Magnetic Field Analysis of Lesion Localization via GMR Probe

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Abstract ¡ Magnetic field is analysed to lesion localization via GMR probe in the paper. Magnetic liquid is used to human body non-trauma lesion localization. Magnetic fluid is sent to the lesion targeted drug. The detection circuitry is a Wheatstone bridge with a giant magnetoresistance (GMR) and a coil. The resistance of GMR changes in magnetic field, then it can pinpoint the location of magnetic fluid.

I. INTRODUCTION

With the progress and development of technology in recent years, more treatments for cancers have been found, but they can only function after pinpointing the lesion. Since the beginning of 21st century, molecule targeted drug has being used as a new weapon to treat cancers. And thanking to molecule targeted drug, pinpointing the lesion and cancerous cells is possible.

Considering the difficulties of human body non-trauma lesion localization, this paper combines magnetic fluid with molecule targeted drug. And therefore by pinpointing magnetic fluid, we can realize the orientation.

II. PRINCIPLES

A. Principle of the Giant Magnetoresistance (GMR) probe

GMR effect is a phenomenon of the resistance of GMR decreasing sharply in a certain magnetic field. And usually it decreases an order of magnitude lower than normal magnetic metals and alloys. This paper pinpoints the magnetic fluid in the body by the GMR effect.

The work principle of the GMR probe is using three common resistors and a GMR resistor to build a Wheatstone bridge, whose circuit structure is shown in Fig.1. There, R_1 is the GMR resistor, R_2, R_3, R_4 are the reference resistors whose resistance should remain constant regardless of changing of the surroundings. There is a coil set on R_1, whose role is to generate a constant magnetic field. By adjusting the coil current, we can make the GMR resistance and reference resistance equivalent. When a constant current source is added between A and B, the Wheatstone bridge reaches equilibrium and the detected voltage signal is 0. When the GMR resistor gets close enough to magnetic fluid, the constant magnetic field of the GMR resistor would be interfered and therefore changed. The resistance of R_1 changes due to the change of the external magnetic field, while the reference resistors R_2, R_3, R_4 remain constant. So the Wheatstone bridge is diverted from equilibrium and output a voltage signal.

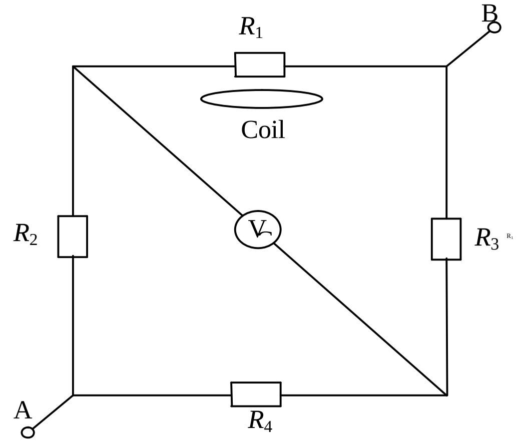

Fig.1 Wheatstone bridge

B. Principle of the Giant Magnetoresistance (GMR) probe

Change of magnetic field could lead up to the change of resistance of GMR. The more magnetic field changes, the more change of resistance of GMR will be, so the detected voltage signal will increase in amplitude. Therefore when the GMR probe is positioned right above the lesion, the detected voltage will reach its peak. According to this principle, two GMR probes would be placed in front of and at the side of a patient¡s body to conduct the orientation respectively as showed in Fig.2. Then we can draw a line L_1 passing through the point whose detected voltage reaches peak from the front probe, so is L_2 from the side probe, and the intersection of L_1 and L_2 would be the pinpoint of the lesion.

III. MAGNETIC FIELD FEM ANALYSIS AND EXPERIMENT

The radius of the coil is 0.5mm, applied current intensity is $10^7/m^2$ and the number of windings is 400. For the volume of GMR resistor is very small, the influence caused by whose magnetic permeability upon magnetic field could be neglected. The field intensity distribution without disturbance of other medium is illustrated in Fig.3, the intensity at point P is approximately 430A/m (which is located 10cm away from the coil).

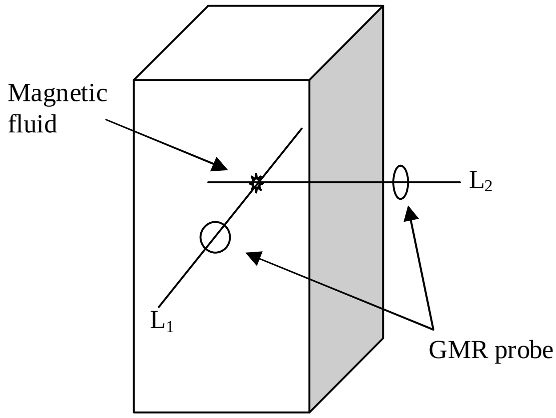

Fig.2 The schematic diagram of the pinpointing

When the magnetic field is disturbed by surrounding magnetic fluid located about 10cm above the coil, the intensity distribution is drawn in Fig.4, and magnetic field intensity at point P is approximately 540A/m. The variation of magnetic field intensity is big enough to change the resistance of GMR resistor, would convert magnetic signal into electric signal. And by using of the intersection method described above, the lesion can be pinpointed.

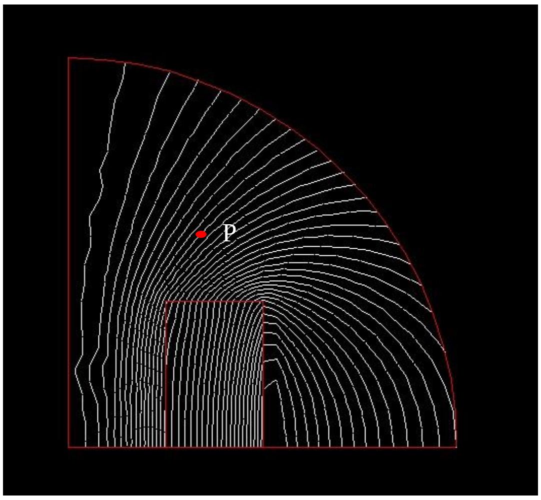

Fig.3 Magnetic field lines without magnetic fluid

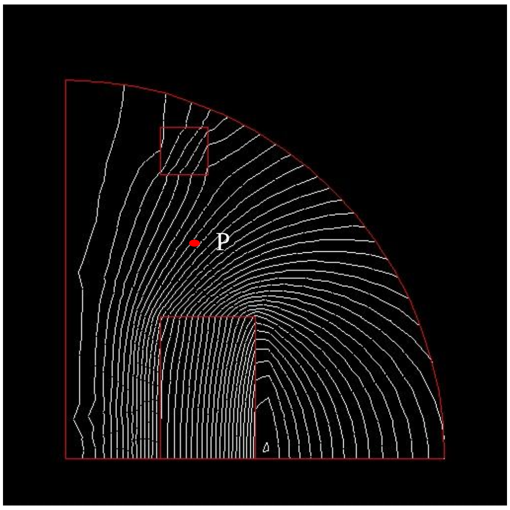

Fig.4 Magnetic field lines with magnetic fluid

IV. CONCLUSION

A device for human body non-trauma lesion orientation is proposed in this paper. At the point of the GMR, The variation of magnetic field intensity is big enough to change the resistance of GMR. So we can pinpoint the lesion. The experiment is still ongoing, final conclusion will be addressed in the full paper.

V. ACKNOWLEDGMENT

This work was supported by National Natural Science Foundation of China under Grant No. 51077037, and Natural Science Foundation of Hebei province, China under Grant No. E2008000050.

VI. REFERENCES

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