DETECTION OF MAGNETIC STRUCTURES IN HUMAN BODIES

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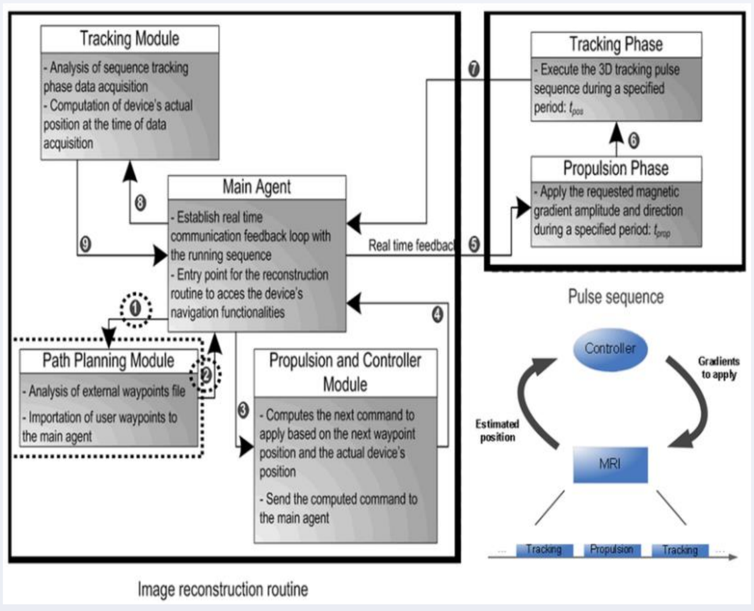
ABSTRACT



Sylvain Martel's block diagram [1]

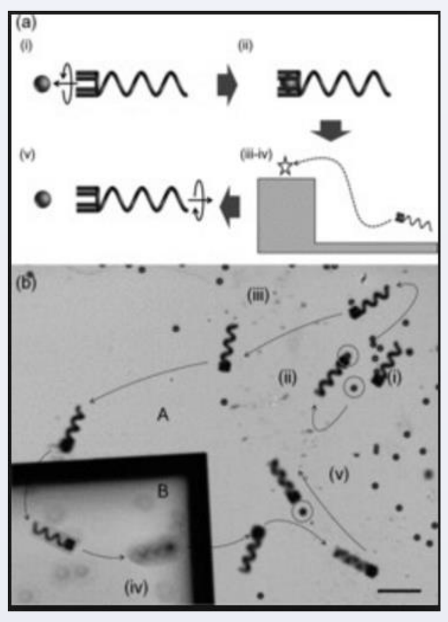


Illustration of transportation procedure by a helical micromachine with a microholder [2]

Swimming micro ana nanorobots have been promising hope in medical field in terms of non-invasive surgery, targeted drug delivering and bio-sensing. Nanorobots can be detected by detecting the magnetic field due to their magnetic components or coat of the nanorobots. However, scalar quantity of the magnetic field is extremely small. There aren't many research to detect extremely small magnetic fields. In this article, two methods of detecting small magnetic fields have been discussed which are optical magnetic field sensor and SQUID.

In 2009, Sylvain Martel published an article claiming that we can use magnetic particles and magnetic field to create nanorobots. He states that with the help of MRI for feeding back to information to a controller which is responsible for control and navigation in the blood vessels of magnetic carriers, nanorobots and magnetic bacteria. Therefore, with the help MRI of magnetic carriers, nanorobots and magnetic bacteria, scientists can be used in medicine to send medicine to cells in human body [1].

Also, there are other scientist who studied nanorobots such as Sámuel Sánchez, Famin Qui and Bradley Nelson. Sámuel Sánchez created a nano-bio device that can be used in medical field in Max Planck Institute for Intelligent System in Germany. Famin Qui and Bradley Nelson studied magnetic helical micro and nanorobots for biomedical applications.

[3].

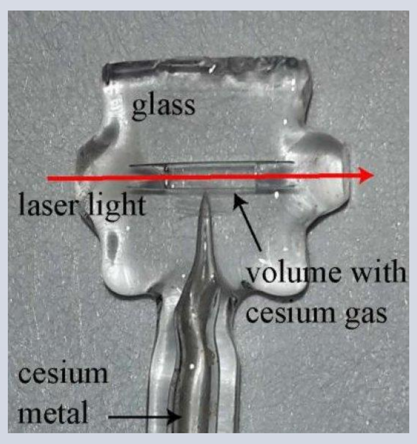
OBJECTIVES

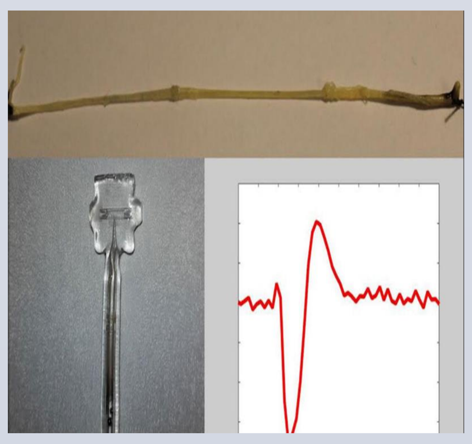
There have been research regarding nanorobots in previous years. However, magnetic field detection is needed to control them. Thus, the magnetic field had been accured is exremely small.

There are two methods to detect extremely small magnetic field. First method is to use a device called optical magnetic field sensor. It has been developed in Niels Bohr Institute. Second method is to use a device called SQUID which is abbreviation for superconducting quantum interference device. SQUID is using magnetic substances, in particular ferromagnetic and ferrimagnetic substances, as enhancing agents for diagnostic magnetometery, and in particular as contrast agents in magnetometric imaging.

Even tough there are other sensor can detect magnetic field, they cannot detect extremely small magnetic fields. Thus, only two method is discussed in this research.

OPTICAL MAGNETIC FIELD SENSOR

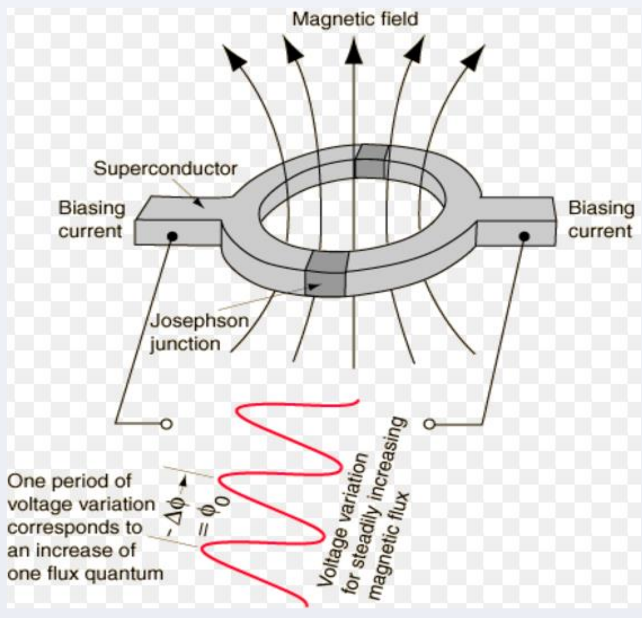




Optical magnetic field sensor's structure is gas of Cesium atoms in a small glass container. Each Cesium atom behaves as a small bar magnet. Each small bar magnet is affected by external magnetic fields. Magnetic field can be detected with the usage of laser lights. It has been proved that the magnetic field sensor can detect the magnetic fields from the electrical impulses from the nervous system. The experiments were done on the sciatic nerve from a frog which has similar structure to nerves in the human body.[4].

Even tough optical magnetic field has many advantages such as less coss, practical, peformance without contact, this sensor might not be working with extremely small magnetic field like SQUID does.

SQUID



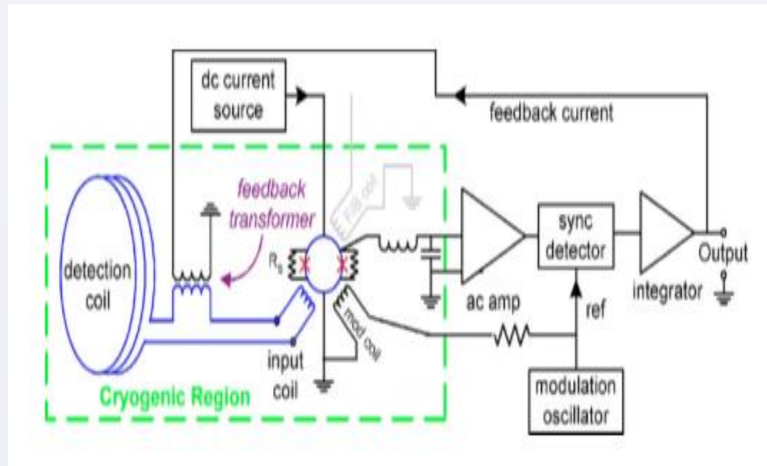


FIG. 16. (Color online) External feedback circuit. Note that the internal feedback circuitry (shown in Fig. 13) is not used.

SQUID magnetometers' structure is a superconducting pick up coil system and a detector system (the SQUID). The detector has been made by inserting one or two Josephson junctions into a loop of superconducting wire. The magnetic flux within such loops is quantized. Because pickup coils can detect an instant and measurable change in the current flowing through the detector, it can detect changes in magnetic field.

SQUID magnetometers can measure magnetic fields up to 10^{-14} Tesla which is one ten billionth the earth's magnetic field. Therefore, it can detect magnetic fields generated by biological activity as low as brain's magnetic field, which is has 10^{-13} T due to electrical activity.[5].

The working principle is based on superconductivity, Josephson junctions and Meissener effect with the help of bias current.

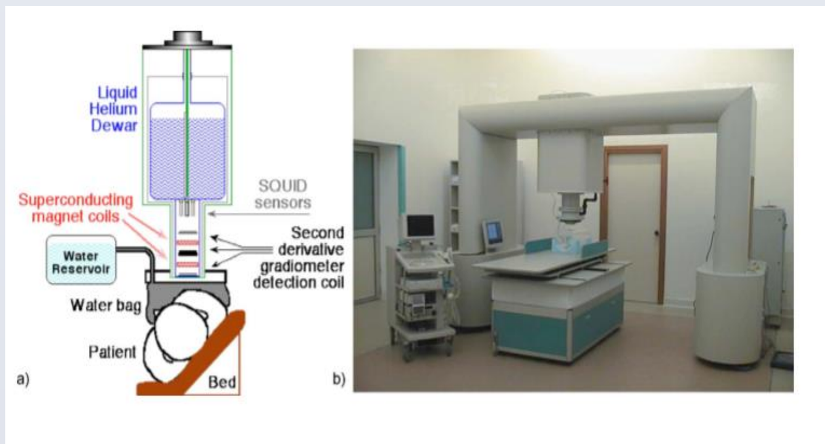


FIG. 66. (Color online) (a) Ferritometer® components. Typical patient movement is 10 cm vertically. The combination of a second order detection coil and a first order magnetizing coil gives excellent near field sensitivity while rejecting distant sources. (b) Installed system showing ultrasound scanner (to left of gantry) and plastic calibration phantom (on bed).

CONCLUSIONS

In order to design nanorobots that swim inside human body, control of nanorobot is necessaty. With the help of the detection of magnetic field, nanorobots can be controlled. In order to do that, optical magnetic sensor or SQUID can be used. When optical magnetic sensor and SQUID are compared with each other, there are advantages and disadvantages of using both of them.

Optical magnetic sensor's first advantage is precisely that the magnetic fields and electrical impulses can be safely and easily picked up at a distance of a few millimetres or centimetres -- without the sensor actually coming into contact with the body. This sensor is cheaper and more practical when it is compared with SQUID. We can also calculate the speed at which the nerve impulses are moving from the measured signals [4].

On the other hand, SQUID is more precise device and it can detect extremely small magnetic fields more efficiently. SQUID has a lot of implementations im medical field including studies of brain, drug development and testing,stroke, blood flow disorders,noninsavie surgeries and so on.

Therefore, for more precise studies in medical field and very small magnetic field detection SQUID will be a better fit. However, if it is not the case, optical magnetic field sensor will be cheaper and more practical device.

LENGTH	OPTICAL MAGNETİC SENSOR	SQUID
1 µm	NO	YES
7 µm	YES	YES
10 µm	YES	YES

REFERENCES

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[2]https://www.researchgate.net/publication/51976292_Micromachines_Magnetic_Helical_Micromachines_Fabrication_Controlled_Swimming_and_Cargo_Transport_Adv_Mater_62012

[3] http://www.msrl.ethz.ch/publications.html

[4] https://www.sciencedaily.com/releases/2016/07/160715112923.htm

[5] http://www.google.com.pg/patents/US5735279