

NewbornCare

NEWBORN MONITORING BASED ON MULTIPLE VISION SENSORS



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What it's about...

Designing new contactless monitoring technologies for prematurely born babies.

Context and project goals

Modern societies are giving more and more priority to increase the quality of neonatal and post neonatal health sectors. The actual neonate sensor setup for heart and respiratory activities, and oxygen saturation is the following: gel electrodes to monitor the heart rate by electrocardiogram (ECG) and pulse oximeter to monitor arterial oxygen saturation (SpO2). The combination of the increasing number of parameters being monitored and the sensitivity of these sensors to body movement (especially the limbs) is responsible for the inacceptable high rate of false alarms, which in turn generates discomfort, stress and cardio-respiratory instability. These false alarms may also be the cause for caregiver desensitization which may dangerously lead to long response times for true alarms. Even if the problem is well known, it has not received new major incomes from the scientific community.

The NewbornCare project proposes to drastically reduce the false alarms of neonate vital sign monitoring by using a computer visionbased approach to accurately measure the heart and respiratory rates in a contactless fashion by combining variation enhancement techniques of both skin color intensity and body motion captured by an imaging sensor with robust tracking and segmentation algorithms. Moreover, the NewbornCare project also proposes to monitor arterial and brain tissue oxygen saturation of neonates using optical sensors (pulse oxymeter and near-infrared spectroscopy) integrated into a single sensor (based on expertise gained in promising NTF NeoSense project). Beside the development and implementation of versatile monitoring devices, the NewbornCare project aims at testing its applicability, specifically the smartphone application dedicated to neonate monitoring, in neonatal intensive care unit (NICU) scenarios. The NewbornCare project is aimed at showing the feasibility of implementing non-occlusive long-term monitoring strategies of multiple vital sign monitoring during neonate health care. This NICU validation will be headed by Prof. Dr. Fauchère at the Division of Neonatalogy, University Hospital Zurich.

The research conducted in NewbornCare will lead to a series of technological novelties, including:

- an embedded robust heart and respiratory rate monitoring system with a dedicated imaging,
- "smart" wireless body area network platforms linking the video with miniaturized multi-sensor devices located on the forehead of the neonates,
- high quality monitoring of arterial and brain tissue oxygen saturation based on miniature multi-sensor device integrated into a headband,
- an innovative multi-neonate monitoring tool for smartphones or tablets dedicated to NICU staff,
- a novel computer-aided diagnostic tool that detects and classify cardiac events based on learning methods,
- a beyond-state-of-the-art monitoring tool to estimate the blood flow over the entire neonate body.

How it differentiates from similar projects in the field

A major innovation in NewBornCare is the integration of a pulseoxymeter and near-infrared spectroscopy sensors for brain oxygenation monitoring.

Also, advanced video processing tools are used for face tracking, segmentation, and enhancement.

Finally, innovative adaptive frequency tracking schemes are used to estimate robustly and with a reduced time delay the heart and respiration rates. This combination of expertise is unique in the field.

Quick summary of the project status and key results

First prototypes of sensors that measure brain tissue oxygenation are being taken into operation in the labs of the University Hospital of Zurich.

The sensor translates the intensity of travelled-through-tissue, nearinfrared light to create and visualize information on the brain tissue oxygenation in real time. It is attached to the head of a newborn by a proprietary headband, which exists in different sizes.

Success stories

CSEM deployed a spectrometer at partner USZ site to precisely measure lighting conditions at the intensive care unit over the course of several days and continuously in time. The insight gained into the intensity and spectrum of light during days and nights will help precisely design the vision components of NewbornCare.

While examining the ways for an easy NIR-sensor fixation on the head of a newborn, there had been numerous apparently unsolvable questions at first. The questions revolved around biocompatibility, one- or multiple-way use, disinfection methods, prototyping and manufacturing.

Getting to know how medical staff works was important to finding a practicable solution. By means of a carefully prepared interview, the knowledge has been brought to light on the ways to attach medical devices to the body of a newborn. The interview has been conducted with a highly qualified nurse and specialist for hygiene in neonatology as well as the head of the department of neonatology at the University hospital of Zurich. A second interview has been conducted working for the same hospital. This brought about additional knowledge on materials and ways to get the fixation manufactured

Main publications

Sibylle Fallet, Jean-MarcVesin, Adaptive frequency tracking for robust heart rate estimation using wrist-type photoplethysmographic signals during physical exercise, Computing in Cardiology 2015, Nice, France.

Sibylle Fallet, Sasan Yazdani, Jean-Marc Vesin, A multimodal approach to reduce false arrhythmia alarms in the intensive care unit, Computing in Cardiology 2015, Nice, France.