1) TITLE: Pseudo orthogonal PN-sequences for ultrasonic imaging system

DESCRIPTION: A 2-D imaging procedure for ultrasonic nondestructive testing has to be realized. It relies on both the use of pseudo-orthogonal sequences and of an inversion procedure made robust by combining the conjugate gradient iterative method with the Total Variation regularization. The effectiveness of the proposed procedure has been verified by experimental results: the overall system proved to be able to detect and locate foreign objects within the inspection area, performing good resolution characteristics. The experiments performed have to allow quantitative evaluation about both benefits and limitations implied by the proposed approach. It is necessary to develop both technical and theoretical aspects. Interesting advantages can be derived from the possibility of attaining a high signal to noise ratio even if low power excitations have been adopted, as demonstrated by previous experiments: if appropriately developed, this possibility can have an interesting impact in the industrial applications of the proposed technique, as it can allow further reductions in the physical dimensions of the ultrasonic devices, and this can lead to much higher flexibility in its practical use in industrial environments. As far as the theoretical aspects are concerned, the work will be aimed to develop computationally efficient deconvolution algorithms needed to adopt the Kasami or Gold codes. This would lead to a further reduction of the cross-talking between different channels while preserving the computational efficiency of the current procedure.
2) TITLE: Non-destructive control of metallic plate with magnetic techniques

DESCRIPTION: Magnetic inspection techniques are nowadays widely used in system for Non-destructive Test (NDT) of various type of application. One of the most important application is the magnetic inspection of metallic object, that use family of sensor (Hall, GMR and coils) sensible to the magnetic flux (Hall and GMR are sensible to intensity of flux, and coils are sensible to the variation of the flux). System based on this techniques, in general, are able to read the sensor and, applying a proper software processing to the data collected, give information about the external an internal state (damage, presence of inclusion) of the object under test. An example of this method is the magneto-inductive inspection of metallic rope, widely used for the inspection of cableways. Design and realization of a sensor able to scan the surface of steel sheets by performing a 2D magnetic image of the sample surface. This image is carried out by exploiting two arrays of Hall probes. An electronic circuit has to be realized to easily interface and drive the arrays. Quite generally the data can be affected by several unwanted noises that could require a combination of different filtering and denoising approaches to be effective. Several alternative strategies can be pursued like wavelet denoising, principal component analysis, etc. (Truchetet and Laligant 2008). The protocol has to be applied to samples having defects with different geometric extension and metallurgic nature. In particular, also defects with extension of few mm² can be detected with a satisfactory signal to noise ratio.

Setup of the sensor. Hall probe are placed between metallic sheet and PM.

Schematic diagram of the sensor connections.
3) TITLE: Binary Spreading Sequences for fast switching process in MRAM

DESCRIPTION: Spin transfer-driven magnetic switching may reduce the current densities required to induce switching or may increase the switching speed in MRAM nanopillar. Recent experiments have shown that a spin-polarized current can excite periodic oscillations of the magnetization in multilayer structures with nanometric thickness. The analysis of the ferromagnetic resonance -FMR- driven by spin-transfer torque is nowadays attracting much attention because it can provide information about the energy dissipation in ferromagnetic structures patterned at nanoscale dimensions. For data storage applications, spin-transfer-torque (STT)-devices have to satisfy two main features: (i) reduced critical current (therefore reduced switching times) in order to be compatible with the CMOS technology, and (ii) high thermal stability. Reductions of the critical current have been obtained with different strategies involving complicated structures. To further improve the switching properties in spin-valves a resonant switching-based memory architectures can be a key solution. Some researchers have recently found that the energy required to flip the magnetization in perpendicular materials can be minimized by simultaneously exciting the sample with a DC spin-polarized current and with a very small transversal microwave sinusoidal field at a proper frequency. Usually, this frequency value corresponds to the natural precessional frequency of the sample. Since non-linear phenomena are present, in general that frequency can be quite different with respect to the FMR one, and it depends on both magnetic and geometric parameters. We propose an innovative way to excite the magnetization able to trigger the reversal mechanism without having to tune the frequency of the sinusoidal signals. Such method exploits the peculiar spectral properties of the so-called binary spreading sequences (BSS) and it allows to overcome the uncertainty in the polarization and in the phase of the transversal field and the sinusoidal current respectively.

Sketch of a memory cell MRAM.