

Smartphone-based system for monitoring electromagnetic signals

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Abstract: - The development of a remote system for receiving, storing, and displaying electromagnetic-signals (EM) at specific frequencies using 2nd generation mobile devices with enhanced network services, is of extreme interest, especially when the final means of display is a smartphone, a very light and compact handheld device. In the following paper the development of applications, that are responsible for remote monitoring EM signals preceding seismic events, is investigated.

Key-Words: - Smartphones, Electromagnetic Signals, GPRS, Wireless Networks.

1 Introduction

Modern wireless technologies have enabled mobile users to communicate using voice, still images and text messages. However, current advances in electronics and microprocessor technologies are more than adequate for computational-demanding tasks and real time wireless connections with local and wide area networks.

Second generation mobile telephone networks are widely spread and available throughout the world. The introduction of GPRS (General Packet Radio Service) in this wireless environment offers access to improved data transfer speeds (up to 171Kbps [1]). These transfer speeds are expected to increase even more with the acceptance of third-generation mobile technologies.

On the other hand, Wireless Local Area Networks (WLANs) are currently being used in a wide area of applications. They offer satisfying transmission data rates over a wide cover range. Furthermore, it is resistant to external interferences caused by other wireless devices in close vicinity,

while security in data transmission is satisfactory [2]. The protocol that fulfills all the above statements and was used in the present study is the IEEE 802.11b.

2 Problem Formulation

The hardware chosen for the present study was the Motorola MPx220 that features a Texas Instruments 200 MHz processor, 32 MB RAM, 64 MB ROM, a Secure Digital Card expansion slot for optionally adding extended memory capabilities and a 176 x 220 16-bit color TFT display with backlight. The operating system is the Windows Mobile for Smartphones 2003 Second Edition [3].

The software packages used for developing the final application include:

- Microsoft Embedded Visual C++ version 4.0 (Software Development Environment and Compiler).
- Microsoft Windows SDK for Smartphone 2003.

The smartphone device selected had built in support for General Packet Radio Service. For the connection of the device with the existing WLAN an IEEE 802.11b compliant secure digital card was used.

The application was exclusively designed and implemented for “Windows Mobile for Smartphones 2003 Second Edition” operating system. Any device that hosts the particular operating system is capable of running the application.

The application was developed on a typical desktop PC (Intel Pentium 4 / 1.8GHz with 512MB RAM) running Microsoft Windows 2000.

Taking full advantage of the wireless networking services, the smartphone application developed can connect 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].



Fig.1 The EM-signal monitoring application

The EM- signals are from 9 field stations scattered around the Greek territory via an established telemetric network [4] [5]. At each field-station, electromagnetic variations at low (3 KHz and 10 KHz) and high frequencies (41 MHz and 46 MHz) are continuously 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.

The user can select to display signals of the 4 receiver frequencies simultaneously, from any one of the 9 field-stations [Fig.2], and for a particular day for which data are available on the server [Fig.3].



Fig.2 Field-station selection menu

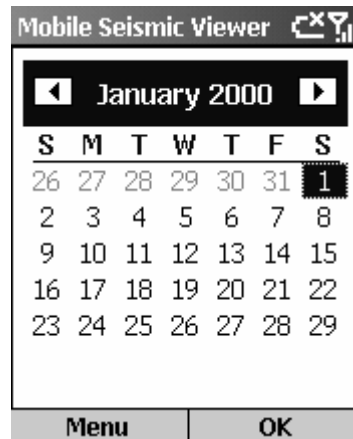


Fig.2 Date selection menu

3 Problem Solution

Modern smartphone handheld devices, combined with wireless networking technology, advanced operating systems and sophisticated image processing techniques, can be used for building a system for monitoring electromagnetic signals preceding seismic events.

The user interface of the whole application was designed and implemented in a simple, elegant way in accordance to the operating environment of the smartphone itself [Fig.4].

The transmission times for one days' EM-signals and for the 4 receiver frequencies (129 KB) were around 2 and 10 seconds for IEEE 802.11b and GPRS respectively including the servers' overhead and the network condition.

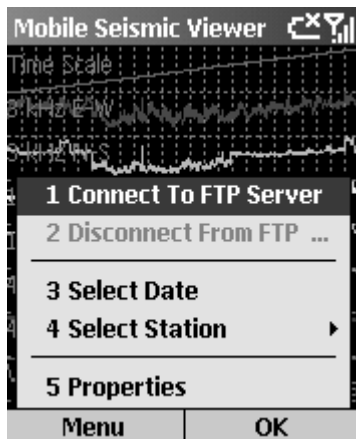


Fig.4 The user interface of the application

An expert physicist (C.N.) assessed the smartphone application useful, easy to handle, and comparable to a similar desktop application.

The new generation of wireless network technologies, such as EDGE (Enhanced Data for Global Evolution) [6], operating at 384Kbps, instead of GPRS, operating at 171Kbps, can increase the data transfer speeds and client module capabilities. The security of the EM-signals when using GSM technology is supported by (a) relying in the internal security of the GSM system [7], (b) full logon procedures for remote file access via standard FTP and (c) by optionally deploying a secure FTP server (SFTP) for maximum security during data transfers. For even higher security, modern protocols like IPSec ensure data integrity and access control at the network layer.

In case of using the IEEE 802.11b standard, the use of new generation wireless network technologies, such as IEEE 802.11g (55Mbps) can further improve the transfer speed and client capacities. The security of the EM-signals is ensured with the employment of special remote access technologies, such as (a) Wired Equivalent Privacy (WEP), (b) Service Set Identifier (SSID) [2] and (c) FTP server logon (user name/password). For advanced security requirements, specialized data encryption protocols, such as IPSec or SSL (Secure Socket Layer) [8], can be integrated on both the server and the client side.

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 smartphone devices. The solution to this limitation could derive from the exploitation of teleprocessing systems, where the mobile device would assign computationally demanding tasks to a network of processing units.

4 Conclusion

Employing state-of-art technology, a Smartphone-based system was designed and proved plausible for application in the analysis of electromagnetic signals.

The educational perspectives of this project for the students are: a) learning the way how smart phone-base system is working. b) Be familiar with the full advantage of the wireless networking services c) be familiar with the telemetry problems.

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