The Use of the Arduino Embedded System as a Prototype of a Mobile System Controlling a Person's Breathing Using a Sensor Printed on a T-shirt

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The aim

- The aim is to make system for measuring the electrical resistance with mobile Arduino microcontroller in the designed/elaborated textile printed sensor.
- Textile sensor was developed by the screen printing technique based on a water dispersion of carbon nanotubes printing composition.
- By stretching and squeezing the T-shirt during breathing, we change the electrical resistances of the printed sensor.
- The measured resistance corresponds to the number of breaths of a person wearing it. The microcontroller can calculate the number of breaths as a number of electrical resistance peaks which can lead to monitoring human live parameters.

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Based on previous work

„Investigation of the Impact of Environmental Parameters on Breath Frequency Measurement by a Textile Sensor" Ewa Skrzetuska and Jarosław Wojciechowski

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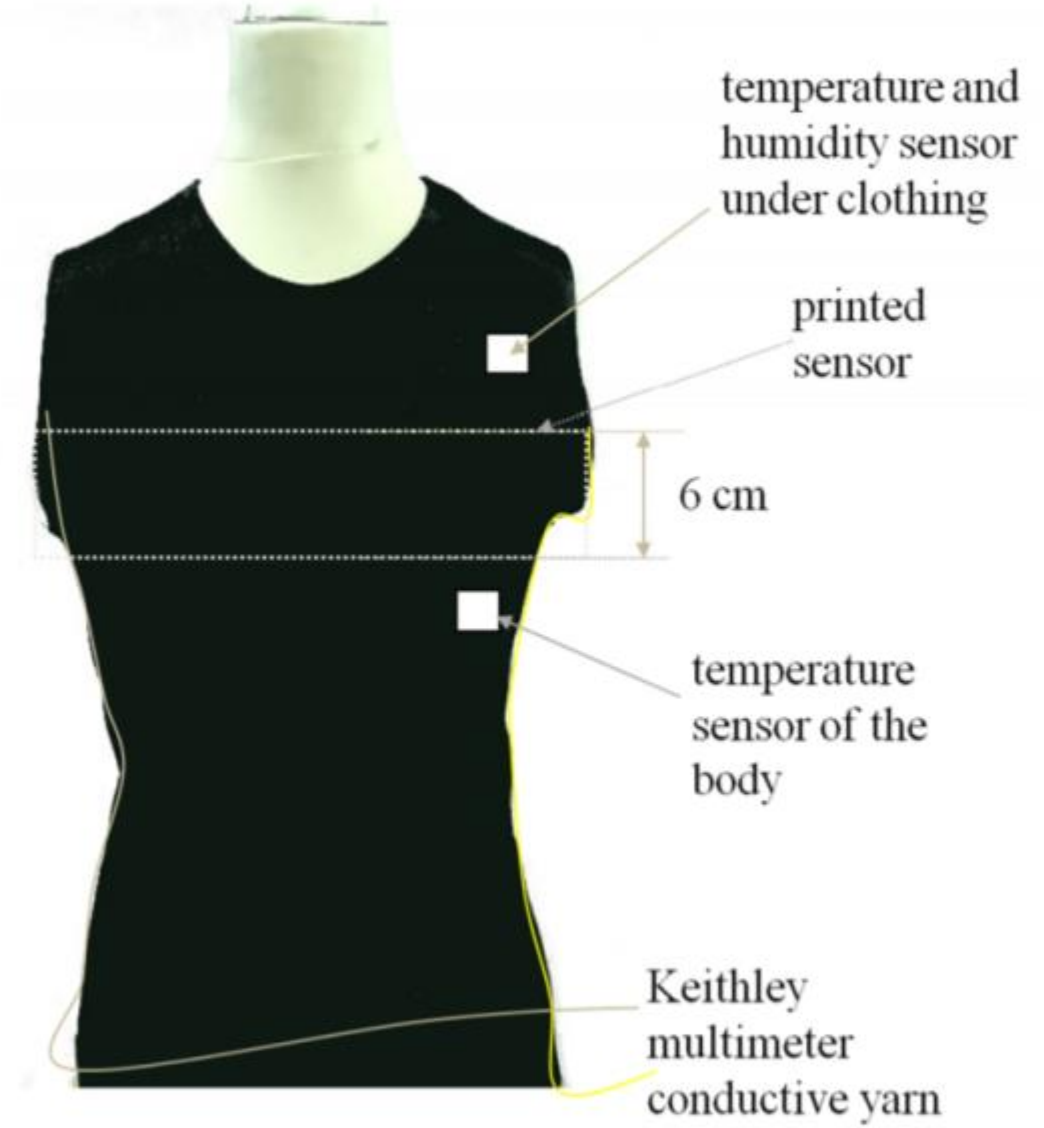
Ewa Skrzetuska, Jarosław Wojciechowski. Investigation of the Impact of Environmental Parameters on Breath Frequency Measurement by a Textile Sensor. SENSORS, ISSN: 1424-8220, vol. 20, no. 4, rok 2020, str. 1-10. WoS. 10.3390/s20041179



T-shirt with imprinted sensor.

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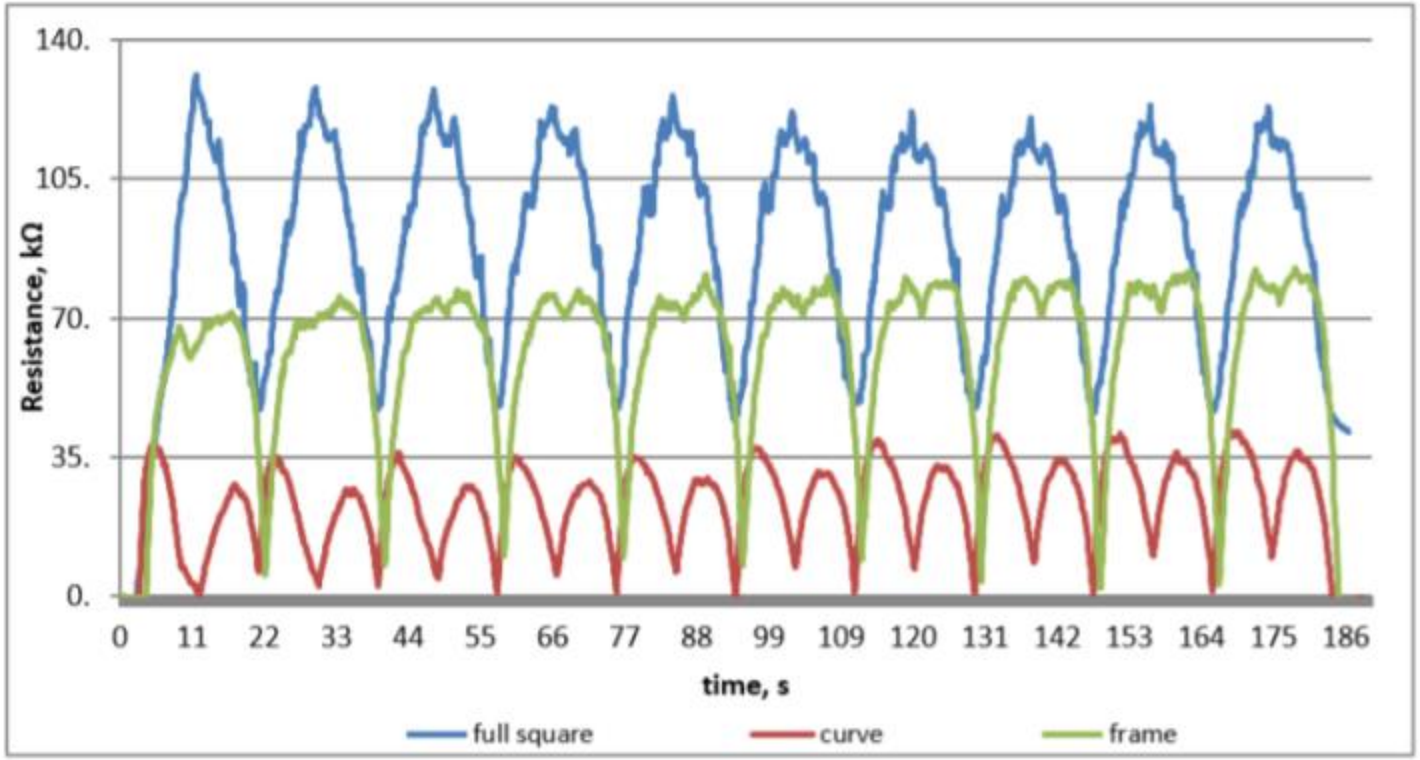
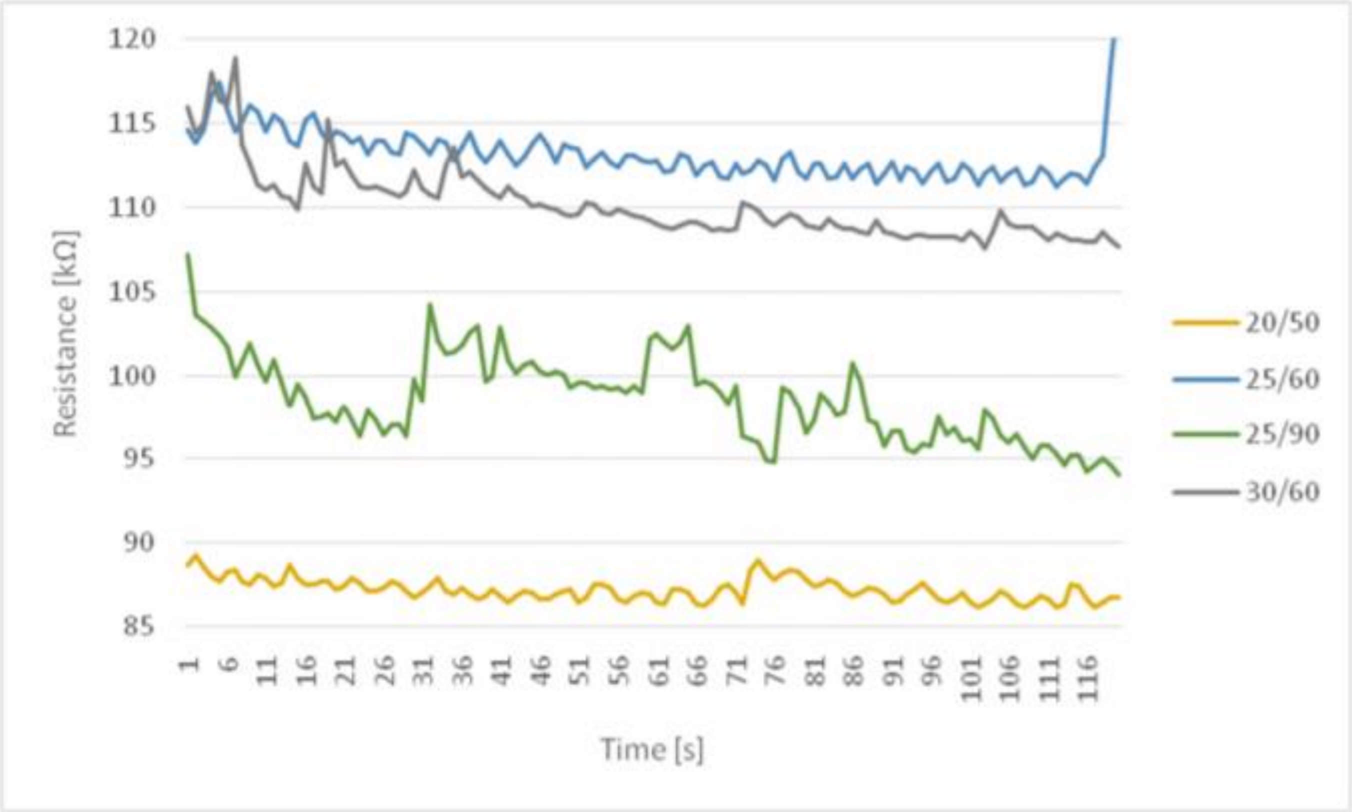


The course of resistance changes during the sensory sensitivity test.

Changes in Resistance at Rest



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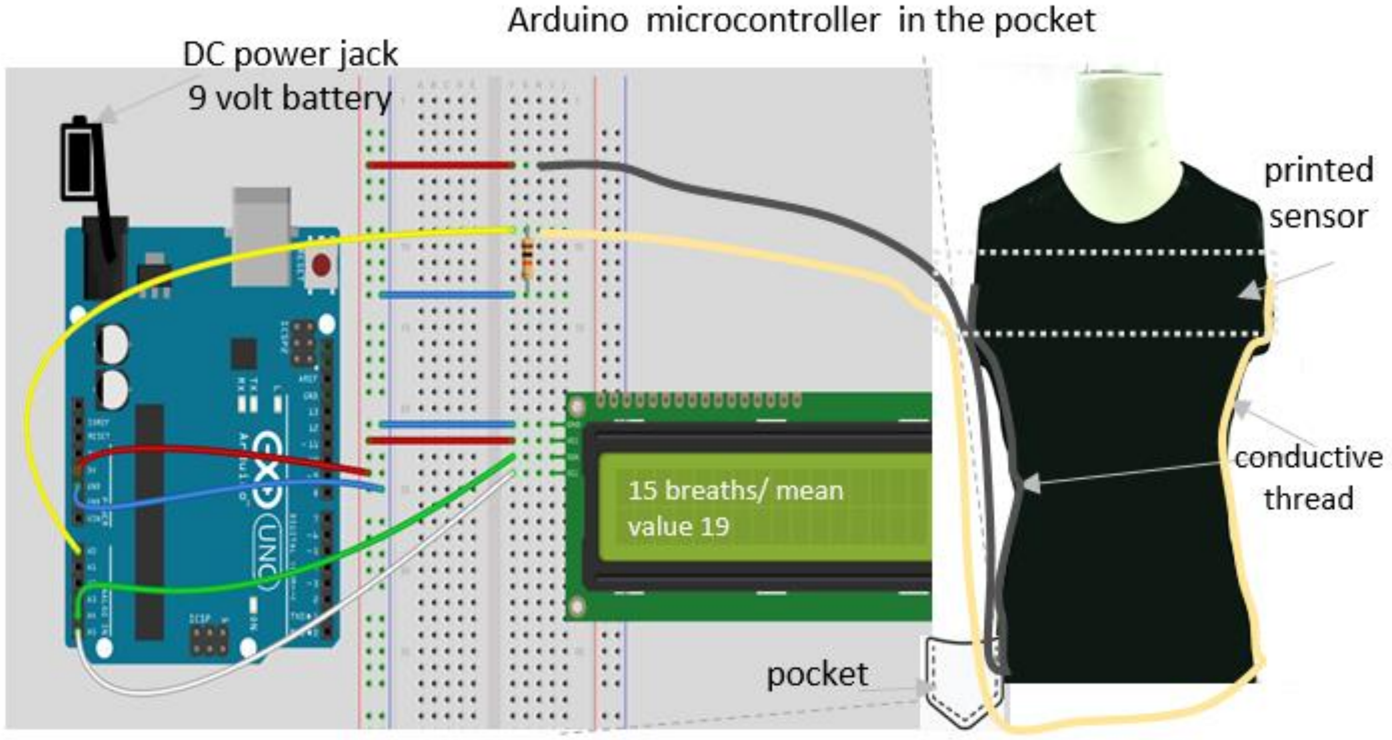
An exemplary architecture diagram.



The microcontroller and textile sensor connection diagram – (own study, Arduino graphics taken from [10])

Practical Measurement

- We will use two resistors, first resistor is 10k Ω and the second is represented by the textile sensor. From the point of view of Ohm's law, it is important that the resistors are connected in series. The resistor with a known resistance of 10k Ohm between the ground and the cable connected to the A0 pin, while the tested textile sensor resistor between the cable connected to the A0 pin and 5V from Arduino.
- Our system consists of two resistors connected in series with values that we will denote R1 and R2. R1 will be our known resistor, while R2 will be a textile sensor. Current I flows through the system. Such current flows through both R1 and R2. The voltage drop is in the whole system and in each of the resistors the voltage changes proportionally to its value. The voltage that falls on the whole system is the voltage taken from Arduino, i.e., 5V - we will denote it as U.

PRACTICAL MEASUREMENT CONT.

- Having the above in mind, we can determine the following formula:
  - 2) U / (R1 + R2) = U1 / R1
  - 3) R2 = ((R1 * U) / U1) – R1
- where ,
- R1- known resistor 10k Ohm, R2-resistance of a textile sensor
- This formula 3) may be calculated inside the microcontroller. The values can be stored in the Arduino memory for 60 seconds interval. An average value of peaks, corresponding to the number of human breaths, may be calculated and displayed on the LCD. By normal breathing we do the change of the textile sensor electrical resistance, we change the value of resistance which is connected to the center pin of the resistor series. This changes the voltage at the center pin. This voltage is the analog voltage that we will be read as an input by *Analog-to-Digital Converter (ADC)*.

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Conclusions

- The authors are aware of the challenge of changing human body size, ambient humidity, temperature, pH of sweat, and the related need to calibrate the sensor in various atmospheric conditions.

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- Thank You for attention