

Remote healthcare: Can we bring care to home ?



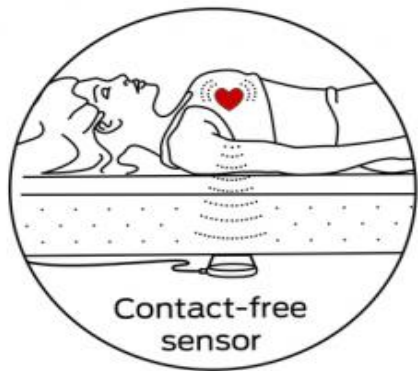
Nasal Airflow Probe



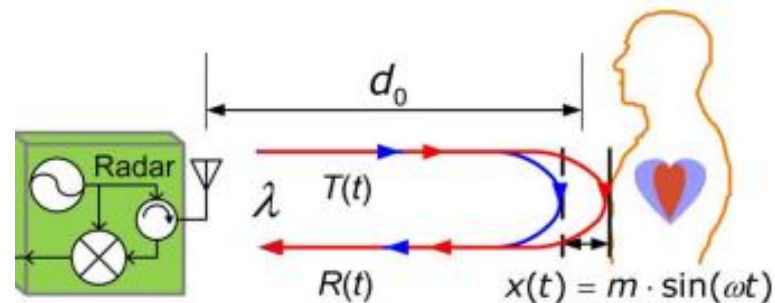
Chest belt



Spirometry



Ballistocardiogram
(BCG)



Doppler Radar



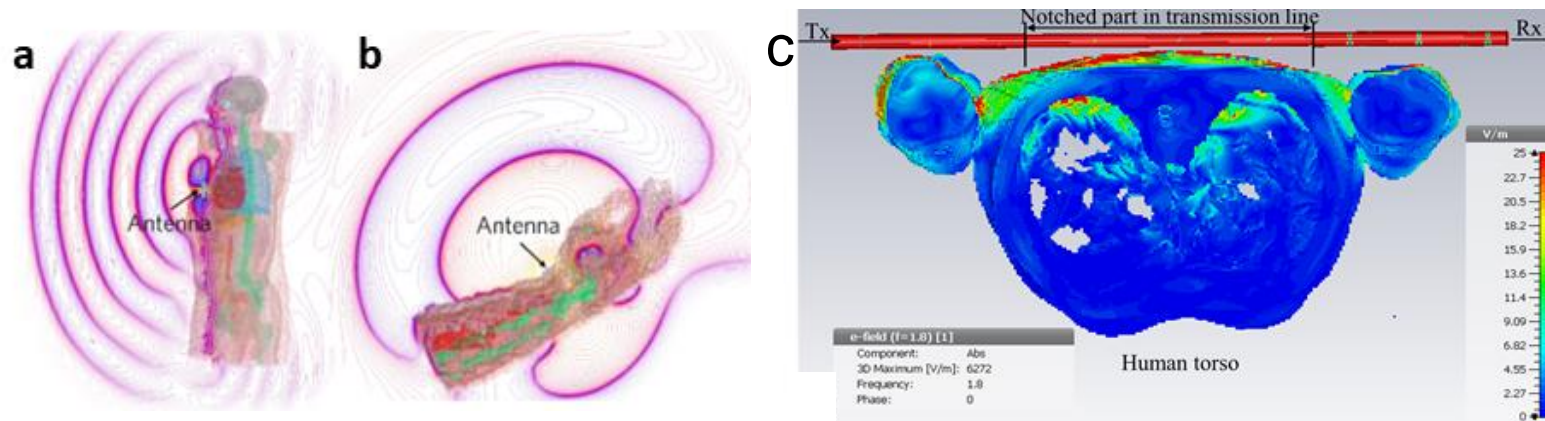
Polysomnography
(PSG)

Non-invasive and continuous monitoring on physiological signals

Near-field Coherent Sensing (NCS)

Couple EM wave to dielectric boundary movement by internal organs to get vital signs and other biomedical signals.

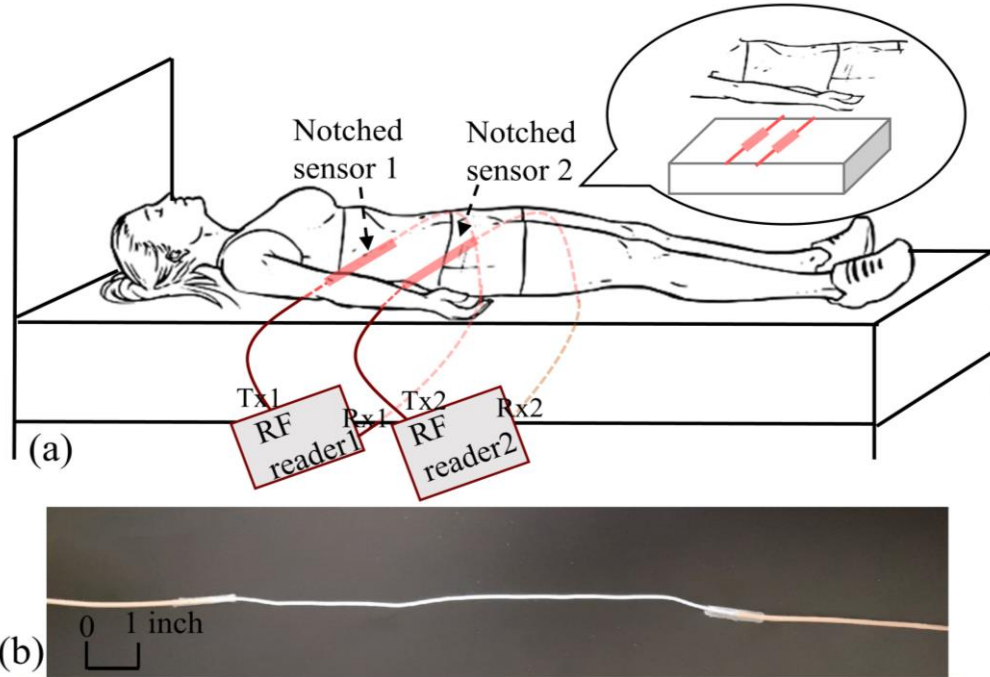
Respiration, Heartbeat, Muscle activity, Tissue motions



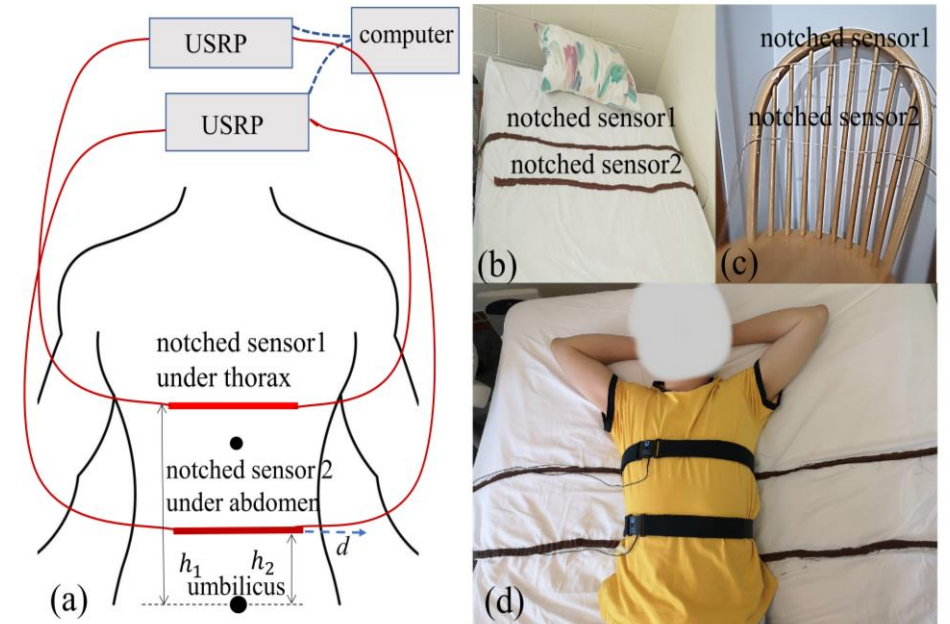
Simulation of Electromagnetic coupling of (a) front of human torso ,(b) wrist and (c) cross section of human torso.

Experimental setup

We present a new respiration sensor integrated into a bed or a chair by modifying a radio-frequency (RF) coaxial cable structure with a designed notch. The lung motion is coupled to the electromagnetic leakage at the notch through near-field coherent sensing (NCS).

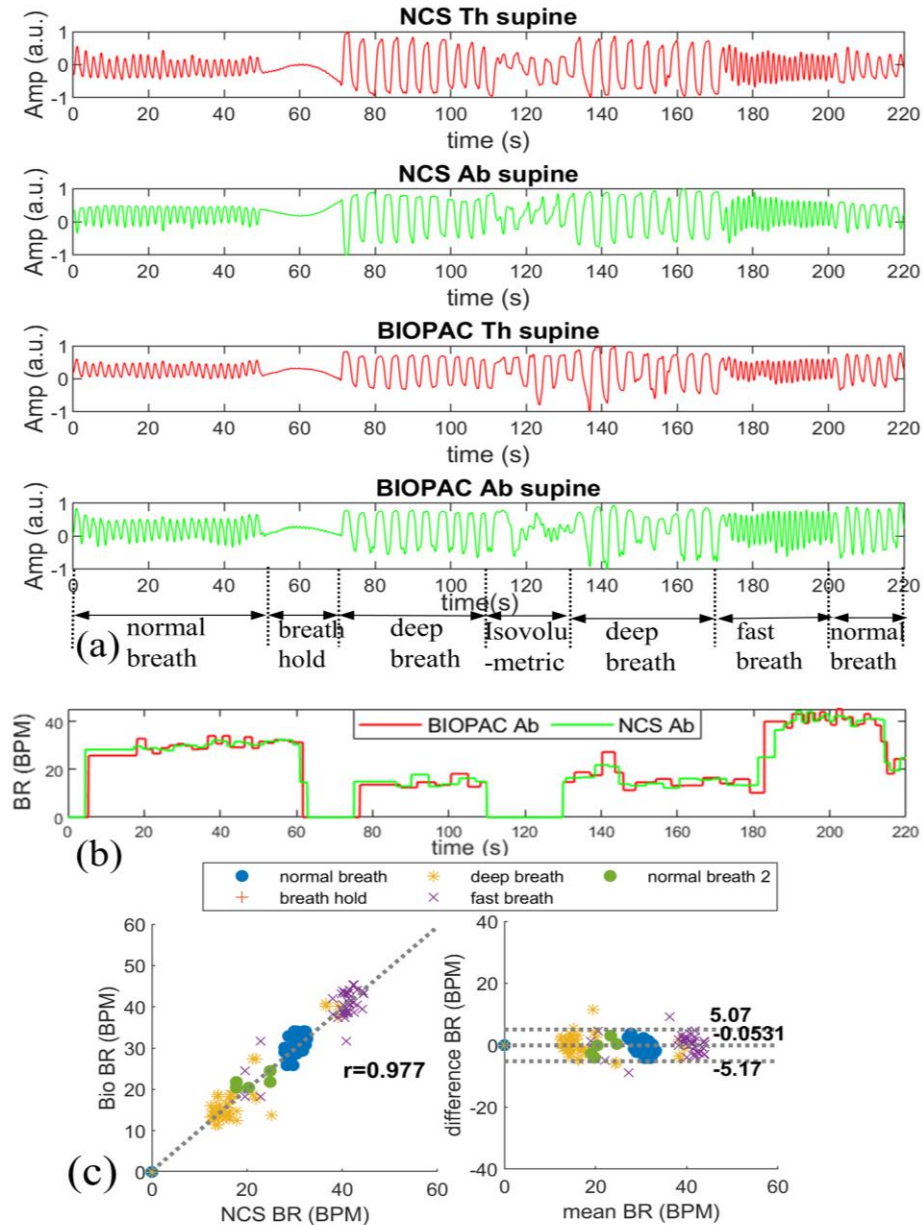


Notched-cable respiration sensor setup: (a) System schematic with bed integration; (b) A photo of the notched cable



Experimental setup of the notched sensors

Benchmark with BIOPAC tension belts



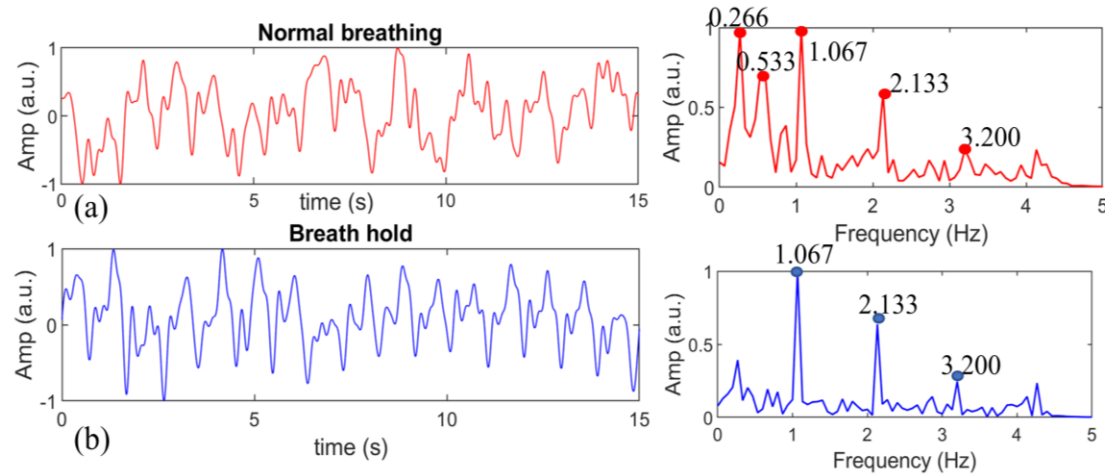
Respiration monitoring in the supine posture with $f_{RF} = 900\text{MHz}$:

(a) NCS and BIOPAC amplitude waveforms in thorax and abdomen during the whole breathing protocol.

(b) Th breath rate (BR) calculated from NCS (green) and BIOPAC (red).

(c) Correlation and agreement between NCS and BIOPAC BR data. Left: The scatter plot with denoted Pearson's correlation coefficient. Right: The Bland-Altman plot showing the mean difference m at the center dotted line and the corresponding limits of agreement (LoA) at the upper and lower dotted lines given by $m \pm 1.96\sigma$.

Heart rate (HR) detection



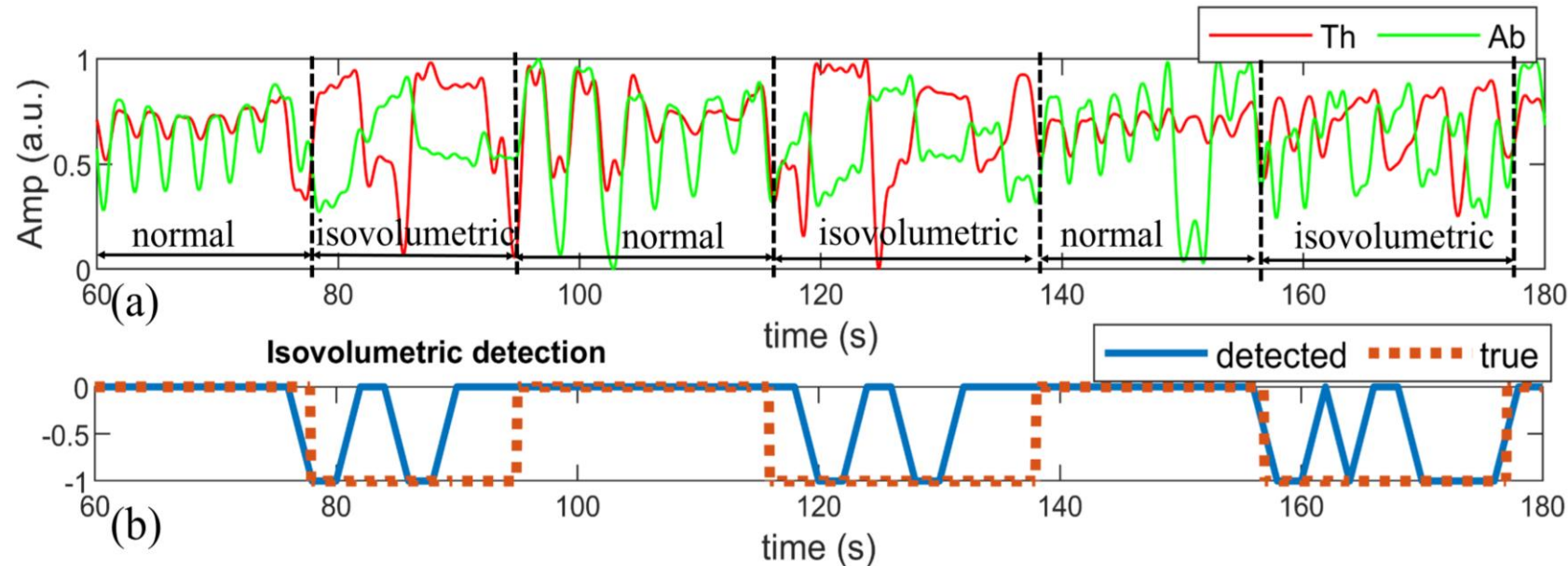
(a) Left: The heartbeat time-domain waveforms from the thorax sensor during normal breathing. Right: The corresponding spectrum with three HR peaks and two BR peaks indicated by the annotation above.

(b) Left: The heartbeat waveforms during breath hold. Right: The corresponding spectrum with three peaks.

The thorax NCS sensor can also retrieve the heart rate (HR) with reasonable accuracy.

The signal was first filtered by a bandpass filter between 0.1 – 5 Hz to remove the DC component and high-frequency noise.

Isovolumetric exercise



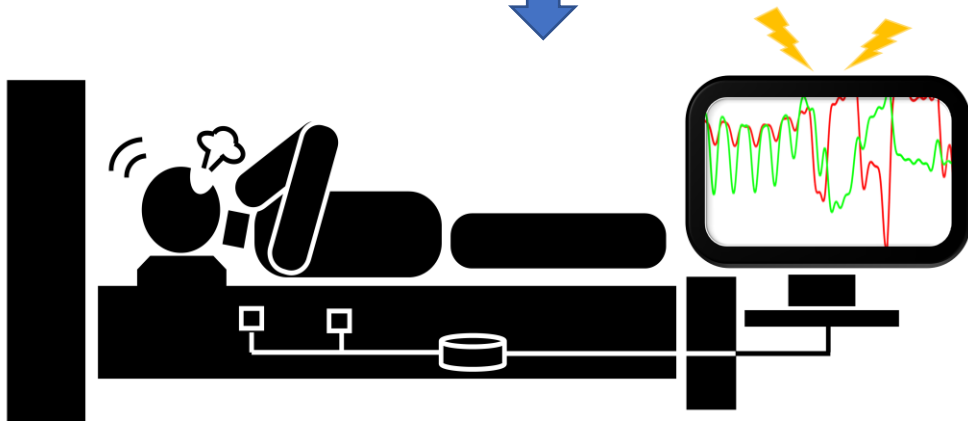
The isovolumetric exercise was represented by paradoxical motion between thorax and abdomen.

Simulated Sleep Apnea

Isovolumetric detection: (a) Respiration waveforms from thorax (red line) and abdomen (green line) sensors during three isovolumetric breathing exercises. (b) Detection by the slope-product method: The blue solid line by the NCS sensor and the orange dotted line from protocol annotation, where -1 indicates detection.

Non-invasive Sensing Vital Signs

To invisible sensing



high user comfort,
worn over cloth, or invisible to user
by furniture integration.
cost-effective, compact

keep long-term and continuous recording data and
provide real-time feedback for early warning and
diagnosis