

Wireless PDAs provide an HMI wherever you need to control a process

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ortability and mobility are essential in many applications involving configuration, data collection, monitoring, diagnostics and troubleshooting. The Palm OS, Windows CE and Pocket PC operating systems residing on PDA (personal digital assistant) platforms from Palm, Compaq and others beckon application developers to harness these platforms to provide a convenient, cost-effective and pocketable HMI solution. Vendors such as Symbol, Intermec Technologies and Unitech provide PDAs that trade off compactness for features such as barcode scanning capability and ruggedized. Wired communication links are the norm with various controllers.

Since most PDAs have builtin infrared transceivers and readily support wireless RF capability, untethered electromagnetic communication links to the controllers are possible. In this article, we explain some of the underlying technology and market issues regarding PDA communications, and present some PDA-based HMI applications.

Dynamometer automation in quality assurance testing of new trucks

A large truck manufacturing company is interested in quality control of the drives on its 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 operation requires the operator to drive the truck onto a platform lift, then lower it onto four sets of rollers for testing.

Using InstantHMI software on the Symbol ruggedized PDA serving as an

operator station, the operator can perform all his tasks from the driver's seat in the cab of the truck. The operator uses the integrated barcode scanner on the handheld PDA to scan the VIN (vehicle ID), in addition to the operator ID, into the system. This allows activation of the

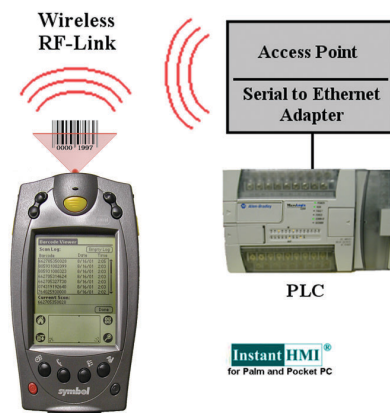


Figure 1 shows the Ruggedized Symbol PDA running Software Horizons' InstantHMI software (www.InstantHMI.com) used in the Dynamometer Automation applied to new truck Quality Assurance Testing. Barcodes are scanned and transmitted by wireless RF communications to the PLC.

test procedure. The HMI software on the PDA (Fig. 1) processes the scanned bar codes and uses the wireless RF (11 Mbit IEEE 802.11b standard) capability built into the Symbol PDA to transmit the barcode to the Allen Bradley PLC, which is programmed to perform the test sequence. The wireless unit allows operation of the motor lifts and test sequences all from the cab of the truck.

Test results are presented by HMI software on a Windows PC monitor positioned in front of the truck. InstantHMI provides this Windows-based HMI access to the crucial barcode information wirelessly over RF link. Testing includes brakes, flywheel horsepower, cruise control, parasitic losses, and transmission shifting all initiated from the cab of the truck. Upon completion of tests, the results are printed. The operator then drives the truck off the test stand and starts the procedure over with the next new truck. The test duration is approximately 20 minutes.

Benefits of mobile HMI in truck testing application

The PDA-based HMI enhances the convenience of initiating the different aspects of the test without leaving the driver's seat in the cab of the truck, and thus affords a hassle-free set up. In addition, avoiding cumbersome cable and other wired connections to the new truck prevents damage to the truck body and keeps it in mint condition. 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 is assured with minimal waste of time. Due to immediate feedback on the handheld, barcode efficiencies are 100%, human errors due to data entry are eliminated, and test results are reported promptly, thus ensuring the highest possible system efficiency.

Other wireless HMI applications

InstantHMI has been used in an application involving off loading of 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 (Fig.2) equipped with a Compact Flash RF adapter and InstantHMI software gives immediate real-time wireless access from anywhere in the coverage area (800'x 200') to the relevant PLC variables, and enables remote monitoring and data entry. Mobile range of more than 1/4 of a mile was accomplished with a di-pole antenna mounted at the PLC end while the PDA had an easily-portable tiny CF adapter with built in antenna.

The handheld HMI has provided a portable IR link to configure and monitor data from Watlow SD model temperature controllers with builtin IR transceivers. The operator does not need to carry any cables, and can upload and download configurations, perform diagnostics etc. using a Palm PDA that he or she can carry in his/her shirt pocket. The efficiency and simplicity of being able to pre-create, save, and download controller configurations in multiple controllers saves valuable engineering time and guarantees high return on investment.

Battle of PDAs: Palm vs Pocket PC

Traditionally, PDAs are used to keep track of schedules, contacts, calendars, etc. Palm and Pocket PCs handle contact management, calendar and to-do lists quite well. Pocket PCs integrate seamlessly with Office™ applications such as Word, Excel and Outlook, while Palm includes Documents-to-Go to provide this functionality.

Palm OS devices are lower in cost (\$199 for the m500 monochrome unit to

\$499 for the recent Tungsten T model) than the Pocket PCs (cost \$399 to \$600).

Palm m500, m505 and m515 are sleeker and lighter than the Pocket PCs, including the Toshiba e310—the thinnest and lightest Pocket PC currently on the market. The recent Palm Tungsten with its high-resolution color screen has an even smaller form factor than Palm m5xx, although it is slightly thicker.

Palm OS is optimized with minimal frills, while the Pocket PC operating sys-

popular, leading to a steady gain in market share. Various predictions indicate a phenomenal growth of PDA market, with approximately 40 - 65 million units being shipped by the year 2005. Some have predicted that Pocket PC devices will dominate the increasingly important enterprise market. Palm has seen its own market share slip recently, and this has been reflected in the abysmal Palm stock prices and a reverse stock split of 1 for 20 in October 2002. However, Palm released

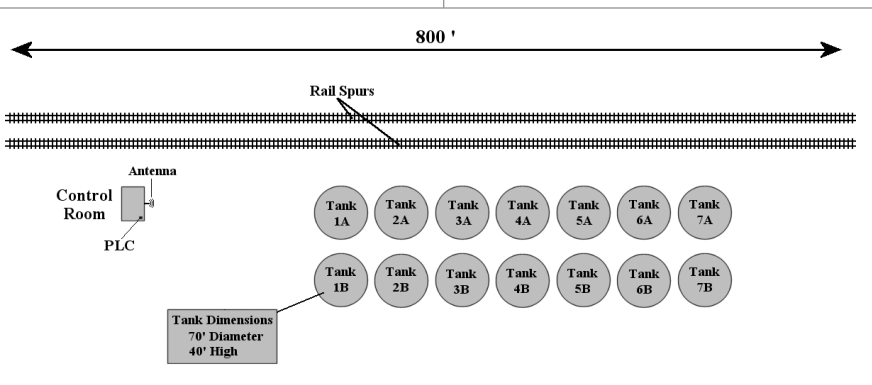


Figure 2 shows an example of IEEE 802.11b protocol in action. InstantHMI in Compaq Ipaq Pocket PC uses RF communication to monitor and/or modify data in Allen Bradley PLC remotely from anywhere in the antenna coverage area

tem, based on Windows CE, is resource hungry. Pocket PCs have rechargeable lithium batteries that last about 8 to 10 hours of use per charge. Palm PDAs can run 7 to 10 days per charge.

Both Palm and Pocket PC can connect to the Internet. Palm m705 and Tungsten W have builtin wireless Internet access. Pocket PC can use Compact Flash RF and Ethernet cards, which are cheaper than the adapters available for Palm. Palm's SD-expansion slot does not have many available accessories.

Until recently (October 2002), Pocket PC had a 4 to 1 advantage over Palm relative to screen resolution. Palm's recently released Tungsten has a resolution of 320x320 pixels, which exceeds the 1/4 VGA resolution of the Pocket PC by 33%. Sony's new Palm OS PDA supports 320 x 480 resolution, which is higher than that of Tungsten.

Palm's simplicity and low price earned it the lion's share of the PDA market. However, the new Pocket PCs such as Compaq's Ipaq have become very

the Tungsten models, which boast the best screen resolution on the market, surpassing the Compaq and other Pocket PC models' resolution by 33%. The PDA war is not over yet.

Wireless LAN technology overview

Approval of the IEEE 802.11 standard for 2 Mbps wireless LAN in 1997, and the subsequent 11 Mbps revision 802.11b in September 1999, have put the promise of truly mobile HMI within reach. The latest 802.11g standard supports 54 Mbps data rate and is backwards compatible with 802.11b standard.

Wireless Ethernet Compatibility Alliance's issuance of the WiFi (Wireless Fidelity) stamp of approval for interoperability for products from different vendors assures the availability of cost-effective WLAN products for wireless connectivity. Because the IEEE 802.11 Media Access Control layer can work seamlessly with the IEEE 802.3 standard Ethernet via a bridge or Access Point (AP), wire-

less and wired nodes on an enterprise LAN can interoperate.

Two or more wireless nodes may recognize each other and establish an ad-hoc network with peer-to-peer com-

Application 1	<---->	Application 2
Serial Port Emulation API	<---->	Serial Port Emulation API
IrCOMM	<---->	IrCOMM
TinyTP IAS	<---->	TinyTP IAS
IrLMP	<---->	IrLMP
IrLAP	<---->	IrLAP
IrDA Hardware	<---->	IrDA Hardware

Figure 3 illustrates the IrDA Protocol Stack used in IR communications. The physical communication link occurs at the Hardware layer.

munications over a given cell coverage area. In most instances, such a basic network 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. 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, then starts transmission after an additional interval of time (based on the random back off procedure).

IEEE 802.11 provides for two variations of the physical layer corresponding to two RF technologies: Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS). These RF transmissions take place in the 2.4 GHz ISM (Industrial, Scientific, and Medical) band with worldwide allocation for unlicensed operation (US 2.4000 - 2.4835 GHz). While both FHSS and DSSS support 1 and 2 Mbps operation, all 11 Mbps radios are DSSS only. The 2.4 GHz ISM band for DSSS system will accommodate up to three non-overlapping 20MHz-bandwidth channels.

The emerging Bluetooth technology (the newer Compaq Ipaq and Palm Tungsten T have builtin support for Bluetooth) also provides RF communications in the 2.45 GHz spectrum with a range of about 30 feet. Serial adapters can provide Bluetooth capability for controllers, which will make another option available for wireless mobility for PDA based HMI.

Where do RF and IR belong in the electromagnetic spectrum?

The most dramatic prediction of Maxwell's equations is the existence of electromagnetic waves that propagate through empty space at the speed of light (3.0×10^8 meters/sec). Light is itself such a wave. When electric and magnetic fields are time dependent they influence each other, and this coupling produces electromagnetic waves. What is special about light as an electromagnetic wave is that we humans can see (the colors of) this light wave—at least the visible spectrum with wavelengths in the range 0.38 - 0.72 microns (10^{-6} meters). Infrared light is invisible and has wavelengths in the range 0.72 - 1000 microns. Half of the sun's energy is IR radiation. Short wave infrared in the range 0.85 - 1.05 micron is used in IR communications with PDAs; these wave lengths correspond to the frequency spectrum 3.0×10^{14} Hz. Medium wave IR (2-4 microns) and long wave IR (4-1000 microns) are used in industrial heating.

Wired communications (with separate wires for transmit and receive) can transmit data in both directions simultaneously; however, IR communications can take place in only one direction at a time because the IR path in the air acts as a single wire link. This link (actually, a 30-degree cone with a range of 3' - 10' emanating from the transmitter to the receiver) is turned around at least every 500 msec under IrDA protocols.

Figure 3 illustrates the IrDA protocol stack used in IR communications. The physical communication link occurs at the hardware layer.

Application 1 hands over its data payload to the protocol layer beneath it

and thus ultimately passes it to the hardware link that transports the packet across the connecting medium (air in the case of IR). One may visualize a specific protocol layer for Application 1 to be logically accessing the corresponding protocol layer for Application 2 as indicated by the arrows.

Figure 4 shows an example of IrDA protocol in action. Application 1 (InstantHMI incorporating an infrared communication driver) running on a Palm PDA that is beamed at the IR transceiver of a Watlow SD controller running Application 2 (Watlow SD firmware incorporating a complementary infrared communication driver). The communi-



Figure 4 shows an example of IrDA protocol in action.

cation link is 'air' and the physical IrDA hardware layer in the PDA and SD.

Conclusion

Wireless IR and RF technologies supported by low-cost PDA hardware and the availability of HMI software for these platforms have made truly mobile HMI a reality. In addition, the emerging Bluetooth RF option and the newly released high-resolution Palm Tungsten hold great promise for mobile HMI.