# Combined Health Monitoring and Emergency Management through Android Based Mobile Device for Elderly People

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**Abstract.** We have developed a combined Android based mobile data acquisition (DAQ) and emergency management solution, which can collect information remotely from patient and send the information towards to the medical data and dispatcher centre for further processing. The mobile device is capable to collect information from various sensors via Bluetooth and USB connection, and further more able to capture and forward manually initiated alarm signals in case of an emergency situation. Beside the alarm signal the system collects and sends information about the patient's location, and it also enables two ways audio communication between the central dispatcher and the patient automatically. The developed software solution is suitable for different skilled users. Its user interface is highly configurable to support elderly persons (high contrast, huge characters, simple UI, etc.), and also provides advanced mode for the "power" users. The developed system becomes part of our testing program, which is carried out in our Hungarian Living Lab infrastructure. The combination of a mobile DAQ device and mobile emergency alarm device within a single software solution enables care givers to provide better and more effective services in elderly patient monitoring.

**Keywords:** elderly people monitoring, Living Lab, combined mobile data acquisition and emergency alarm software.

## 1 Introduction

With mobile devices used as data acquisition (DAQ) systems we are able to collect vital information about the elderly and demented patients remotely. Through the co-operation of commercial companies, universities and other non-profit organizations the direct goal of the AALAMSRK [2] project is to develop an integrated,

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standardized dementia and health monitoring system (ALPHA system) supported by innovative, modern measurement and info-communication technologies. By the integration of medical expertise and developing assisted living patterns (ALPs), the realized system offers personalized monitoring solution for monitoring and prevention of elderly people, particularly who suffer from neurological diseases such as stroke, dementia or depression.

Considering the real social and market demands and the needs of the health care service provider segment [1], the general project aim is to improve the quality and cost effectiveness of health care services by developing service models, methods, tools, products and services. A consortium led by GE Healthcare - a unit of General Electric Company-, also includes two Hungarian healthcare companies Mednet 2000 Ltd. and Meditech Ltd., and three universities: the University of Pannonia, the University of Szeged and the Obuda University. The consortium is doing research and development of remote telemonitoring system that monitor both activity levels and vital signs such as blood pressure and heart rate, alerting caregivers about potential health issues or emergency situations.

## 2 Living Lab Infrastructures

Main novelties of the AALAMSRK project are that it brings into the patient's home the medical knowledge and assistance and also it supports new potential opportunities to capture insight medical knowledge with its effective non-stop health monitoring methods. The monitoring is done by the standardized, well-defined environments (so called Living Labs). The Living Labs are supporting all the R&D tasks of the medical, engineering and business (marketing) work packages and also provides evaluation and test environment for new hypotheses and results. Beside a normal full functional HomeHub system which is running on a commodity PC, we have developed an Android based HomeHub using a mobile device (See Fig.1.). This

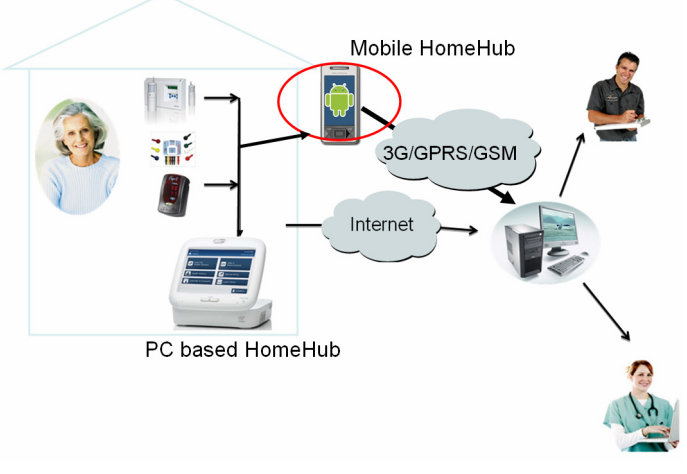


**Fig. 1.** In our Living Labs PC based and mobile HomeHubs are collecting sensor data

mobile HomeHub is targeting only limited functionalities of the full solution (due to the smaller screen size and fewer hardware interfaces), but it can extend the usability with additional special features, such as mobility, location awareness and small size.

### 2.1 Living Labs

The established Living Lab environments are located in three different regions within Hungary (capital city, middle size city and rural area), thus the type of patient environments (living space size, accessibility, communication infrastructure, etc.) are totally inhomogeneous (see Fig. 2.).


**Fig. 2.** Used Living Lab infrastructures (No.1.:metropolitan, N.o.3: city, N.o.2:rural)

During the test periods we have learned a lot from the different environment features, and revealed many aspects of various issues concerning sustainability, usability, etc.

## 3 Mobile and Station like DAQ Systems – a Comparison

In the homes of each monitored patient different type of sensors have been deployed and -with our android mobile and PC based HomeHub software solution- we are collecting information from these sensors about:

- patient movement within the house, with the usage of wall mounted sensors
- patient medication, with sensors of the medicament dispenser
- patient's eating habit, with sensors placed on the refrigerator
- patient activity with so called Actigraph, which is a watch like sensor on the patient's wrist

- patient's blood sugar level
- patient's blood pressure
- patient's weight

**Both android mobile based and PC based HomeHub solutions provide:**

- Health status visualization (limited) at the HomeHub
- Multi-language support at the HomeHub
- Silent sensor DAQ mode (automatic sensor data collection) via Bluetooth

**General features of the PC based software solution are:**

- Manual DAQ mode (optionally GUI initiated sensor data collection) via USB or Bluetooth or Zigbee
- Automatic data compression and encryption during data transmission towards the data center
- Automatic sensor data pre-evaluation at the HomeHub
- Health status visualization (with statistics and data mining facility) at the data center
- Emergency alarm

**General features of the android mobile based software solution are:**

- Manual DAQ mode (optionally GUI initiated sensor data collection) via Bluetooth
- Automatic data compression and encryption during data transmission towards the data center (limited)
- Automatic sensor data pre-evaluation at the HomeHub
- Full featured mobile emergency alarm

## 4 Mobile Device User Interface

The software is suitable for different skilled users. Its user interface is highly configurable to support elderly persons (high contrast, huge characters, simple UI), and provides advanced mode for the "power" users. We have identified and defined during our Living Lab experiments multiple user skills and hw/sw utilisation levels:

- Elderly persons without any IT knowledge - the front-end can be configured to hide completely the underlying mobile device (all menus and icons, see Fig 3.), in such case the device can act as an intelligent mobile emergency signal device, which can be called from the central dispatcher. Such oversimplified mobile HomeHub, collects and forwards sensor information in stealth mode in the background and contains on its screen only a big red panic button. The emergency alarm can be initiated by a pre-defined utilisation pattern (long button push for 3-5 seconds, repetitive button push for 3-5 times).

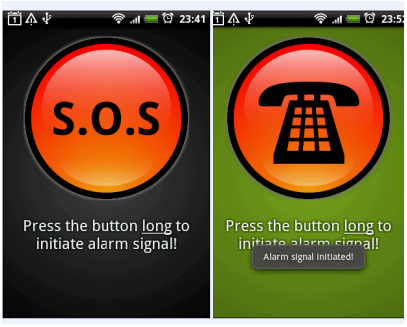


**Fig. 3.** Screens of the mobile Android based HomeHub solution

- For normal and expert end users the in-build additional sw/hw functionalities of a normal Android mobile phone are available (menu sets, SMS , dialing, applications, etc.).

## 5 Location and Sudden Event Monitoring

In a sudden panic situation the patient can manually (or in future based on some of the sensor data even automatically) activate an alarm with the mobile device. When an alarm signal initiated the central dispatcher is able to receive information about location from the received GPS and GSM/GPRS cell information immediately after the alarm signal is arrived. The automatically established two way voice communication can help to understand the context of the sudden event and refine or drive the problem solving procedure. The dispatcher center has access to all the information about the patient (his/her health/medication status, location, etc.), which is vital in emergency situations.

**Some features of the developed software solution are:**

- Emergency call soft key
- Automatic location data forwarding (GPS coordinates + GSM/GPRS cell information) via SMS and/or data channel
- Emergency phonebook (with multiple entries)
- Automatic call pick up after emergency call
- Voicemail prevention during emergency call
- Automatic event logging
- Compatibility with large number (about 97%) of available Android based mobile devices (Android version 2.1, and above)

### 5.1 Emergency Signal – in the Panic Situation

The initiated emergency alarm information is automatically forwarded to the data center/dispatcher. The mobile based HomeHub provides location information of the

event. The dispatcher service agent receives this information parallel within a predefined SMS and within a web service call. Both the SMS and the web service call contain: timestamp, the user ID, the phone's IMEI number, the GPS coordinates and the available cell information. The back end of the web service is appending the event data with additional information (google maps link) and sends towards to the dispatcher's Living Lab event tracking subsystem [3] (See Fig. 4.).

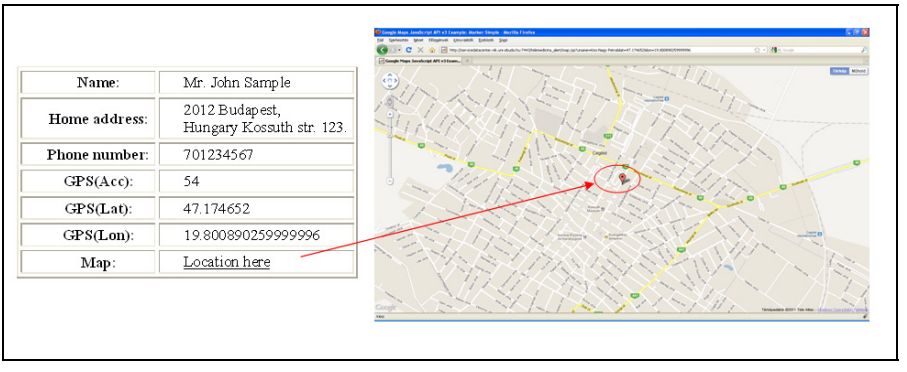


**Fig. 4.** Received information by the dispatcher about the panic event (via email)

## 6 Evaluation of the System

Both the mobile and the PC based HomeHub have been tested on various levels from different perspectives by different purposes. Functionality tests, security and performance test have been carried out to provide quality control of the developed software solutions. During our system evaluation we have redesigned the whole HomeHub-data center communication, because the mobile android based HomeHubs have difficulties to use the same JAVA communication interfaces due to the limited available API. In the mobile HomeHubs the central databases are accessed directly through a lightweight web service like interface, and the

Usability tests in our Living Lab environments have been used extensively to receive feedbacks from patients. As a result, in the mobile based HomeHub solution we had to monitor not only the status of the software, but also some mobile hardware specific parameters remotely (such as: battery level), and we had also to redesigned the whole user interface of the handheld device to support elderly persons with low IT skill sets. According to the distributed and collected/evaluated surveys our android based mobile HomeHub solution is capable to provide seamless remote monitoring of elderly persons not only at home, but also abroad. It provides important feedbacks about health status to the patient, and opens up a seamless, location aware, reliable mobile communication channel in emergency situations. As future work we are trying to include fall detection to capture emergency situations and activate an alarm with the mobile device automatically.

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## References

1. Wimo, A., Jönsson, L., Gustavsson, A.: Cost of illness and burden of dementia in Europe - Prognosis to 2030 (October 27, 2009), http://www.alzheimer-europe.org/Our-Research/European-Collaboration-on-Dementia/Cost-of-dementia/Prognosis-to-2030
2. Proseniis- Innovation for healthier senior Age, http://www.proseniis.hu/ (acc. August 9, 2011)
3. Kozlovszky, M., Meixner, Z., Windisch, G., Márton, J., Ács, S., Bogdanov, P., Boruzs, A., Kotcauer, P., Ferenczi, J., Kozlovszky, V.: Network and service management and diagnostics solution of a remote patient monitoring system. In: Lindi 2011 Conference, Budapest, Hungary (2011)