MOBILE TECHNOLOGIES FOR MODELING URBAN SPACE ALLOCATION IN REAL TIME

Dr. G. Szabó [a, *], Dr. A. Czinkóczky [a]

[a] Dept. of Photogrammetry and Remote Sensing at Budapest University of Technology and Economics, Hungary , 1111.Budapest, Műegyetem rkp. 7-11,
gyszabo@eik.bme.hu

[b] Dept. of Garden and Open Space Design at Faculty of Landscape Architecture, Corvinus University, 1118. Budapest, Villányi út 29-43. Budapest, Hungary
anna.czinkoczky@uni-corvinus.hu

KEY WORDS: monitoring, automated data collection, radio-frequency isolation, wireless system site management, GSM network

ABSTRACT:

Monitoring the mobility patterns of urban citizens can be used effectively in different areas of city planning and may serve as a basis for automated data collection of potential customers, business partners, inviduals in a specific location in a given time period. Many projects have been created to analyze people's activities by collecting data of GPS and mobile phones, smart cards, etc.
There are different technologies (such as GPS, GSM, Wi-fi, RFID and image based systems) exist for detection of position and speed. Although the penetration of the mobile phones is the highest, mass access to mobile data is restricted.
The main problem is to find the proper platform of infrastructure and technology to answer to several questions related to urban design and monitoring. What is the optimal technology and what type of network can be efficiently used?
Besides the technological and financial parameters, some other problems (strategic, safety and privacy issues) should be considered.
In our research we would like to focus on complex monitoring of human activities. If we combine the GPS and data obtained by Radio Frequency Systems (RFS) , we can answer some questions that most people are concerned: Is our urban life is safe or what are the most "dangerous" activities? Moreover : what are those non-ionized radiation sources that can be eliminated or minimized? In our research, we used equipments that were based on RFID and RFS (VHF and UHF band) technology, using the method of radio frequency isolation. This technology can reliably filter out unwanted interference of different signals. It can also compare the magnitude of radio signals that a person in an urban environment receives indicating activities that involve a high or potentially risky level of electromagnetic radiation.
The research objective is to spatially and temporally separate, measure, quantify, visualize radiation of energy levels emitted by different objects, hence monitor and analyze activities of people using RFS technology.

1. INTRODUCTION

1.1

Up to the recent decades, the determination of accurate position was a rather costly and a slow process which required years or generations sometimes. Moreover, up to the millenium only static position determination technologies were used mostly.

It has been a long time goal of GIS to monitor human activities spatio-temporarily. The recent development of mobile technology has opened new horizons for the so called ubiquitous computing, implying that information processing has been thoroughly integrated into everyday objects and activities, creating a new field of Information Technology called *pervasive or ubiqutous computing.* In an ambient intelligence world, devices work together to support people in carrying out their everyday life activities, tasks and rituals in easy, natural way using information and intelligence that is hidden in the network connecting these devices. As these devices grow smaller, more connected and more integrated into our environment, the technology disappears into our surroundings until only the user interface remains perceivable by users.
Nevertheless, the development and availability of the new technology does not automatically imply that the obtained data will be integated into meaningful system that can be used to to generate knowledge, may improve urban environment and should inspire trust and confidence[1]

1.2 Motivation of research

In the last few years, the large deployment of pervasive technologies in cities has produced an enormous amount of data which can be considered as "digital footprints" of humans, i.e. masses of records were generated about where people have been and when they were there. These records can be analized to show individual mobility pattern. (Real-time Rome project). In the past few years several similar projects have been followed world wide. Hungary, as being a member of the European Union, has launched subsequent measures to comply with the recent GSM technology. Penetration of mobile phones is high (over 10 million devices for a country of 10 million people) and large number of mobile GPS equipment has been sold to support navigation of trains, private cars, taxicabs, etc.
Besides mobile phones and GPS, other technologies exist

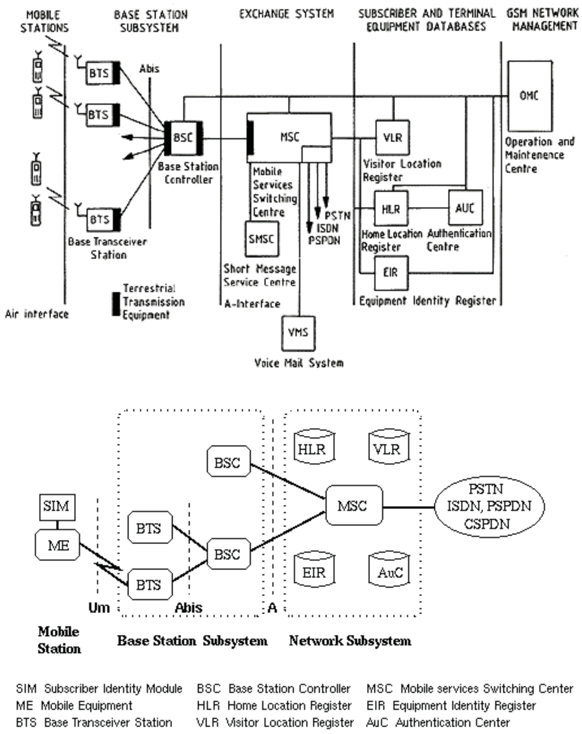
* Corresponding author.

that can detect and measure human position and activities.
Since the mobile data was not available in Hungary for a research purpose, we have chosen a different method based on a non-ionized radiation called Radio Frequency Systems a type of electromagnetic resonation technology - which is an effective method to separate energy waves of different frequencies, hence it is possible to monitor and analyze daily urban activities. Superposing it with GPS, it is possible to detect those activities which can yield to a potentially dangerous level of energy exposition.
Finally, we discuss mobile RFID services that can be combined with different system architecture to assist real world problems of 21st century.

2. POSSIBLE MOBILE TECHNOLOGIES TO COLLECT AUTOMATED DATA FROM MOVING OBJECTS

2.1 GSM system components

The GSM Network comprises three parts, Mobile Station (MS) which is similar to a cordless phone with extra features, the Base Transceiver Station (BTS) that controls the connection with the Mobile Station, the Base Station Controller (BSC) that controls multiply Base Transceiver Station.



1. Figure: GSM architecture

The main features of the GSM network are the following:

- cellular network
- use of several carrier frequencies
- not the same frequency in adjoining cells
- cell sizes vary from some 100 m up to 35 km depending on user density, geography, transceiver power etc.
- hexagonal shape of cells is idealized (cells overlap, shapes depend on geography)
- if a mobile user changes cells handover of the connection to the neighbor cell

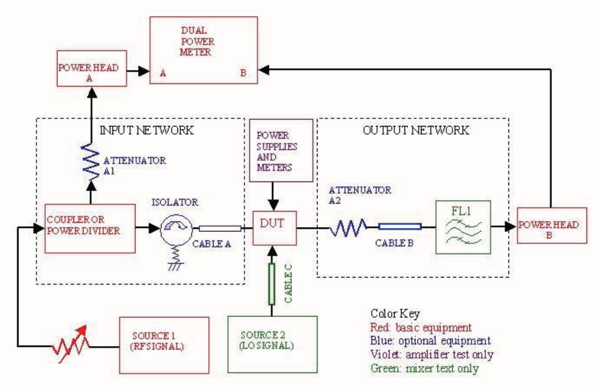
2.2 Extended Applications of the Mobile Phone Systems

High-end mobile phones can exchange information using broadband data collections and can detect position using GPS. This enables a new class of augmented reality applications which use the phone camera to initiate search queries about objects within a user proximity. The phone can be equipped with different sensors, such as GPS location, compass direction, accelerometer, sound and wireless sensitivity . Hence, the mobile phones provide a wide range of applications to augment reality for an urban citizen.

Very High Frequency (VHF) characteristics

VHF waves are ideal for short-distance terrestrial communication, with a range generally fom 30 MHz to 300 Mhz and are mainly used in FM radio and television broadcasting and land mobile stations. Unlike high frequencies (HF), the ionosphere does not usually reflect VHF radio and thus transmissions are restricted to the local area.

2.3 Radio Frequency isolator



2. figure: RF isolator

An RF isolator is a faraday cage, which becomes more effective as the frequency becomes higher. This is also why lead or concrete will stop nuclear gamma rays. FM (VHF) and TV (UHF) signals are limited by the spherical shape of the earth. Shortwave signals bounce off the atmosphere and can be received around the world if the conditions are favorable. Long wave signals will bend along the atmosphere, but require a lot of energy to be transmitted over long distances.
Wireless land mobile communications sites have been established on several places, buildings, hill top or mountain tops. There are many other desirable locations that could serve as remote sites, however, government and private ownership tends to limit this usage mainly due to aesthetic reasons. An RF isolator can be attached to ordinary objects or people outdoors or indoors and usually cover the frequency range from 100 MHz to 26.5 GHz.

2.4 RF isolator used in test

Medium Power Dual Isolator Input Port

With 100 watts of power applied at input:

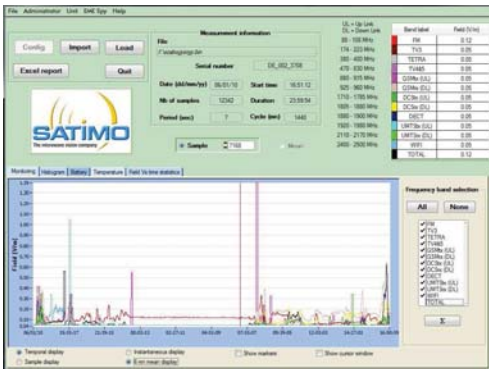
- -Insertion loss, 1st junction, 0.2 dB 4.4 watts
- Power circulated to input load port with 2:1 VSWR mismatch at input port 19.25 watts
- -Max. power reflected from input of second section (based on 26 dB return lossat conjunctive match)
- 5.0 watts

Total 28.65 watts

In our experiment, the RF isolator was combined with a mobile phone to form a mobile **GSM network**

3. SEPARATION OF DIFFERENT SOURCES OF EMISSION BY BAND WIDTH

As we have mentioned, the access of the GSM data is restricted hence it is a property of the mobile phone companies. Nevertheless, it is possible to use an other type of technology –Radio Frequency System (RFS) measuring non-ionized radiation. The following figure shows a distribution of different bands at given time stamps.



3. figure: complexity of different band widths

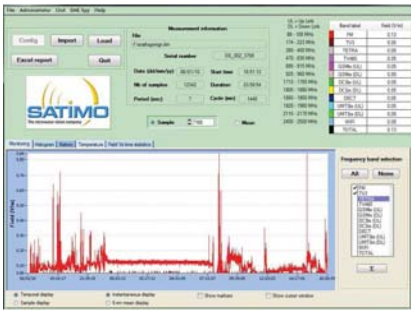
The ERM used in our test was attached to a human body for a 24-hr monitoring and was set to differentiate between the following bands:

.

	MHz	
Band label	UL= uplink	DL= downlink
FM	88	108
TV3	174	223
TETRA	380	400
TV4&5	470	830
GSMx (UL)	880	915
GSMx (DL)	925	960
DCSx (UL)	1710	1785
DCSx (DL)	1805	1880
DECT	1880	1900
UMTSx (UL)	1920	1980
UMTSx (DL)	2110	2170
Wi-Fi	2400	2500

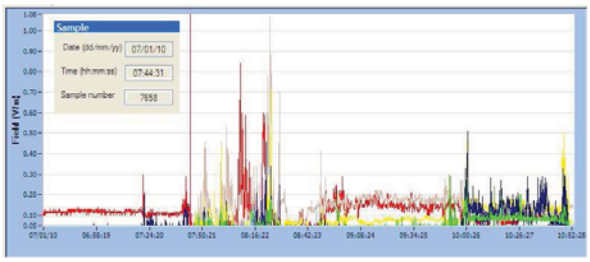
Table 1. EMR frequency band distribution

If we filter out the FM channel , we get the following:

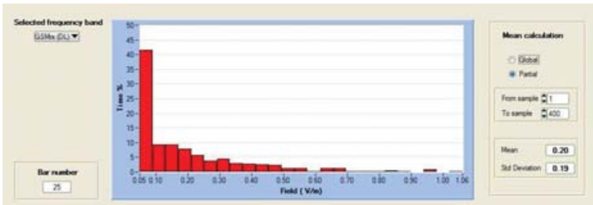


4. figure: FM band

The following figure shows the signals received during a morning travel. The high peak near 07:50' indicates a high change in energy level (i.e. an SMS was sent).



5. figure: morning travel monitoring



6. figure: GSM home

3.1 Levels of Non-ionized radiation (NIR)

As 5. figure shows, the peak value of the non-ionized radiation (which is detected when a mobile phone was used actively) exceeds 1.5 V/m value.

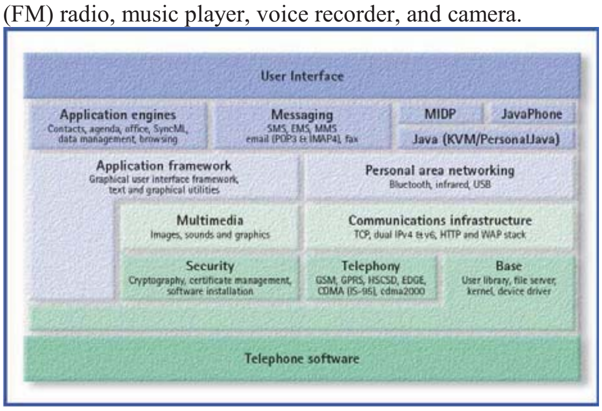
The most widely accepted exposure level guidelines for the protection of the public from the hazardous effects of non-ionizing radiation are those developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which were adopted by the World Health Organization (WHO). As the research suggests, it is not practical to establish a single treshold value for biological hazards, but according to the *Threshold Limit Values for Chemical Substances and Physical Agents,* American Conference of Governmental Industrial Hygienists (ACGIH), 2005 edition, the treshold value is 5 V/m, so a single source of a mobile phone reaches approx. a 30% safety level.

3.2 Superposition of non-ionized radiation levels

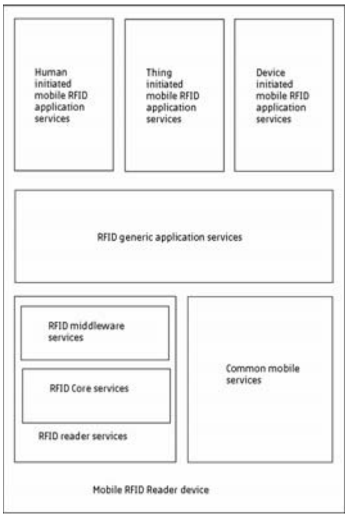
According to the 3. and 5. Figures, the other bands, do not contribute a significant effect to the total radiation level, so as a conclusion we can state that mobile phones should be the main concern for reducing dangerous level of non-ionized radiation.

4. MOBILE RFID SERVICES

Mobile RFID (MRFID) services use RFID as an enabling technology to access the information on the object equipped with RFID tag over a telecommunication or other network.
Mobile services are the features offered by mobile device software. Mobile device software makes use of the network, integrated hardware, device sensors, connected devices, storage, and multimedia applications to provide such features.
A framework for creating MRFID services are provided at different level.
Nowadays smart phones ship with some built-in services from the manufacturer itself. Additional services can be subscribed to from the network operator. Smart phone devices can also be integrated with third party service providers or system integrators. Services on the smart phone can be classified into three types. The first types of services are called device services. Device services don't need any services from the internet or mobile network to operate or they simply don't need the network connection at all. Examples of such services include calendar, alarm clock, Global Positioning System (GPS), Frequency Modulation (FM) radio, music player, voice recorder, and camera.



6. figure: A mobile terminal platform architecture



7. figure Mobile RFID System Architecture at the device side

The RFID generic application services layer consists of services such as attaching and detaching a tag as well as reading and updating information. These services are not specific to any application, but they can be generally used to compose specific application services. Also these services involve more than a trivial task at the lower layers. For instance, in order to perform an attaching tag service, a few services at the lower layers are needed, such as reading the ID of the tag, fetching the information to be attached, presenting the information on the UI, performing the attaching operation at the backend, updating the database, parsing the information, and verifying and displaying the error information are all needed.
By using quality attributes, Mobile RFID services can be used in a complex way to serve specific requirements of pervasive computing.

References from Journals:

- Malcolm McCullough, Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing, MIT Press, 2005
- X. Wang, J. S. Dong, C. Chin, S. R. Hettiarachchi and D. Zhang. Semantic Space: A Semantic Web Infrastructure for Smart Spaces. IEEE Pervasive Computing, 3(3):32-39, July-September 2004

References from Books:

- Donald Norman, The Design of Everyday Things, Basic Books, 2002
- Tom Igoe and Dan O'Sullivan. Physical Computing: Sensing and Controlling the Physical World with Computers, Course Technology PTR, 2004
- Joseph Pine and James Gillmore, The Experience Economy: Work is Theatre and Every Business a Stage, Harvard Business School Press, 1999

References from Other Literature:

Yang Cai and Juli Abascal (eds.), Ambient Intelligence for Scientific Discovery: Foundations, Theories, and Systems, Springer Lectures Notes in Computer Science (LNCS 3345).

- Juan C. Augusto, Daniel Shapiro and Hamid Aghajan (Eds.). Proceedings of the 3rd Workshop on Artificial Intelligence Techniques for Ambient Intelligence (AITAmI2008), Patras, Greece. 21st-22nd of July 2008. Co-located event of ECAI 2008.

Personal Environment Service [51]- Network architecture for AmI, IEEE Proceedings of Vehicular Technology Conference 2006, VTC-2006 Fall.

Ratti C, Pulselli R M, Williams S, Frenchman D, 2006, "Mobile Landscapes: using location data from cell phones for urban analysis" *Environment and Planning B: Planning and Design* **33**(5) 727 – 748

- Martin Peter Michael: Architectural Solutions for Mobile RFID Services on Internet of Things (2007) Master's Thesis

libdoc.who.int/publications/1972/9241560371_(chp15).pdf

References from websites:

http://www.emrcorp.com/techinfo/1/pdf/rf_isolators%281-14%29.pdf

- http://www.mobileworld.org/gsm_about_05.html
- http://www.microwaves101.com/encyclopedia/powermetermeasurements.cfm