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(54) **SYSTEM AND METHOD FOR RADAR-ASSISTED CATHETER GUIDANCE AND CONTROL**

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(58) **Field of Classification Search** 600/114, 600/117, 118, 173, 420, 424
See application file for complete search history.

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(57) **ABSTRACT**

A Catheter Guidance Control and Imaging (CGCI) system whereby a magnetic tip attached to a surgical tool is detected, displayed and influenced positionally so as to allow diagnostic and therapeutic procedures to be performed is described. The tools that can be so equipped include catheters, guidewires, and secondary tools such as lasers and balloons. The magnetic tip performs two functions. First, it allows the position and orientation of the tip to be determined by using a radar system such as, for example, a radar range finder or radar imaging system. Incorporating the radar system allows the CGCI apparatus to detect accurately the position, orientation and rotation of the surgical tool embedded in a patient during surgery. In one embodiment, the image generated by the radar is displayed with the operating room imagery equipment such as, for example, X-ray, Fluoroscopy, Ultrasound, MRI, CAT-Scan, PET-Scan, etc. In one embodiment, the image is synchronized with the aid of fiduciary markers located by a 6-Degrees of Freedom (6-DOF) sensor. The CGCI apparatus combined with the radar and the 6-DOF sensor allows the tool tip to be pulled, pushed, turned, and forcefully held in the desired position by applying an appropriate magnetic field external to the patient's body. A virtual representation of the magnetic tip serves as an operator control. This control possesses a one-to-one positional relationship with the magnetic tip inside the patient's body. Additionally, this control provides tactile feedback to the operator's hands in the appropriate axis or axes if the magnetic tip encounters an obstacle. The output of this control combined with the magnetic tip position and orientation feedback allows a servo system to control the external magnetic field.

10 Claims, 20 Drawing Sheets