UHF RFID Anisotropic Magnetoresistance Sensor For Human Motion Monitoring

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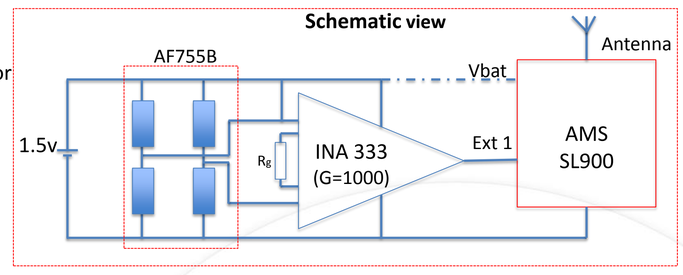
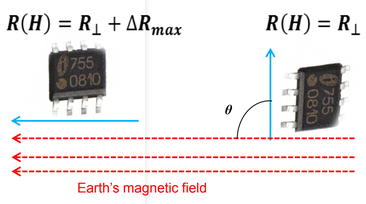
INTRODUCTION - Many different disciplines use motion analysis systems to capture movement and posture of the human body. The idea of miming human motion for animated characters is not new, but thanks to the evolution of technology over the past 40 years, the measure has reached a higher sensitivity and resolution definition. Years of technological development for the sake of human movement analysis has led to five key detection principles: mechanical, optical, magnetic, acoustic and inertial [1]. In this paper, we are interested by physical activity and its easy measurement. We propose a solution to estimate the physical activity of a person based on the coupling of radio frequency identification (RFID) with a magneto resistive sensor through the use of a specific tag IC. With this system, we just want to know if this person has moved with which magnitude and with which frequency. These informations allow us to quantify the human movement. Our final goal is to propose a RFID sensor wrist strap estimating the actimetry from persons who suffer of obesity or sarcopenia.

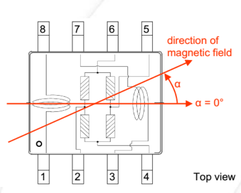
UHF RFID SENSOR

Compound to :

- an Anisotropic Magnetic Resistive (AMR) Sensor (AFF 755B) produced by Sensitec
- a Low power Instrumentation amplifier (INA 333) produced by Texas Instrument
- an UHF RFID Chip (SL900) produced by AMS
- a RFID Dipole Antenna designed by IES
- a Battery







Focus on AMR Sensor

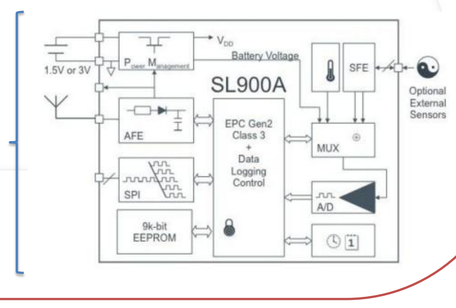
$$\Delta R(H) = \Delta R_{max}\left(\frac{1}{2} \pm \frac{H_y}{H_0}\sqrt{1-\left(\frac{H_y}{H_0}\right)^2}\right)$$

H_y: magnetic applied field H_0: magnetic saturation field

- Resolution specified : 2nT
- Sensitivity : 15mV/V/KA/m

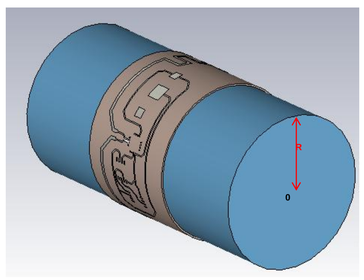
Focus on RFID Chip

- Frequency : 860 to 960 MHz
- Battery Supply : 1.5V or 3V (Also powered from RF field of reader
- EPC Class 3 chip with sensor
- On chip 9k bit / Real time clock for data logging
- Record sensor data
- Data logging from : On chip Temperature sensor & 2 external sensors
- Activation power : -15dBm



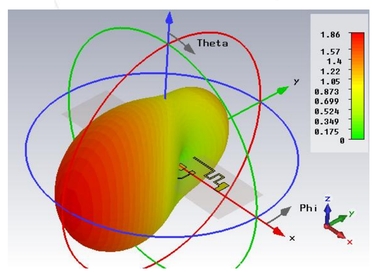
UHF RFID ANTENNA OPTIMIZATION

Read range simulation for flexible antennas

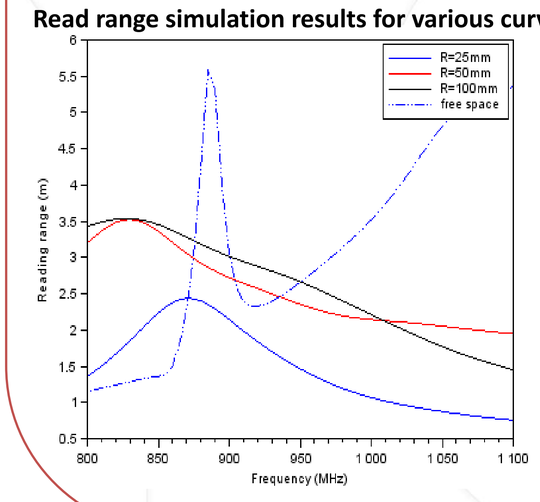


- Dipole-based Antenna designed
- Conjugate matching Between Zant and Zchip
- Using CST MicroWave studio to simulate
- Real conditions (Wrist format, bio-tissue)
- Study between the curvature radius R
- Total surface 102 X 22 mm²

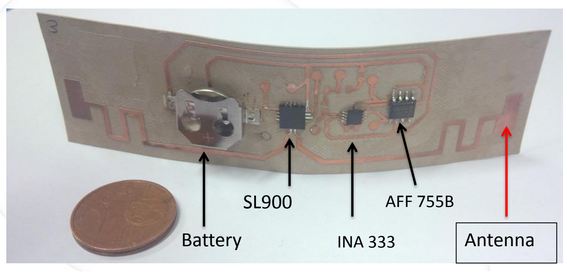
3D radiation pattern



Read range simulation results for various curvature radius

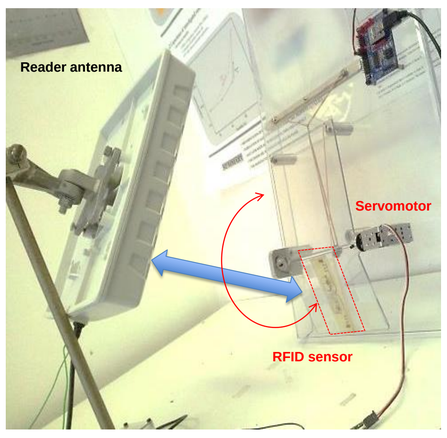


Prototype view



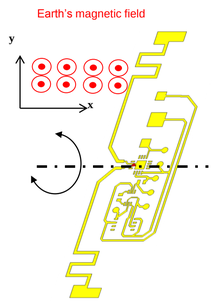
- Read range simulation results of design on human body proposed
- Curvature radius R changes from 25mm to 100 mm

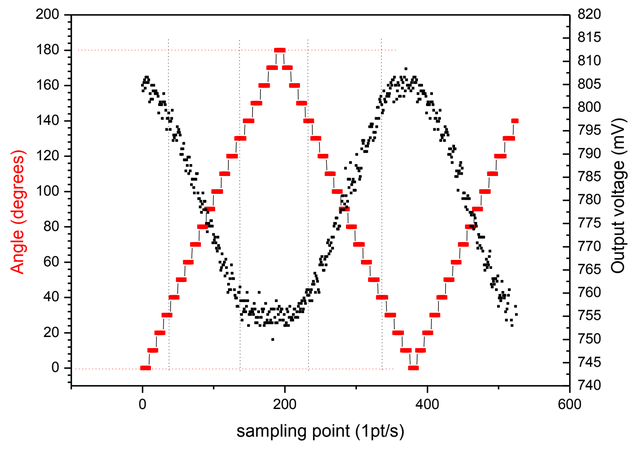
EXPERIMENTAL SET-UP & FIRST RESULTS

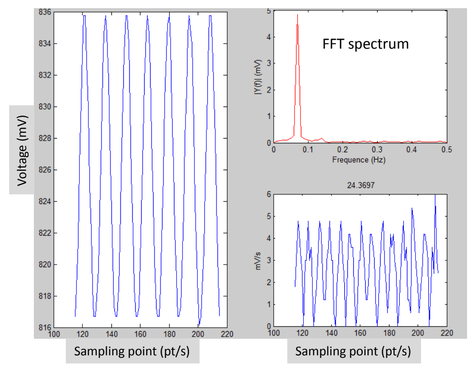


Set-up for rotation tests

- RFID reader (20dBm)
- AMS software (EPC code + Sensor)
- Matlab for curve extraction
- FFT treatment
- Idenfication of arm movement







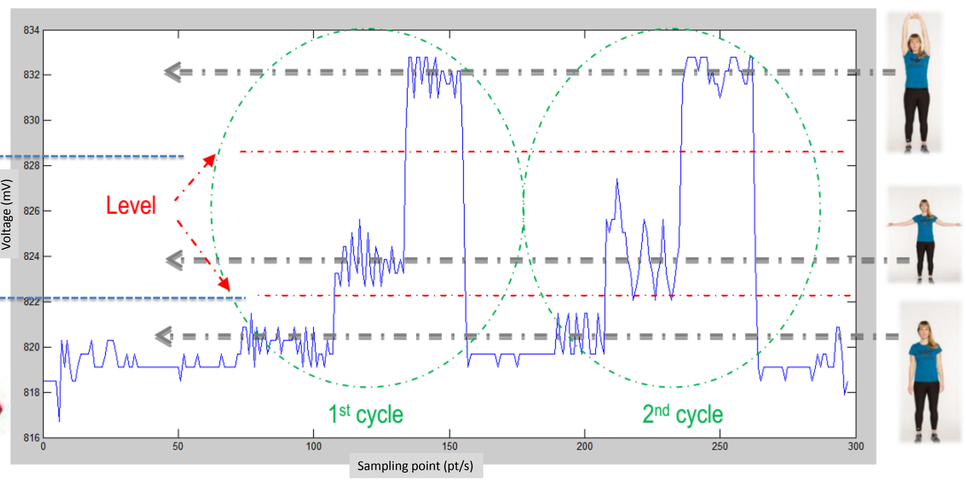
- Calculated speed with Matlab soft: **24,3697° /s**
- Servomotor speed: **20° /s**

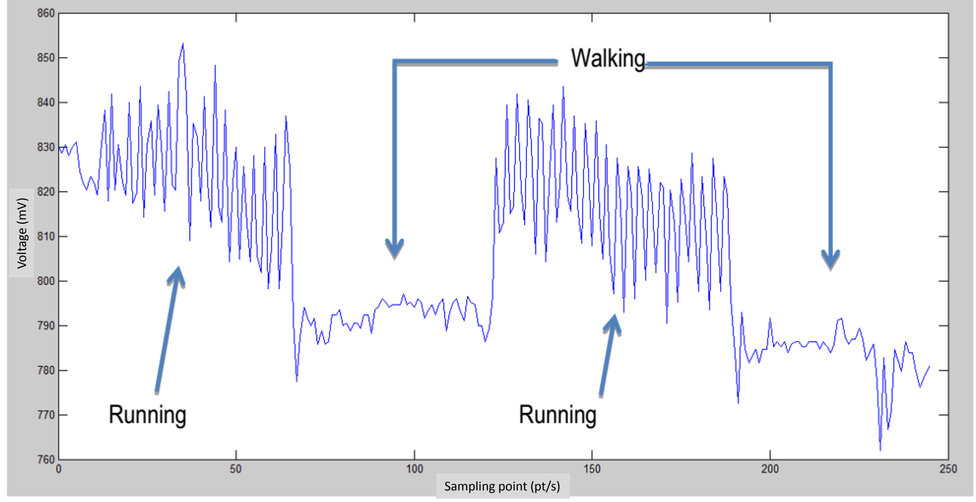
UHF RFID Sensor prototype wrapped around a voluntary person's wrist

Static measurement
- Arm positions (along the body, tense, cross)
- Arm oscillation s to each position

Quantification by Colorimetric indicator

High activity — A, B
Medium activity — C, D, E
Low activity — F, G





Dynamic measurement
- 2 periods : Walking and Running
- Arm movement means the period

SUMMARY/PERSPECTIVES

- ✓ Possible to measure motion changes and record them with RFID sensor system based on the apparent variations of geomagnetic field.
- ✓ First results confirm that this simple and cost efficiency RFID sensor could be used to measure physical activity of persons.
- ✓ Study of the optimum positioning of UHF RFID Sensor to precisely correlate the physical activity with the recorded data.
- ✓ To develop a specific software (Apps for mobile phone)

[1] D. Roetenberg, Inertial and Magnetic Sensing of Human Motion. PhD thesis, University of Twente, Twente, The Netherlands, 2006.

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