Wearable Automatic Biometric Monitoring System for Massive Remote Assistance

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The time required to alert medical assistance after a fall or loss of consciousness is a critical factor of survival. The elderly population, who often lives alone and isolated, is the most sensible to those risks. Researches are going on since several decades to develop smart environment able to track symptoms [i] of such crisis and to automatically alert appropriate assistance in case of emergency [ii]. Human measurements like body temperature, skin conductivity and physical activity are among the basic signals used to determine a person health and stress. Unfortunately, the instruments and wires used to keep track of this information often limit the mobility and comfort of the user.
This abstract presents the development of a very compact monitoring system, based on a set of sensors connected to a remote server via a Personal Digital Assistant (PDA), using local wireless connections between elements (Bluetooth) and WiFi to the distant server. This system also features vibrotactile feedback to alert the user and check his response. We also used WiFi access points and quality of signal to determine an approximate localization of the users within a known perimeter. Such a system is intended to be used as a massive, non invasive, biometric instrument to constantly check the health of a large amount of users over an internet connection.

Embedded system

The embedded system is based on a microcontroller which recovers data from the different sensors and sends information to the PDA via a serial Bluetooth communication. The sensors used in this application are analogical ones related to activity measurement: skin conductivity, body temperature and angular acceleration of the limbs. Measurements are taken through an integrated 10 bits ADC controller of the microcontroller. The system collects and treats the information in order to send it as a formatted data structure to the handheld device through the Bluetooth connectivity with a refresh rate around 200 Hz.
The embedded system also includes vibrotactile feedback to alert the user in case of need when an emergency situation is detected. In this case the PDA sends vibrotactile feedback to render onto the user’s skin. The vibration motors are driven by PWM generated by the microcontroller. The whole embedded system is low power consumer (below 1 W) and doesn’t weight more than 10 grams, in order to be easily integrated in the clothing of any users (see Fig.1).

Server/client architecture

Handheld devices connect over a WiFi network to a remote server. Information gathered by the sensors is first processed by a microcontroller embedded in the clothes and forwarded via Bluetooth to the PDA. The PDA performs a first-level analysis of these values and regularly sends information to the remote server. In case of minor troubles (connection lost, anomalous data received from sensors or malfunctions), the PDA software informs the user about the problems and how to solve them. The PDA software is extremely user-friendly and is based on the top of our real-time 3D platform described in [iii] to provide a multimedia interface with images and animations instead of plain text (difficult to read on the small embedded display). Server-side, the information is stored in a database and compared with values previously received in order to determine if sudden changes have occurred or abnormal data has been recorded (for example when a user's temperature is very high or low and his/her movement absent). In these cases, alert signals as well as the user profile and data are displayed on the server screen to inform the server-side assistant and help him taking a decision. By using the WiFi geo-localization system, an approximate position of the user is also given to guide a first aid team to reach the patient. In case of emergency, the server assistant can also try to talk with the user by meaning of a voice-over-IP service (VoIP) and the integrated speaker/microphone embedded in the PDA, or try to wake up the user by remotely activating the vibrators.

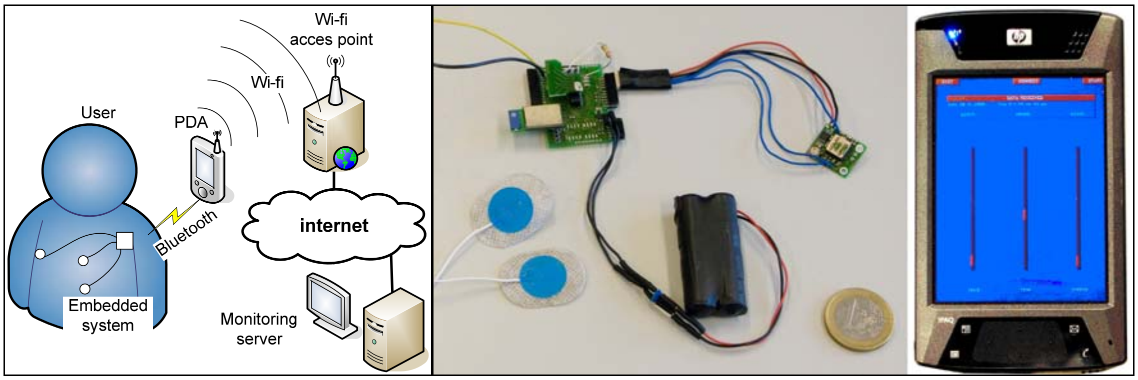

Fig.1: schematic overview of the system architecture (left), hardware to embed in clothes (center), the PDA software interface (right)

Conclusion & future applications

Our platform is intended to be used in scenarios where monitoring of a large amount of users would be concretely difficult and expensive. Such a system could keep track of their health by offering a partially automatic way to identify potentially problematic cases and requires only a PDA and some non expensive sensors. The use of an already existing WiFi infrastructure also considerably reduces the installation and maintenance costs of our solution: WiFi areas are also more and more widely available and continue to increase in the urban regions (like recently in Paris, with the installation of a large number of free access-points all around the city).

The system can also be generalized to all kind of application which requires full duplex telemetry. In a future application such a system will be used in our laboratory to gathers data and send control commands to an unmanned flying vehicle. The goal in this particular application will be to improve presence of the tele-operated system by adding multimodal feedback reconstructed from the different sensors on board.

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