# HARD SENSORS FOR INTELLIGENT TEXTILES

Petr Exnar[1], Ivan Doležal[2]

**Abstract**: Experiments were provided with Swiss sensors Sensirion SHT15 regarding to actual unavailability acceptable sensor of the Czech production. It turned out, while experiments in the Sport laboratory TUL. It is too complicated obtain reproducable outcomes for closed and heat-uninsulated clothes, or well defined systems without expressive movement and ventilation (baby bags).

The Atmel RZ200 Demonstration Kit has been utilized for initial experience with ZigBee radio. USB/ZigBee modem was built to provide Radio Control Board with connection to PC. Besides temperature and relative humidity sensor SHT15, new digital triaxial accelerometer SMB380 was employed. These sensors were assembled on a small board that connects them to the Radio Control Board. Firmware of the developed sample transmits temperature, humidity, acceleration in 3 axes, battery voltage and radio link quality from more than one unit to a remote Display Board that displays them.

## 1. Introduction

Selection, evaluation and application of various sensors suitable for embedding into textiles are running in scope of activity in Research Centrum TEXTIL II. Although detectors are being developed and their properties are measured, too, commercial sensors were used for tests.

One possible application of sensor in textiles lies in special protective overalls e.g. for firefighters where temperature, humidity, presence of dangerous gas, acceleration, position etc. could be checked.

## 2. Gas sensors

Preparation sensor of gas matters potential acceptable into the intelligent textiles is still in stadium of making. In terms of collaboration with company Tesla Blatná was tested succesion of active layers for phosgene, carbon dioxide and ammonia. Any of them weren´t sufficient sensitive onto the mentioned matters. At present is designed cheap sensor of humidity for using in intelligent textiles.

Another experiments were provided with Swiss sensor Sensirion SHT15, regarding to unvailability acceptable, final and cheap sensor from Czech production. Measuring of overall manned with sensor Sensirion was proceed in the Sport laboratory TUL, while stress of figurant on the spiroergometer. For unclosed and heat-uninsulated clothes was turned out, that it is very complicate obtain reproducable and interpretable outcomes. On this account an observation and transfer of data about temperature and humidity are potentional acceptable only for closed (heavy protective clothing, for example for firemen) or well defined systems without expressive movement and ventilation (baby bags).

[1] doc. Ing. Petr Exnar, CSc.; Technical University of Liberec, Department of Chemistry; Hálkova 6, Liberec 46117, Czech Republic, petr.exnar@tul.cz
[2] doc. Ing. Ivan Doležal, CSc.; Technical University of Liberec, Institute of Mechatronics and Computer Engineering; Hálkova 6, Liberec 46117, Czech Republic, ivan.dolezal@tul.cz

## 3. Wireless data transfer from remote sensors

Whilst the only GSM technology (a common mobile phone net) is available for a long range data transfer among moving locations, more platforms can be considered for very short or mid-short distance, either of Wi-Fi, DECT, Bluetooth, ZigBee standards or proprietary solutions (transceiver modules of various manufactures with specifics protocols, e.g. IQRF modules).

Radio modules running under IEEE 802.15.4/ZigBee standards were selected for wireless connection of more miniature sensor devices to a central unit. The Atmel RZ200 Demonstration Kit has been utilized for initial experience. The kit consists of 5 pieces of Radio Control Board (RCB) and single Display Board.

As the Display Board has not got any connection to PC available some of this would be useful in general. Indication of remote sensor data will be done thus either on a stand-alone indication unit or in an application running on PC. USB/ZigBee modem was designed, assembled and housed in a plastic box. It consists of the RCB and a supplemental PCB (Printed Circuit Board) that carries USB/UART converter chip. Related Windows drivers establish Virtual COM Port on PC that can be used by any application in conventional manner.

Remote Sensor Board is a small supplemental PCB that is connected to the RCB so both form the Remote Sensor Unit. The assembly composes a wireless unit that transmits data from temperature, relative humidity and acceleration sensors.

The SMB380 (Bosch Sensortec GmbH, Germany) was the only triaxial low-g acceleration sensor with digital output in time of selection. It allows measurements of accelerations in perpendicular axes. The sensor is really a smart device that has a flexible on-chip logic and computational core which can be programmed to evaluate acceleration data autonomously during tilt, motion and shock vibration.

Sample application for remote monitoring of sensors on the Remote Sensor Board has been designed. Remote Unit firmware fulfills battery voltage measurement, acceleration capture and conversion to ‘g’, the SMB380 interrupt evaluation (if any), temperature/humidity data capture (from the SHT15 sensor) and conversion to °C/%RH and finally sending of a data packet using ZigBee stack over air.

Display Board firmware displays several pages on the LCD. Besides an introductory page with application name and firmware versions, page No.1 presents temperature and relative humidity of remote sensor units (maximal for 6 units together) with possible alarm indication (e.g. “wet”), page No.2 presents acceleration in all 3 axes and page No.3 presents the SMB380 accelerometer events (currently “Motion detected“ only). Last 4th page presents battery voltage of the remote unit and a radio link quality.

The developed system is intended for an adaptation into a monitoring system of baby bags e.g. for maternal hospitals.

**Acknowledgement**

This work was supported by the Research Centrum “TEXTIL II”, Code 1M0553.