264, H263, MPEG4, MPEG2, VC1, and JPEG. The LCD display benefits from accelerations, including image scaling and image rotation, color space conversion (YUV to RGB) for the rendering of compressed formats, and a picture-in-picture capability. Overall, the hardware decoder and 2D accelerator provides a high-quality visual experience for the user while preserving the full processing power of the central processing unit for the application.

Embedded microprocessor vendors offer a fast growing range of ARM926-based devices optimized for industrial iUI applications. They are supported by a comprehensive eco-system including open source Linux and Android solutions and commercial software from Microsoft, Mentor Graphics, Fluffy Spider Technology and QNX reducing the complexity towards a more intuitive user interface. I/Os support 1.8 V or 3.3 V operation independently configurable for the memory interface and peripheral I/Os. DDR2 memory support is provided, as well as an optional video decoder and 2D graphics accelerator. On-chip power-up and reset control eliminates the need for any external level shifting or expensive power management ICs.

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