PDA-based system for monitoring electromagnetic signals

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Abstract

The development of a mobile system for receiving, storing, and displaying electromagnetic-signals (EM) at specific frequencies using mobile devices and wireless networks, is of extreme interest, especially when the final means of display is a PDA, a very light and compact handheld device. In the present study, an application is developed for remote monitoring of EM-signals preceding seismic events. The particular advantages and challenges faced when developing such application are explained and future work in this area is presented.

Keywords

PDAs, Electromagnetic Signals, Wireless Networks.

1. Introduction

During the past few years, the increased use of mobile devices, Personal Digital Assistants (PDAs), and wireless devices in general, have changed the way we perceive things around us and have induced a radical impact on our working environment. Currently, the small size and weight of PDA devices provide tremendous convenience and portability. Furthermore, with the rapid evolution of electronic technology, PDAs are now capable of accomplishing more challenging tasks. In addition, modern PDAs are also capable of connecting to both wired and wireless networks and fully exploit their potentials.

Second generation mobile telephone networks are widely spread and available all over the world. The introduction of General Packet Radio Service (GPRS) offers access to enhanced data transfer speeds (up to 171Kbps)[1]. With the deployment of third-generation mobile technologies, such as Universal Mobile Telecommunications System (UMTS), data transfer speeds increased even more: up to 2Mbps in stable position, 384 Kbps in traveling speeds[2].

On the other hand, Wireless Local Area Networks (WLANs) are currently being used in a wide area of applications. The reasons behind the vast popularity of WLAN-related applications are mostly associated with increased portability, as opposed to wired LANs. Today, WLANs offer satisfying transmission data rates over a wide cover range. Furthermore, they are resistant to external interferences, caused by other wireless devices in close vicinity (they are spreading their signal over a given frequency band), while security in data transmission is satisfactory[3].

The aim of the present study is to develop a mobile wireless system to be used for monitoring electromagnetic signals, employing WLANs and PDAs technologies. The uses of such system are becoming apparent (especially to a region of intense seismic activity such as Greece and its surrounding areas), as expert advice and data monitoring should be available to scientists as soon as possible, irrespective of their location.

2. Material and methods

The hardware platform chosen for the final prototype of this study was the HP iPaq rx3715. The device features a 400 MHz Samsung S3C2440 Processor (ARM compatible), 64 MB SDRAM, 128 MB Flash ROM, a Secure Digital Card expansion slot for optionally adding extended memory capabilities and a 3.8" / 89-millimetre diagonal 240x320 16-bit color TFT display with backlight. It also offers WiFi connectivity through its integrated IEEE 802.11b compliant wireless network card as well as Bluetooth connectivity. The operating system of the device is the Windows Mobile 2003 SE. The overall cost of the system is about 500 Euros.

The software packages used for developing the final application include: Microsoft Embedded Visual C++ version 4.0 (Software Development Environment and Compiler) and Microsoft Windows SDK for Pocket PC 2003. The application was developed on a typical desktop PC (Intel Pentium 4 / 2.8GHz with 1GB RAM) running Microsoft Windows 2000[4].

Taking full advantage of the PDA’s wireless networking card, the developed application can be connected to the FTP server of the Institute of Geodynamics of the National Observatory of Athens (NOAIG) and receive, store, and display EM-signals from a secure FTP folder [Fig. 1].

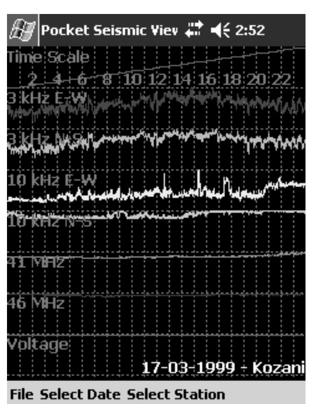

Figure 1 – The EM-signal monitoring application

The EM-signals are gathered from 15 field-stations spread around the Greek territory via an established telemetric network[5][6]. At each field-station, electromagnetic variations at low (3 KHz and 10 KHz with E-W and N-S polarization) and at high frequencies (41 MHz and 46 MHz) are constantly recorded with a sampling rate of 1 sample per minute. Each sample corresponds to the average of the EM-signal level at the recording frequency, for one minute period [Fig. 2].

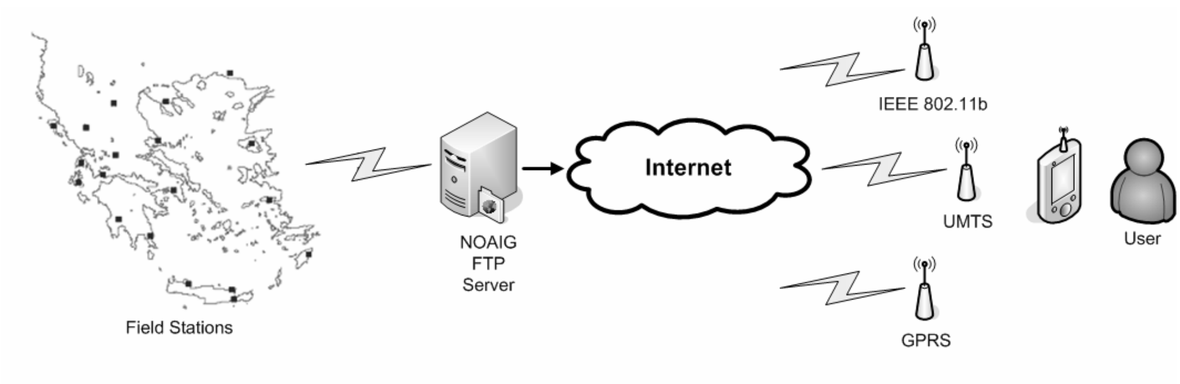

Fig. 2 – System's architecture

The user can select to display signals of the four receiver frequencies simultaneously, from any one of the 15 field-stations, and for a particular day for which data are available on the server [Fig. 3].

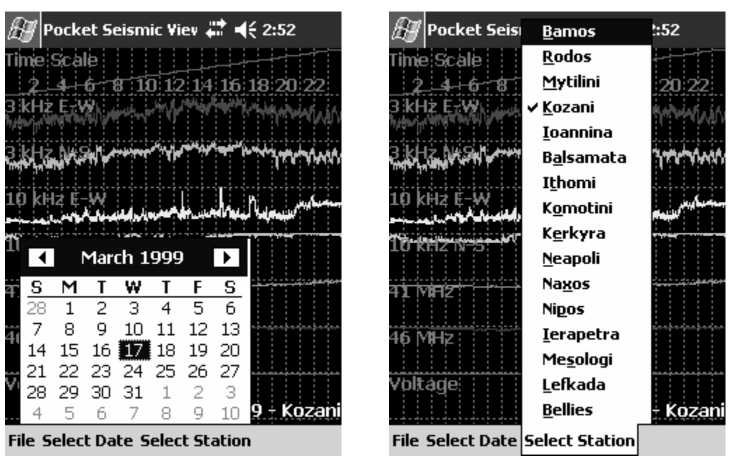

Figure 3 – Date and field-station selection menu

3. Results and discussion

The developed application was designed to run on the application layer of the TCP/IP protocol suite[7]. As a result, it can cooperate with any IP-based network protocol such as GPRS and

UMTS, as long as there is a compatible network card installed on the PDA, or internal support of such networks by the PDA. Moreover, the application is functional even when the underlying connection protocol changes on-the-fly (from WiFi to GPRS/UMTS and vice-versa). This permits the physicist to either use WLAN connection when he/she is around an area with WiFi support (close to the research center, at any hot-spot around the city, etc), or be truly mobile with GPRS/UMTS connection when he/she is outside the coverage of any WLAN. This property renders the system truly mobile, delivering to the user access to the EM-signals from practically anywhere. However, despite the fact that the system can collaborate with any IP-based network, initial tests were done using just the IEEE 802.11b environment: the Access Point (AP) providing the wireless link was attached to a gateway that allowed for hi-speed Internet connection and from then onwards to the ftp server of NOAIG.

It takes about two seconds transmission time for one day's EM-signals and for the four receiver frequencies (129 KB), employing the IEEE 802.11b protocol, including the servers' overhead and the general network additions.

Networks engineers put the system several times in the test and its behavior was stable and predictable. It was also evaluated by an expert physicist (C.N.) and was deemed easy to use, with results and handling comparable to a similar desktop application.

The security of the EM-signals was ensured with the employment of special remote access technologies, such as Wired Equivalent Privacy (WEP), Service Set Identifier (SSID) and FTP server logon (user name/password).

The system was also tested in a newer PDA/mobile phone device (Qtek 9000) that had higher specifications (520MHz, 32 bit CPU, 2GB of external memory, 640x480 TFT screen, keyboards) while having internal support for both GPRS and 3G network connections.

Regarding future work, implementation of signal processing and analysis algorithms is under investigation. One of the most serious drawbacks of this undertaking is the limited processing capability of PDA devices. The solution to this limitation could come from the exploitation of teleprocessing systems, where the mobile device would assign computationally demanding tasks to a network of processing nodes.

4. Conclusion

Employing state-of-art technology, a PDA-based system was designed and proved plausible for application in the analysis of electromagnetic signals. This minimises the time required for initial expert consultation, as the physicist in charge can now have access to critical data while being geographically independent from the data source.

As the number of hot-spots around urban and semi-urban areas increase (especially with the introduction of WiMax), it will be increasingly easier to use these kinds of applications by connecting to high speed wireless networks, while at the same time minimising the cost of communication.

5. Acknowledgements

This work and its dissemination efforts have been funded by the research program "Arximidis I" of Greek Ministry of Education.

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