TEXAS INSTRUMENTS

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Scalable Solutions for HMI

Executive summary

The demand for increased quantity, quality, environmental protection and economic efficiencies has led to an increasingly connected factory floor and process flow. This, in combination with decreased personnel, has led to increased information to be processed by fewer and less field-specific operators in the control center. A well designed HMI system decreases that gap between the production process and operator through an intuitive visualization system, layers of detail to allow for a bird's eye view down to the minute details, as well as training material and documentation at the operators' fingertips.

The overall benefits to a well-designed HMI system are numerous and include increased safety, quality, quantity and economic efficiencies. HMI systems also minimize the risk of disruption in the production process, reduce overall downtime and allow for fewer operators to manage more information with less field-specific knowledge.

Introduction

HMI, also referred to as a user interface, operator panel or terminal, provides a means of controlling, monitoring, managing and/or visualizing device processes. An example is an operator panel which allows an industrial machine operator to interact with a machine in a graphical, visual way. With controls and read-outs graphically displayed on the screen, the operator can use either external buttons or the touch screen to control the machinery. Ranging from simple segmented displays to high-resolution LCD panels, HMIs can be located on the machine, in battery-operated, portable handheld devices, and also in centralized control rooms. They are used in machine and process control to connect the operator with the programmable logic controller (PLC) application systems which control the sensors, actuators and machines on the factory floor.

HMI system applications include:

- Industrial automation such as factory and production process automation
- Building automation including HVAC control, lighting temperatures (energy), elevator monitoring, crowd control (occupancy) and video security through video overlay
- Product advertising
- Vending machines
- Automotive and marine industrial clusters
- Household appliances

An industrial HMI system's usability is determined by its processing power, ability to render complex and reality-like screens, fast response time to user input and its flexibility to handle various levels of operator interactions. HMIs require dynamically changing graphics which, in turn, require a high-performance solution that can support high refresh rates with varying resolutions and displays. They also have to support multiple connectivity and communication protocols to communicate between the operator and numerous machines and control systems.

Texas Instruments (TI) offers a comprehensive range of HMI solutions with the right mix of performance and peripherals to meet the needs of each application category. In many cases, they are also optimized and tested to work together as well as scale up in performance and integration for decreased costs and time to market. The four market tiers in HMI systems are:

HMI Form Factor	Requirements
High end	• Up to WUXGA display • 2D/3D graphics • User interface application • Video playback • HTML5
Mid end	• Up to XGA display • 2D graphics • User interface application
Base	• Up to XGA display • Light-weight user interface
Entry	• Up to QVGA display • Simple user interface

With a wide range of HMI solutions, TI has product to fit every need.

Embedded Processing

TI's processing and control solutions offer a breadth of performance, key industrial peripherals, and robust software development kits to enable product family scalability, value through integration, and fast time to market. TI's Tiva™ ARM® Cortex®-M MCUs are perfect for the entry-level tier of the HMI market supporting up to WVGA displays, simple user interfaces and key industrial connectivity options. TI's scalable Sitara™ ARM Cortex-A series of processors are the best fit for the base, mid- and high-end markets with speeds ranging from 300 MHz to 1 GHz. The processor portfolio includes unique combinations of industrial interfaces, communication protocol capabilities and accelerators to drive down system cost and expand connectivity options.

Graphics and Video

For mid- to high-end HMI systems, the need for high-performance graphics increases to improve the intuitive and visual interfaces, simplify the operators' awareness of system status and improve decision-making capabilities when needed. Graphic hardware accelerators integrated in TI's Sitara™ ARM Cortex-A8-, A9- and A15-based SoCs (system on chips) support these optimized HMI systems through 2D/3D acceleration, alpha blending, picture in picture, chroma keying, images with texture, special effects, on screen display and layers of graphics and windows.

Software

TI supports a wide variety of operating systems, such as Linux®, Windows® CE and Android™, as well as multiple real-time operating systems like QNX®, Green Hills Integrity®, Wind River VXWorks®, and TI's SYS/BIOS. TI's Code Composer Studio™ integrated development environment can also be used for development and debug across most of the platforms.

Industrial Communications

Real-time communications is the heart of industrial automation. With a unique architecture of an integrated ARM core (or cores) and programmable Industrial Communication Subsystem (PRU-ICSS), TI supports many popular, certified serial and Ethernet-based protocols. The PRU-ICSS is comprised of dual 32-bit RISC proces- sors with no cache and single-cycle instructions to enable 100% deterministic acceleration of protocols such as PROFIBUS®, CANopen®, DeviceNET, EtherCAT®, EtherNet/IP™, PROFINET®, Modbus TCP/IP, Sercos® and POWERLINK. The PRU-ICSS provides HMI manufacturers the flexibility to support multiple in-dustrial communications protocols on one hardware platform without the need for external FPGAs and ASICs. The PRU-ICSS can be found on many TI embedded processors scaling in performance and integration to offer opportunities for design and software reuse.

Display

TI has the industry's widest range of products to generate Haptics effects – a feedback technology that takes advantage of a user's sense of touch – by driving motor-based and piezo-based actuators to deliver vibration and/or motion to the user interface. Haptics increases user confidence and decreases task completion time for HMI tasks. TI also offers resistive-touch screen controllers which are cost-effective, robust solutions for touch controls.

Power Management

TI provides power management units (PMU), specifically matched with corresponding processors as well as other solutions, to deliver power such as DC-DC controllers, Low Drop Out regulators (LDO), Power over Ethernet (PoE) devices, LCD bias (to deliver power to your display) and backlighting solutions such as white LED drivers.

Wired Connectivity

TI has solutions to enable wired connectivity by communication standards such as CAN, UART, USB, RS-232, RS-485 and 10-/100-Mbit Ethernet with integrated PHY. These interface options enable hooking up the system to a myriad of external peripherals and accessories, depending on the need of the end application.

Wireless Connectivity

TI offers solutions for Bluetooth®, ZigBee®, Sub-1 GHz and WLAN networks to enable portable HMI solutions. TI's broad portfolio provides more options for maximum flexibility in wireless design. TI's WiLink™ 8 solutions can provide high-performance Wi-Fi® and *Bluetooth*®/*Bluetooth*® low energy in one combo module, and TI's SimpleLink™ CC3000 module is an option for easy-to-integrate Wi-Fi. The Sub-1 GHz Performance Line delivers the most reliable range and best coexistence in the industry and the CC253x ZigBee system-on-chip (SoC) is the ideal SoC for high-performance ZigBee applications.
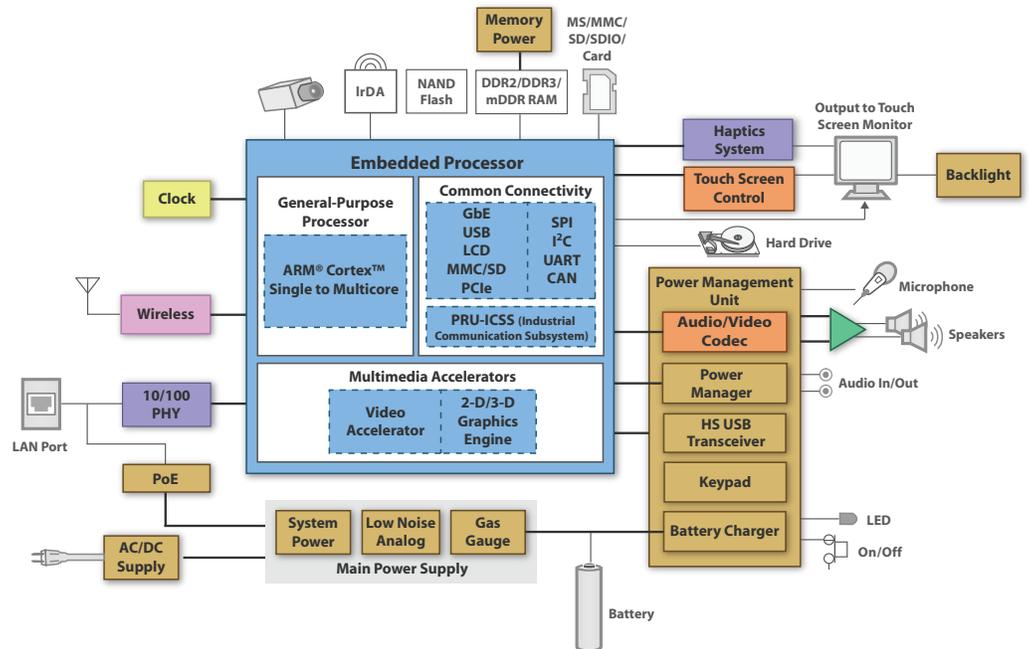
HMI system block diagram of mid to high end system

TI is committed to offering robust and optimized industrial solutions to support a wide range of industrial application needs, from sensors and I/Os, motor control, PLCs and advanced HMIs. By focusing on differentiating low power, integration, high performance and advanced graphics, TI can offer a wide range of devices designed to work together as well as provide a roadmap for compatibility and reuse. Moreover, with numerous evaluation and development platforms available across the TI portfolio of embedded processors for the industrial market, HMI manufacturers are given the tools to quickly move from concept to product and provide operators with the right tools for their job.

For more information on TI's HMI solutions, please visit **ti.com/automation**.

IMPORTANT NOTICE

Products		Applications	
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Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
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Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
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