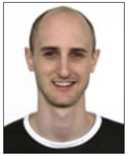

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Datalogger Implant for Osteosynthesis Research

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Subject Area	Mobile Communications
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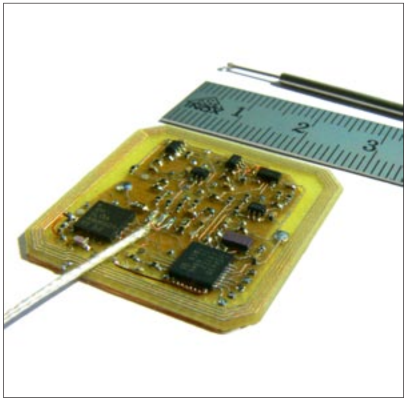

Implant and sensor

Topic: AO Foundation, a non-profit organization in the medical sector, has recently been researching the influence of dynamic stress on artificial bone implants. Dynamic stress is thought to expedite the healing process of bone fractures. The principle is called passive-dynamic osteosynthesis, where the stress on the bone while walking repeatedly stimulates the implanted bone.

An implant with a sensor to measure the deformation of a bone implant in a sheep already exists. But until now, the sensor was wired through the skin to the outside, where the signal conditioner was connected. Because of the constantly open wound, the healing is slowed down and the risk of infection is very high. In order to minimize that risk, the communication from the sensor to the outside needs to be wireless and the whole circuit needs to be self-powered. Furthermore, the data from the sensor has to be logged and stored inside, thus allowing constant observation of the sensor displacement. The results can then be transmitted to the outside.

The requirements for this stand-alone implant are:

- Dimension: no more than 30 × 20 × 10 mm
- Stand-alone operation time: at least nine months
- When activated, constantly log the traveled distance detected by the sensor and count the number of strokes.
- When requested by a wireless receiver, provide all the logged data.

Objective: The objective of this thesis is to design a stand-alone implant prototype with all the above mentioned functions, ready to be implanted. To achieve this, adequate hardware for the signal conditioning and wireless standards have to be determined, especially regarding the limited space and power supply inside the sheep. The printed circuit board has to be designed and crafted. In addition, a Windows application needs to be created that will allow the measurement data to be stored and read easily.

Solution: RFID technology, commonly known from the small tags that protect merchandise in stores, is used mostly because it is small and fully passive. The required power to transmit data is provided via induction by the RFID Reader. Such transponders are already available on the market, even with integrated memory. The problem is that in most cases the memory can only be accessed via wireless transmission. Finally, only one transponder was found whose memory can also be accessed via a wired connection.

The output of the sensor is an alternating signal. There are many possibilities to detect the contained information, such as amplitude-, frequency- or phase modulation. Two potential principles have been evaluated.

- Peak detector, using a schottky diode and a capacitor: get the result according to the DC level
- Lock-in amplifier, providing the alternating signal to an analog-digital-converter, then calculate the result digitally

For the handling of the logging and data storage function, a low-power microcontroller is used.

There are only a few ways to provide the power for the microcontroller and the signal conditioning, mostly because of the small space available and the fact that the whole circuit is under the skin. As it is undesirable to install any kind of object on the skin, the power source needs to be inside as well, leaving only the possibility to use a battery: one that is small enough, like a coin cell.