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Fall Risk Assessment – A Comparative Analysis of Fall Risks in Elderly and their Underlying Causes

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Falls are a prevalent issue in the geriatric population and can result in dangerous injuries. Every third person above the age of 65 and every second person above the age of 80 experiences at least one fall per year. For elderly, falls often cause serious injuries, such as hip fractures or head injuries entailing tedious healing processes, or even death. After experiencing a fall, 25% of the affected persons have an increased need for care. Though there are many approaches for fall detection, these technologies trigger an alarm only after the fall has occurred. Therefore, we are aiming at preventing the person from falling in the first place to avoid the consequences of such events.

Hence, we analyzed risk factors and underlying causes for falls to enable an automatic real-time fall risk assessment of elderly. We classified internal causes for falls in elderly into musculoskeletal deficits, cardiovascular diseases, sensory functions and cognitive and mental impairments, and outlined the correlation between the causes, symptoms and fall risk. Most state-of-the-art methods for automatic fall risk assessment analyze gait characteristics as a general symptom for an increased risk. Many approaches employ accelerometers for observing gait and related movements, while other methods use 3D-cameras or insole pressure sensors. Although many risk factors can be reflected in an abnormal gait, it mainly captures musculoskeletal and cognitive deficits. Furthermore, gait analysis does not provide insight into the underlying causes of an increased fall risk, which would allow for corresponding prevention measures.

To improve fall prediction for elderly and enable preventive actions according to the underlying causes, it should also be paid attention to other risk factors. Further investigation will focus on the detection of dizziness and its causes as second general risk factor with a prevalence of 30% in the population above the age of 60.

Wireless heart rate monitoring system with capacitive ECG sensors

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Capacitive ECG measurement is a promising alternative to galvanic ECG. For a high acceptance rate, a simple and fast application procedure for capacitive ECG is required. It should feel like putting on a shirt or a jacket and then you are already prepared for measurement. Without any galvanic contact of the sensors to the skin, the risk of irritations and allergically reactions are reduced to a minimum. So, the complete hardware of the monitoring system will be integrated into the smart clothing. Therefore, the energy consumption and system size have to be reduced.
The developed hardware system consists of two main functional parts: An analog frontend with an integrated analog filter based on the Pan-Tompkins detector and a controlling and communication part. For ECG acquisition two sensor elements are used and connected to an ultra-high impedance instrumentation amplifier. Further, ultra-low energy consuming operation amplifiers are used for the filter design. The microcontroller uses pin-interrupt wake-up routines to reduce the power consumption. The interrupt timings are used to calculate the heart rate intervals. No additional analog-to-digital converter is required, and the ECG signal is not recorded. Furthermore, a real-time clock module generates a time stamp, which is saved with the R-R interval timings. Finally, we use an 802.x communication module to transfer the stored data to a computer. The implemented power management is an important issue to reduce the power consumption to a very low level. A rechargeable battery is used as power supply. In a further step, tests with subject in rest and during motions will be progressed.

Intelligent Assistance Systems with Real-Time Sensor Data Analysis-Framework for Digital Care

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Introduction

A real-time sensor data analysis-framework in the field of "Ambient Assisted Living" was developed. The aim was to provide a medical valid - integrated real-time picture of the patient's situation by using an ad hoc interconnected sensor – actor infrastructure with a latency period of less than 10 ms. In this paper, an overview of the whole project fast care will be given and the results of the integrated situation picture will be discussed.

Methods

The challenge of a distributed, real-time medical sensor technology and signal processing is to be processed by means of sensor-based data processing and sensor hubs, optical sensors, hardware system optimisation, the development of distributed systems as well as by fast interfaces. The focus of the project was on the intelligent fusion of sensor and actuator data as well as the evaluation and delivery in real-time. The following investigations have been realised

- Data acquisition
- Data analysis
- Data fusion
- Acceptance analysis
- Situation detection/assistance

Results

A sensor system was developed that allows monitoring of vital parameters. Inertial sensors, sensors for pulse and blood pressure and respiration measurement were used. For the fusion of these different sensor data, appropriate algorithms were developed and used. Within 10ms the data are merged and analyzed in the real-time server. The data values are then graphically made available to the user online in an avatar presentation with evaluation of the vital data. Subsequently, the systems were tested both technically and for user acceptance.

Conclusion

In the BMBF project a demonstrator of a real time sensor network was established and proved to get an integrated situation picture of the patient at home.