Fig. 1 shows the IG values, in bits, of the 19 sensors as measured in upper limb adduction, sorted in descending order. Values obtained confirm the dependence between sensor location and joints. Data are currently under treatment to joint movement model by using k-statistic methods.

Wearable low and high frequency acoustic systems
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Recent years have seen rapid growth in ultrasound imaging. Usual transducers for real-time scanner typically contain over 300 crystals where each emits and receives an ultrasound beam in rapid succession to form a sweep. The transducer is included in modern ultrasound equipments which are heavy and bulky, hence not suitable to be integrated in wearable systems. The challenging research activity we endeavored to perform is to realize a wearable, portable and automatic ultrasound system integrated with breath and heart apex pulse system detector, which does not require human contribution in positioning and directing the acoustic wave. The novelty is the bi-modal use of the transducer, which, in addition to actively transmit and receive ultrasound signals for detecting heart wall movements, can behave as passive sensor at low frequency and acquire cardiac sound, breathing signal and heart beat-rate. A suitable electronic switching system allows changing from one modality to the other one. In order to assure the bi-modality, the transducer, made of piezoelectric material (PVDF), should have a low Q factor [2]. Q factor is defined as the ratio between the centre frequency (resonant frequency) and bandwidth, therefore a low value implies a broader working frequency range. The system is based on a textile band containing the transducer, which is connected to an electronic board inserted into a belt through electric paths, realized on a textile substrate. The same transducer excited at high frequency to generate an ultrasound echo, it is also used to acquire cardiac acoustic and breathing signals at low frequency. The system checks the subject status through the low frequency analysis, and when an anomalous event occurs in every part of the signals (shape, frequency etc.) it activates the ultrasound system to emit an impulse train that analyzes the mechanical heart wall movement. A simultaneous ECG signal is acquired to provide the interlock signal in the ultrasound investigation. Moreover it provides information about the electric behavior of the heart and can enrich the clinical picture of the cardiac activity in addition to the signals acquired by the ultrasound transducer. A single signal comprising breath and heart apex pulse is acquired by a charge amplifier. High frequency investigation has shown the movement of the heart wall in terms of spatial length expressed in centimeters. The accuracy of these results (Fig. 1) depends on how good the transducer adheres to the thoracic wall as well as on the high sampling frequency, and the algorithm implemented to localize the return echo. Nonetheless, several issues should be more deeply addressed. As the system should be wearable and used for a long time, the relative body-transducer displacement as well as skin-electrode mismatch are crucial aspects. Skin transducer or skin-electrode interfaces, indeed, should have a good electric coupling and, at the same time, should be comfortable for the subject wearing the system. As the system is thought to be used by a subject while he is doing usual daily actions, motion body can produce significant artefacts in the mechanical coupling and materials used.

References

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