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A Computer Algorithm for Automatic Tracking of Catheters Marked with Resonant Coils in MR

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Introduction: Magnetic resonance imaging is becoming an attractive modality in minimally invasive surgeries, especially for the guidance of catheter-based interventions. This is due to several attributes like the rich soft tissue contrast, the ability to provide functional information and the absence of the ionizing radiations in MR imaging. In addition, it is possible nowadays to obtain MR Images in very short time with satisfactory spatial resolution. Important factors during endovascular procedures are both accurately tracking the position of the catheter and also the visualization of the instrument within the anatomy of interest. This work presents a new catheter tracking algorithm to be used in MR guided procedures.

Method: The algorithm uses a probability map generated for each MRI frame. This probability map is based on the similarity to a given marker model. The method to assess the similarity between the marker template image and the different sites on each MR frame is based on SURF (Speeded-Up Robust Features) signatures [2] extracted from the gradient image. The probability map is used in a Mean-Shift localization framework [3] to track the catheter in the dynamic sequence of MR images. The algorithm developed was tested on LC resonant markers [1] tuned to the larmor frequency of the MRI scanner. Such a circuit amplifies the local B1 field by a factor of typically 10 or more, resulting in a local increase of the flip angle in the vicinity of the circuit and thus a brighter signal in the MR image. A circuit configuration of single loop coil with rectangular shape was designed with an inductance of 30nH. The coil was soldered to a 47 pF capacitor and the resonant circuit was attached to the tip of a 5F size catheter. The catheter was then introduced into a vessel-like phantom filled with water. The catheter was slowly moved inside the phantom while a series of images was acquired.

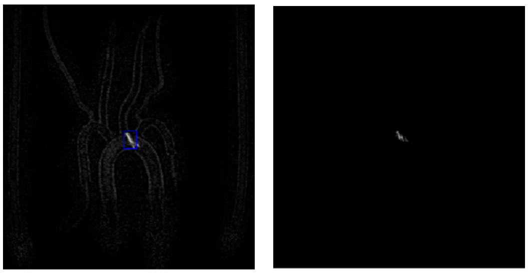
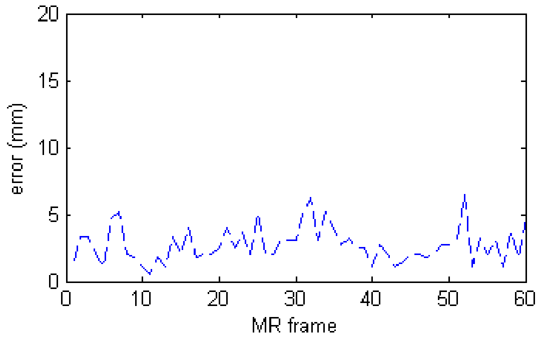


Figure 1: MR frame (left) and the associated probability map (right)

Results: The results showed that the tracking algorithm was quite robust and reliable in tracking the position of the catheter tip, and that it is possible to use it in an automatic image acquisition and visualization scheme for MRI guided catheterization. The discrepancy between the automatic algorithm output and a manual human localization on each MR frame was (2.7 mm) on average. In the next step, we will test this algorithm on MR images acquired online and we will use the output of the tracking to drive the MR scanner and control the image acquisition.



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tracking and the human manual localization at each time MR

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