A prototype remote access and mobile data transaction system for police cruisers

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Abstract – Project54 is an effort to integrate embedded and wireless mobile technologies into the police cruisers of the New Hampshire State Police. While performing their job, police officers often find themselves outside of their cruisers. A prototype system, called the Remote Access and Mobile Data Transaction System, which provides remote accessibility to some of the functionality and the data available within the in-car Project54 system, was designed and implemented using a palm-sized computer, a two-dimensional barcode scan engine, and wireless communication modules. The system was integrated into the Project54 system using the Intelligent Transportation System Data Bus (IDB) and the IDB controllers developed by Project54. The system was successfully tested in laboratory conditions.

I. INTRODUCTION

The Consolidated Advanced Technologies for Law Enforcement Program (Project54) is an effort to integrate embedded and wireless mobile technologies into police cruisers. As a result of Project54 efforts, a prototype in-car system was designed and implemented [1, 2]. The system integrates general purpose computing facilities, voice and data radio communications, and special purpose devices such as radar, lights and siren, video units, fingerprint sensors, and GPS units. The system provides access to both local and remote data in support of typical public-safety applications such as license and registration checks, criminal records checks, fingerprint checks, computer aided dispatch, vehicle navigation, reports/forms entry, and so forth.

While performing their job, police officers often find themselves outside of their cruisers. Outside the cruiser, the officers' safety and efficiency would be improved if they had access to the functions available in the cruiser, such as records checks, lights and siren controls, etc. This paper introduces the design and implementation of a prototype system that provides remote accessibility to some of the functionality and the data available within the in-car Project54 system. The system was named the Remote Access and Mobile Data Transaction System [3].

The design of the Remote Access and Mobile Data Transaction System was based on the following ideas:

- The system should be based on a handheld computer, which would allow the police officer to connect to the Project54 in-car embedded PC using a wireless connection.
- Many states, including New Hampshire, have drivers' licenses that include operator information in barcode as well as text format. To take advantage of the bar-coded data the system should be equipped with a barcode reader.
- In order to demonstrate the functionality of the new system its software should be integrated into the existing software architecture of the Project54 system.

II. BACKGROUND

An important research effort, which may be considered as the starting point of indoor wireless network interfaces for mobile computing, is the PARCTab project [4, 5]. PARCTab is a ubiquitous computing experiment developed at Xerox's Palo Research Center (PARC) between 1988 and 1994. The work concentrated on a Palm-sized computer, called PARCTab, and its integration to a LAN. The PARCTab device is low-powered and runs on a simple operating system. The devices are connected to PARCTab transceivers over infrared links. In other recent research, the Wireless Services Access Platform (WISAP) project [6, 7] and the experimental prototype system called BlueSky, aim at providing a low-cost, low-power, indoor Radio Frequency (RF) wireless networking solution for handheld devices. The proposed solution consists of two

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components: a BlueSky wireless attachment that plugs into any palmtop device, and a LAN access point that acts as a layer 2/3 bridge between the wireless and the wired parts of the network.

Another important research effort is the Pittsburgh Pebbles Personal Digital Assistants (PDA) Project ongoing at Carnegie Mellon University since 1998 [8]. The Pebbles project is exploring how PDAs can be used when they are communicating with a personal computer (PC), with other PDAs, and with computerized devices such as telephones, radios, microwave ovens and factory equipment [9, 10, 11]. The key idea of the research is that the handheld computers can be used both as output devices and as input devices to control the activities of the other computers.

III. SYSTEM HARDWARE

A prototype system, which provides remote accessibility to some of the functionality and data available within the in-car Project54 system, was designed and implemented. The system, called the Remote Access and Mobile Data Transaction System, is outlined in Figure 1. The design uses a Handspring Visor palm-sized computer. This computer is intended to be used by a police officer outside the cruiser to access in-car data and functions of the Project54 system. This access is accomplished by setting up a communications link between the Visor and the in-car embedded PC, which is at the center of the in-car Project54 system. The Visor is connected to an off-the-shelf wireless communication module (RadioModem), which acts as a wireless modem. The main function of this module is to replace the RS232 cable for serial communications and maintain a transparent RS232 link. The link has transmission speeds of up to 14400 bps and can cover 300 meters in open environments.

The Project54 system accomplishes hardware integration by using the Intelligent Transportation System Data Bus (IDB). All devices in the cruiser are connected to the IDB [12]. Most devices meant for police cruisers are not able to connect to the IDB, however most of them have serial and/or parallel inputs and outputs. Project54 developed an embedded device that can interface to electronic products in a serial and parallel fashion, and can communicate with the IDB. Using this device, messages from the IDB can be translated and sent to a connected device, and responses from that device can be put on the IDB. As shown in Figure 1 the RadioModem device connects to an IDB control box which translates the modem's serial output and puts it on the IDB. Another IDB control box reads the IDB and relays the serial information to a PC computer.

In order to allow easy data entry when accessing in-car data, the Visor controls a Symbol Technologies SE2223 two-dimensional barcode scan engine. This device allows the scanning of two-dimensional bar codes. Many states include such bar codes on driver licenses as an additional means of encoding driver information.

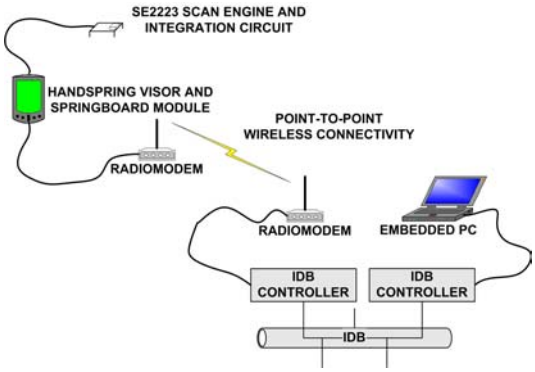

Figure 1 Prototype system outline

The Visor handheld computer provides a single serial port. This port was used to connect the Visor to the wireless modem. However, there was a need for a second serial port because the barcode scan engine provided serial data. The second serial port was implemented using an off-the-shelf Springboard module. Springboard module is the generic name for Visor extension modules. This system used a Springboard module which implements a serial port. In addition to this module the system also implemented a custom integration circuit which was used to control the operation of the scan engine.

IV. SYSTEM SOFTWARE

The system software has two major parts: the Visor Project54 Remote Access Application Software and the Embedded PC Remote Access Test Application Software. The block diagram in Figure 2 illustrates the system software.

The Visor application software provides a user interface, controls the Scan Engine's data output and communicates with the Embedded PC.

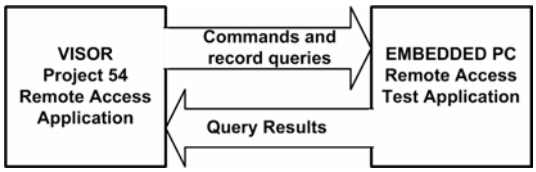

Figure 2 The system software

The Embedded PC application software provides a user interface, displays the text messages received from the Visor application software and communicates with the Visor.

A. Visor application software

A simple, user friendly, easy to upgrade, modular software application was created for the Visor. This application provides a user interface, controls the scan engine's data output by using the Springboard Module's serial port, and communicates with the embedded PC through the built-in serial port of the Visor.

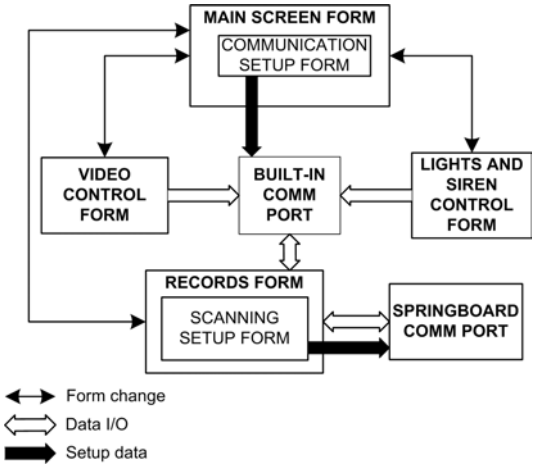

Figure 3 The high-level block diagram of the Visor application

The high-level block diagram of the Visor Project54 Remote Access Application is shown in Figure 3. The main modules of the application are:

- Main Screen Form
- Lights and Siren Control Form
- Video Control Form
- Records Remote Access Form

As an example of how the forms operate the screen view of the Lights and Siren Control Form is illustrated in Figure 4.

The Main Screen Form becomes an active form as soon as the application starts. The form contains the control buttons (Lights, Video and Records) to switch to other forms, and text fields showing the current date and time. It also allows the setup of the built-in communication port.

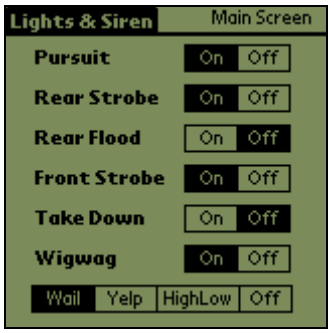

Figure 4 The screen view of Lights and Siren Control Form

The Lights and Siren Control Form enables the user to send command text messages for the Lights and Siren functionality of the Project54 system. The user can switch to the "Main Screen Form" by tapping on the top right corner. The button positions are saved when closing the form. The Lights and Siren Control Form is illustrated in Figure 4.

Another control form, the Video Control Form (Figure 5) is also activated from the Main Screen Form. It sends command text messages using the built-in port communications functions whenever the user presses control buttons on the form (such as Play, Stop, etc.).

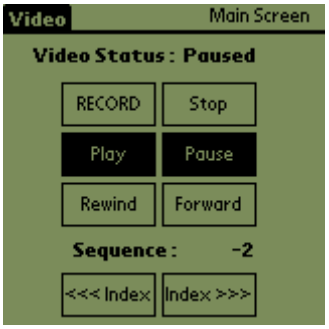

Figure 5 Video control form

Finally, the Records Remote Access Form is shown in Figure 6. The form does not contain any control buttons as shown in the figure. However, the default built-in buttons (*Date Book*, *Address*, and *To Do List*) are used to interface with the form features:

- The *Date Book* button is programmed to start serial communications via the Springboard Diagnostics Reference Module for receiving the decoded barcode data sent by the Scan Engine.

This requires interfacing with the Scan Engine Integration Circuit using the Springboard module's serial port.

- The *Address* button is programmed to start serial communications via the built-in port for sending the license number information for records query and receiving the query results sent by the Embedded PC Remote Access Test Application.
- The *To Do List* button is programmed to clean and reset the text fields.

Figure 6 Records Remote Access Form

B. Embedded PC application software

Another software application, which runs on the embedded PC, was also implemented. This application is called the Embedded PC Remote Access Test Application. The application was created for the embedded PC using the existing Project54 software architecture [2].

The Embedded PC Remote Access Test Application was designed to demonstrate and test the mobile data transaction between the Remote Access Unit (the Visor and the Scan Engine) and the Embedded PC via the communications modules. Therefore, the application has the ability to receive command and query text messages (such as messages to turn the lights on or Motor Vehicle record query messages) sent by the Remote Access Unit, display them and send a default query response text to the Remote Access Unit. The current version of the Embedded PC application does not communicate with the other applications in the Project54 system in order to control electronic devices when it receives commands from the Remote Access Unit. However, the Embedded PC application is created using the same software architecture and procedures as the other applications in Project54 system and it can be easily modified to fulfill the device control requirements.

Figure 7 shows the application window of the Remote Access Test Application running in the Project54 environment. Like in all Project54 application windows there are columns of virtual buttons on the left side of the window. The three implemented buttons allow return to the *Main Screen* of Project54, *Send*ing data to the Visor, and *Clear*ing the text fields. There are four status buttons in the window. One is used to signal an existing connection with the Visor (this is the button to the right of the top text field). The other three indicate the type of the received text strings. Currently the application can recognize commands related to the lights and the video unit of the cruiser, and record queries. The window also contains three text fields. The top field shows the command received from the handheld unit. This command can be related to either the lights or the video unit. If the text string received from the Visor is a query its text will show up in the middle text field, and the response to be sent to the Visor will be in the bottom field (this is the case shown in Figure 7).

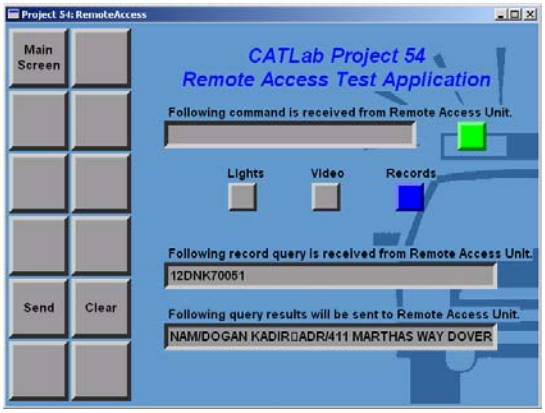

Figure 7 Remote Access Test Application window in the Project54 environment

V. CONCLUSION

A prototype system that provides remote accessibility to the data and some of the functionality available within the in-car Project54 system was implemented. The system is called the Remote Access and Mobile Data Transaction System.

The hardware components of the designed system include:

- palm-sized computer;
- Springboard module implementing an additional serial port for the Visor;
- Barcode scan engine and an integration circuit;

- Wireless communication module (the RadioModem) and IDB setup.

A simple, user friendly, easy to upgrade, modular software application, which provides reliable communications features, was also implemented for the palm-sized computer. The Visor application software provides a user interface, controls the scan engine's data output by using the Springboard module's serial port, and communicates with the embedded PC through the built-in port of the Visor.

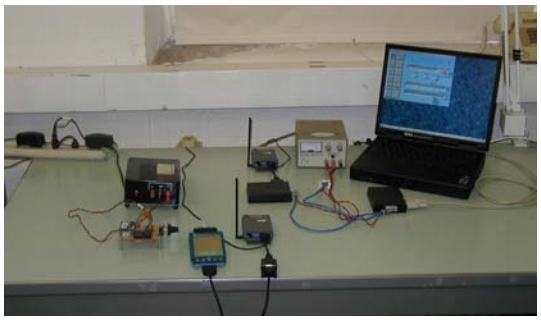

Figure 8 Implementation of the Remote Access and Mobile Data Transaction system

Another software application, which runs on the embedded PC and has features to test and demonstrate the functionality of the Remote Access and Mobile Data Transaction system, was also implemented. The application is called the Remote Access Test Application. It was created for the embedded PC using the existing Project54 software architecture. This application software provides a user interface, displays the text messages received from the Visor application software, and communicates with the Visor.

The Remote Access and Mobile Data Transaction system was successfully implemented and tested in laboratory conditions (Figure 8). We are currently working on creating a prototype system which will be tested in police cruisers. This will require creating a wireless link using smaller form factor wireless communications devices.

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