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The trends in technology allow the decrease in both size and power consumption of complex digital systems. This decrease in size and power gives rise to the concept of wearable devices which are integrated in everyday personal belongings like clothes, watch, glasses, et cetera. Power supply is a limiting factor in the mobility of the wearable device which gets restricted to the lifetime of the battery. Furthermore, due to the costs and inaccessible locations, the replacement or recharging of batteries is often not feasible for wearable devices integrated in smart clothes. Wearable devices are devices distributed in personal belongings and thus, an alternative for powering them is to harvest energy from the user. Therefore, the energy can be harvested, distributed and supplied over the human body. Wearable devices can create, like the sensors of a Wireless Sensor Network (WSN), a Body Area Network. A study of piezoelectric, inductive and thermoelectric generators that harvest passive human power is the main objective of this thesis.

The physical principle of an energy harvesting generator is obviously the same no matter whether it is employed with an environmental or human body source. Nevertheless, the limitations related to low voltage, current and frequency levels obtained from human body sources bring new requirements to the energy harvesting topic that were not present in the case of the environment sources. This analysis is the motivation for this thesis.

The type of input energy and transducer form a tandem since the election of one imposes the other. It is important that measurements are done in different parts of the human body while doing different physical activities to locate which positions and activities produce more energy. The mechanical coupling between the transducer and the human body depends on the location of the transducer and the activity that is done. A specific design taking this into account can increase more than a 200% the efficiency of the transducer as has been demonstrated with piezoelectric films located in the insoles of shoes.

Acceleration measurements have been performed in different body locations and different physical activities, in order to quantify the amount of available energy associated with usual human movements.

A system-level simulation has been implemented modeling the elements of an energy self-powered system. Physical equations have been used for the transducer in order to include the mechanical part of the system and electrical and behavioral models for the rest of the components. In this way, the process of the design of the complete application (including the load and an energy storage element when it is necessary) is simplified to achieve the expected requirements. Obviously, the load must be a low power consumption device as for example a RF transmitter. In this case, it is preferable to operate it in a discontinuous way without a battery as it is deduced from simulation results obtained. However, the evolution in low power transmission modules can change this conclusion depending mostly on the evolution of the power consumption in stand-by mode and the configuration time in transmission operation.

It has been deduced from the analysis of inductive generators that time-domain analysis allows to calculate some magnitudes that are not available in frequency domain. For example, the maximum power can be calculated in frequency domain, but for energy harvesting applications it is more interesting to know the value of the recovered energy during a certain time, or the average power since the power generated by human activities can be highly discontinuous.

It has been demonstrated that energy harvesting transducers are able to supply power to present-day low

power electronic devices as was demonstrated with a RF transmitter powered by a thermogenerator that employs the temperature gradient between human body and the environment (3-5 K) and that it is able to sense and transmit data once every second.

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