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Project54: Standardizing Electronic Device Integration in Police Cruisers

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Technological advances have introduced many electronic devices into police cruisers. Today's police cruisers are equipped with not only lights and sirens but also digital radios, GPS units, computers, radars, and other devices. These in-car devices aren't usually designed with integration in mind. This design approach creates two problems. The first stems from the fact that police cruisers are primarily vehicles and the officers operating them are primarily drivers. Because in-car devices aren't designed for integration, most police departments install them in cruisers as stand-alone devices, each with its own user interface. Consequently, the officers operating the cruisers must deal with the distraction of interacting with multiple user interfaces in the hands- and eyes-busy environment of a car. Research shows that interacting with even a single in-car device can lead to safety problems.[1] Interacting with multiple in-car devices clearly poses a safety problem. This problem is likely to worsen as new devices are installed in cruisers.

The second problem is that exploiting potential synergies between individual devices is difficult. One way to exploit such synergies is to create an integrated system of in-car devices controlled by a single computer. Interestingly, most electronic devices designed for police cruisers can be connected to a computer relatively easily. Yet many manufacturers appear to still think of their devices as stand-alone even if they can be computer-controlled. Not concerned with integration, different manufacturers use different hardware and software interfaces to connect their devices to computers. Often, these interfaces are not freely available to third-party engineers. Even if the interfaces are available, every integration effort is unique and depends on the specific equipment a department uses. New efforts can't capitalize on the experiences of previous ones. Even worse, incremental changes to integrated systems will likely be complicated.

Project54 (www.project54.unh.edu), at the University of New Hampshire's Consolidated Advanced Technologies Laboratory (Catlab), is tackling these problems.[2] Our goal is to create integration standards for in-car electronic devices. From the viewpoint of the officer operating a cruiser, the project aims to create a system with a standard, safe user interface that allows hands- and eyes-free operation of in-car devices. From the viewpoint of the department that installs and maintains in-car devices, the project aims to create a modular, scalable system that's easy to install, modify, expand, inspect, and repair.

Project54 uses a two-pronged approach to integration. First, we've adopted publicly available hardware and software standards for including electronic devices into a computer-controlled integrated system. If devices conform to these standards, in-car systems can incorporate them without costly integration efforts. Second, we've created a standard speech-based user interface for the system, shared by all in-car devices. By creating a system with a single user interface, we expect to minimize user distraction. A speech interface lets users keep their hands on the wheel and their eyes on the road.

Editor's Perspective

One basic issue that intelligent vehicles must address is the availability of easy-to-use human-machine interfaces, particularly in these times when fully autonomous systems are unavailable. Supervised systems, in fact, require an interface in order for users to interact with them. This issue's article presents this problem from a slightly different viewpoint: the integration of many different devices on police cars triggers the need for human-machine interfaces as well.

If you have any comments on this department, feel free to contact me. I also seek contributions on the current status of ITS projects worldwide as well as on ideas on and trends in future transportation systems. Contact me at broggi@ce.unipr.it; www.ce.unipr.it/broggi.

—Alberto Broggi

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Hardware integration

To realize hardware integration, the Project54 system uses the *Intelligent Transportation System Data Bus*. The IDB standard prescribes both the hardware components and the protocol needed to accomplish control tasks and to exchange information between the car's systems.[3]

Most devices meant for police cruisers can't connect to the IDB; however, most have serial and/or parallel inputs and outputs. We developed the *Common IDB Interface*, an embedded device that can interface to electronic products serially or in parallel and can communicate with the IDB. Through the CIDBI, the Project54 system can translate messages from the IDB, send them to a connected device, and put responses from that device on the IDB.

Figure 1 outlines the Project54 system's hardware devices. At the system's center is the embedded PC. The figure's bottom part shows the devices that connect to the PC through the IDB: the lights and siren, the radar, the radio, the video recorder, the GPS unit, the bar code scanner, and the push-to-talk button (used to signal that the system should perform speech recognition). The CIDBI connects all these devices to the IDB. The figure's top part shows devices that connect directly to the PC: the system disk, the keyboard and mouse, the microphone and speakers, the LCD touch screen, and the wireless-network card. The card provides 802.11 connectivity and allows wireless connection to a handheld computer.

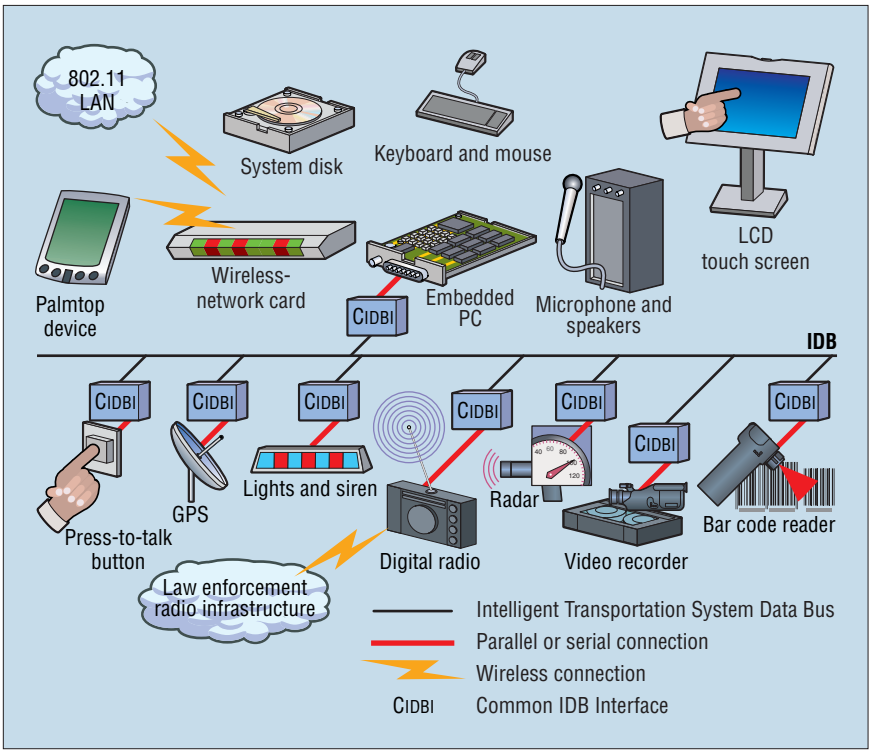

Figure 1. Hardware devices for the Project54 system.

Software integration and user interface integration

Figure 2 shows the high-level block diagram of the Project54 system's software architecture. The software, which runs on the embedded PC under Windows 2000, comprises applications and system-wide support components. The applications (Applications 1 through *n* in the figure) usually control one or more electronic devices. They may also provide a functionality that isn't related to controlling a particular device—for example, one application in our system provides access to IP-based networks.

The support components provide communication, registry, network, logging, and user interface support for the applications. Communication support allows one-to-one connectivity between the applications. This lets the system exploit synergies between the devices controlled by the applications. It also lets a single application provide a service, such as access to IP-based networks, to the entire system. Registry support allows access to the Windows Registry to applications and other support components.

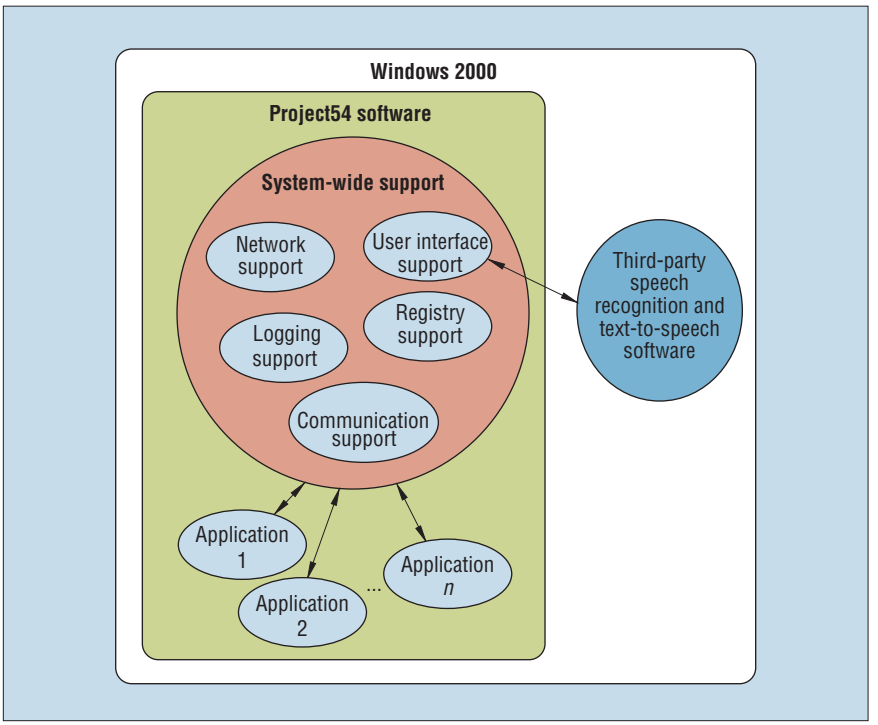

Figure 2. Project54 system software.

Figure 3. Project54 system hardware installed in a New Hampshire State Police cruiser.

By storing system settings in the registry, we can avoid hard-coding them. Network support provides access to the physical network connecting the electronic devices to the PC. Applications use the network support component to interact with electronic devices. By simply modifying this component, we can support new physical networks without recompiling the applications. Logging support provides a centralized way for all the system's parts to log events and errors.

User interface support allows the creation of an integrated user interface. This support lets applications implement graphical and speech user interfaces using input and output hardware as well as third-party speech recognition and text-to-speech engines. The individual GUIs have the same look and feel and can be speech enabled. So, from the user's viewpoint, the system has a single speech-enabled user interface.

The system software has an open architecture. New applications can be added to the system as long as they conform to the interapplication communication standard, which is freely available from Catlab.[4]

Results

Figure 3 shows the Project54 system hardware installed in a New Hampshire State Police (NHSP) cruiser. The center console contains the embedded computer, the radio, the radar, and miscellaneous electronics. The system includes an LCD touch screen, which can serve as a second I/O modality if the speech interface is unavailable. The system also includes a keyboard, a directional microphone on the visor, and the push-to-talk button on the steering wheel. Officers can use the keyboard to perform tasks while the cruiser is parked. The directional microphone reduces the influence of sounds that don't come from the driver, thereby improving the speech recognition engine's performance.

Officers can operate all in-car electronic devices by issuing voice commands to the system. To do this, the officer presses the push-to-talk button and utters a predefined phrase. For example, the officer can say "strobes" to turn the strobe lights on and "strobes off" to turn them off.

Control of the police VHF radio provides a good example of how the system simplifies operations in the police cruiser. The VHF radio has 256 different channels, organized in 16 zones with 16 channels per zone. The radio's standard manual control has "zone up," "zone down," "channel up," and "channel down" buttons and a display window showing a two-character zone indicator and a six-character abbreviation of the channel name. To switch to a specific channel, the officer must push the zone button repeatedly to find the correct zone and then push the channel button repeatedly to find the correct channel, all while trying to watch the current channel name in the small display window. With the Project54 system, the officer can say "headquarters" to switch to the state police headquarters channel, "Exeter" to switch to the channel used by the local police in Exeter, New Hampshire, and so forth. The officer also receives voice confirmation of the channel selected.

We successfully tested the Project54 system in NHSP cruisers. Over a period of approximately two years between January 2001 and spring 2003, the NHSP issued cruisers equipped with the Project54 system to six police officers. The officers used the system in their everyday work and provided feedback to us about system operation. They provided feedback in person when they visited our on-campus facility for upgrades or repairs and through frequent telephone conversations and emails. This long-term test produced excellent results. Throughout the testing period, the system hardware operated reliably (except for several initial glitches). The system software proved to be robust and, to the best of our knowledge, bug-free.

We are deploying the system in NHSP cruisers. We expect to install the system in 75 cruisers by the end of 2003. Over the next year or two, the NHSP plans to install the system in about 300 cruisers. We are also installing the system in cruisers of local law enforcement agencies in New Hampshire.

We plan to improve the system by introducing an in-car expert assistant module. The expert assistant will handle the interaction between the police officer and the system in a somewhat human-like fashion. Speech will continue to be the primary modality of interaction. The expert assistant will present information to the officer on the basis of predefined priorities. It will also let the officer, as well as the system, interrupt current tasks and start performing new tasks. We are also working on implementing the Project54 system software using distributed components. This approach will facilitate incorporating handheld computers into the system. ■

Acknowledgments

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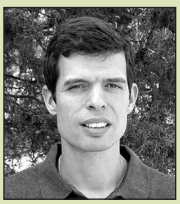

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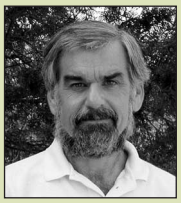

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