Mobile HMI

PDAs with a wireless capability.

By Ramal Murali

Information beamed via infrared from PDA to controller.

Good decisions require timely and accurate information. In process control, the appropriate sensors provide critical information to automated control systems that perform the control functions. In the absence of adverse events, everything works as it should, and no human intervention is necessary.

Any enhancements in productivity require a better understanding of the process at hand, which can lead to the design and implementation of better monitoring and control strategies. In any process control situation, the human operator is the crucial element. The operator can be the strongest or weakest link in the chain, depending on the information at hand. Critical process information in your hand enables good decisions. Handheld personal digital assistants (PDAs) can serve as platforms with links to crucial information. Information links to the process under control may be wired (serial/Ethernet cable) or wireless (infrared, Wi-Fi, Bluetooth, or cellular). Wireless links untether the operator and enable "any time, any place" connectivity.

Portability and mobility are essential in applications involving configuration, data collection, monitoring, diagnostics, and troubleshooting. The Palm OS, Windows CE, and Pocket PC operating systems residing in PDAs beckon application developers to harness these platforms to provide a convenient, cost effective, and portable human-machine interface (HMI). Wired communication links are the norm with most controllers. Because most PDAs also have built-in infrared transceivers and readily support wireless radio frequency (RF) capability, untethered (electromagnetic) communication links to the controllers are possible wherever the controller communication interface can convert to a wireless medium.

HMI software in conjunction with a wireless link to relevant information helps human decision makers zero in on the critical subsystem that needs their attention so they can take action. You can gain remote access to critical information, which you can save for analysis later, over a cellular network or the Internet, and personnel can figure out what to do. The operator does not need to carry any cables, and can upload and download configurations and perform diagnostics using a PDA that fits in a shirt pocket.

The following are some of the underlying technology issues regarding PDA communications and some real-world HMI applications.

Mobility to the max

Approval of the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard for 2-megabits-per-second (Mbps) wireless local area network (WLAN) in 1997, and the subsequent 11-Mbps revision 802.11b in September 1999, made mobile HMI a reality. The recent 802.11g standard supports a 54-Mbps data rate and is backward compatible with the 802.11b standard. Wireless Ethernet Compatibility Alliance's issuance of the Wi-Fi (wireless fidelity) stamp of approval for interoperability for products from different vendors resulted in the availability of cost-effective WLAN products for wireless connectivity.

Because the IEEE 802.11 medium access control (MAC) layer can work seamlessly with the IEEE 802.3 standard Ethernet via a bridge or access point (AP), wireless and wired nodes on an enterprise local area network (LAN) can interoperate with each other. Wireless network interface cards get 48-bit MAC addresses, which look like Ethernet network interface cards. Rather than the collision detection (CSMA/CD) employed by 802.3 Ethernet, 802.11 wireless uses collision avoidance (CSMA/CA). To prevent collisions, 802.11 allows stations to use RTS/CTS "handshaking" to clear out an area for RF transmissions; in this case the system positively acknowledges communication frames.

Two or more wireless nodes may recognize each other and establish an ad hoc network with peer-to-peer communications over a given cell coverage area. The smallest possible 802.11 network is an independent basic service set. In most instances, such a basic network also contains an AP, and all communications between wireless stations—or

between a wireless station and a wired LAN node—go through the AP. The APs are not mobile and form part of the wired LAN infrastructure. Association is the process by which mobile wireless stations join an 802.11 network; a mobile station can associate with only one access point at a time. Each station must listen for other stations and begin transmission only if the channel is idle. If the channel is busy, each station waits until the channel is clear and then starts transmission after an additional interval of time (based on the random back off procedure).

IEEE 802.11 RF transmissions take place in the 2.4-gigahertz Industrial, Scientific, and Medical (ISM) band with worldwide allocation for unlicensed operation (U.S. 2.4000–2.4835 gigahertz). The 2.4-gigahertz ISM band in 802.11 may have one of three physical layers (PHY): frequency hopping (FH) PHY, direct sequence (DS) PHY, and high rate/direct sequence (HR/DS) PHY, 802.11b. The FH PHY is now obsolete (FH is used in Bluetooth). Three HR/DS networks can deploy in an area at once while ensuring sufficient channel separation.

The original 802.11 also provided for an infrared physical layer (IR PHY). The limited range of IR (3 feet to 10 feet) makes this medium not suitable for wireless networks. The IR ports implemented on laptop computers and controllers follow the Infrared Data Association standards.

Bluetooth technology also provides RF communications in the 2.45-gigahertz spectrum (using frequency hopping) with a range of about 30 feet. Serial adapters can provide Bluetooth capability for controllers that make another option available for wireless mobility for PDA-based HMI.

A user can scan bar codes and then transmit them via wireless RF communications to the PLC.

HMI via infrared

Through software, there is a portable IR link to configure and monitor data from temperature controllers with built-in IR transceivers. The operator does not need to carry any cables, and can upload and download configurations and perform diagnostics using a PDA. The efficiency and simplicity of being able to pre-create, save, and download controller configurations in multiple controllers saves valuable engineering time and guarantees a high return on investment.

Bluetooth to the rescue

There are PDAs on the market that have built-in Bluetooth radios. Because Bluetooth RF links have better range (30 to 100 feet omnidirectional compared to a 10-foot 30° cone for IR) the availability of cost-effective serial-to-Bluetooth converters and/or Bluetooth-equipped controllers may be a better technology alternative for a one-on-one controller communication link in the long run. IEEE 802.11b RF links have proven to be cost-effective communication links where omnidirectional RF links over larger distances (100 to 1000 feet and more) are required.

A large truck manufacturing company is interested in controlling the quality of the drives on their two-axle and three-axle 185–365 HP trucks on the dynamometer. The control system includes programming for four-axle testing capability and the selection of four wheelbase lengths. The operator drives the truck onto a platform lift and then lowers it onto four sets of rollers for testing. The HMI software serves as an operator station, so the operator can perform all tasks from the driver's seat. The test duration is twenty minutes. The integrated bar-code scanner on the unit scans the vehicle identification number and the operator identification, which activates the test procedure. The HMI software processes the scanned bar codes and uses the wireless RF (11-megabit 802.11b standard) capability built into the PDA to transmit the bar code to the programmable logic controller (PLC), which performs the test sequence. The wireless unit allows for operation of the motor lifts and test sequences from the cab of the truck. Test results come via HMI software on a Windows PC monitor positioned in front of the truck. The software provides this Windows-based HMI access to the crucial bar-code information wirelessly over an RF link. Testing includes brakes, flywheel horsepower, cruise control, parasitic losses, and transmission shifting, all initiated from the cab of the truck. After the tests wrap up, the user can print out the results. The operator then drives the truck off the test stand and starts the procedure over with the next new truck.

The HMI software makes it more convenient to initiate the different aspects of the test without leaving the driver's seat. In addition, avoiding cable and other wired connections to the new truck prevents damage

Essence of wireless networks is mobility

An extended basic service set may start up when we connect multiple access points with their associated basic service set (BSS) to a backbone Ethernet network. In an infrastructure BSS, the BSSID is the MAC address of the wireless interface in the access point (AP) creating the BSS. BSS transitions require cooperation between access points. The access points in the market use an interaccess point protocol (IAPP) to help in a seamless roaming of stations from one BSS to an adjacent BSS. IAPP (draft status IEEE 802.11f) is not a standard yet, and hence a single AP vendor may be required. IAPP allows wireless stations to move from one AP to another without interrupting link layer connectivity.

The backbone network linking multiple APs should form a single IP subnet. It is important to understand the difference between portability and true mobility. Portability ensures that users can connect to information wherever it is convenient. However, there is no maintenance of the network connection while the device is in transit between one location and another. Mobility ensures the network connection remains maintained while the station is in transit from one location to another. As long as a station stays on the same IP subnet, it does not need to reinitialize its networking stack and can keep its TCP connections open. Due to distribution overhead, the throughput expected in an 802.11 network is only about 50% of the nominal bit rate.

The Mobile IP Working group (Internet Engineering Task Force) has developed a plan to support IP nodes to seamlessly "roam" among IP subnetworks and media types. The difficulty is that delivery of frames to the mobile node's current location depends on the network number contained in the node's IP address, which changes with each point of connection. Mobile IP solves this problem by allowing the mobile node to use two addresses: a home address and a care-of address, which identify the mobile node's point of attachment. When the mobile node is away from its home address, the home unit gets all the frames and delivers them to the care-of address.

to the new truck body. The simplified testing procedure helps minimize errors, allows fault diagnosis, and provides corrective actions to ensure reliable testing. Efficient throughput in terms of number of vehicles tested occurs with minimal waste of time. Due to immediate feedback on the handheld, bar-code efficiencies are 100%. You can also eliminate human errors due to data entry and report test results promptly, thus ensuring the highest possible system efficiency.

Another case of HMI software involves off-loading ship cargo onto railroad cars where the operator moves from car to car while the PLC and the control room are several hundred feet away. It is not feasible to have a display monitor for operator feedback. A handheld PDA equipped with a compact flash (CF) RF adapter and HMI software gives immediate real-time wireless access from anywhere in the coverage area (800 feet by 200 feet) to the relevant PLC variables and enables remote monitoring and data entry. Mobile range of more than ¼ mile occurred with a dipole antenna mounted at the PLC end, while the PDA had an easily portable tiny CF adapter with built-in antenna.

Engine control

When it comes to a gas control, this application uses a Pocket PC with built-in Wi-Fi to communicate with the controller on the engine. A serial-to-Ethernet converter and an access point give the Modbus port RF capability to link with the Pocket PC. The user can monitor the 24 channel trends of interest on-screen using any selected group of channels. The screens consist of data fields, touch zones (with bitmaps to provide desired appearance), and screen navigation zones. Trend plots come together using the HMI software and deploy on the platform(s) of choice. The system captures the trends, and the user can review their history.

Controlling cranes

This application requires wireless coverage over an area covered by 22 trolleys and hoists used to transport new truck bodies from station to station. The user needs multiple access points to enable the roaming operator(s) with PDA-based HMI software to wirelessly access the programmable controllers mounted on the 22 trolleys. The operator will get alerts to any alarm conditions along any of the trolleys or hoists. The operator can selectively view any parameters of interest and initiate any control commands. This application exemplifies the fact that "the essence of wireless networking is mobility." A site survey is an important prerequisite in a wireless application of this complexity.

Wireless IR and RF technologies supported by low-cost PDA hardware and the availability of stand-alone HMI software for these platforms have made mobile HMI a reality. In addition, the emerging Bluetooth RF option and the plethora of newly released high-resolution PDAs have enhanced the functionality of mobile HMI. In addition, next-generation HMI technology that can deploy simultaneously on multiple platforms including Windows PCs, PDAs (Palm and Pocket PC handhelds), and Windows CE devices has arrived. W

Behind the byline

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