Journal of Special Topics

P1_6 Implanting a Sixth Sense

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February 26, 2011

Abstract

The following article investigates a body modification technique that purports to give users the ability to sense magnetic fields. Some calculations of this are made and it is found that an implanted magnet in a fingertip may be able to detect fields from common household appliances but only over very small distances.

Introduction

Available body modifications range from the common-place (ear piercings and tattoos) to far more extreme techniques such as tongue splitting. One technique, which has only recently been documented, involves the implantation of a small, rare-earth magnet in the fingertip. First hand accounts discuss this augmentation giving an ability to sense nearby magnetic fields, which some have compared to having a sixth sense [1].

Figure 1: X-ray of finger tip with implanted magnet [2].

Discussion

The initial experiment was carried out in 2004 by implanting a small disc-shaped neodymium magnet such as is easily available online [3][4]. The calculations that follow are based on a magnet found available to purchase after a quick internet search [4].

Human fingertips have a sensitivity of $0.2 g/mm^2$[5] which is equivalent to approximately 1960Pa. As this is a pressure measurement it is reasonable to assume that fingers will have the same sensitivity whether pressure is applied to the inside or the outside of the skin. For a typical neodymium magnet with a diameter of 1.6mm this pressure will be achieved with a force of 3.883×10^{-3}N.

A typical magnet has a surface dipole field of 2103G[4]. The magnetic moment of this can then be calculated using,

$$m = \frac{4\pi r^3 B}{\mu_0} \qquad [6](1)$$

where B is the surface field (in Teslas, which can be easily calculated from the Gauss value by multiplying by 10^{-4}), r is half the diameter of the magnet and μ_0 is the permeability of free space. From Equation 1 it can be calculated that the described magnets will have a magnetic moment of 1.051×10^{-3} JT^{-1}.

The force experienced by a dipole in a magnetic field is given by,

$$F = m.\nabla B \qquad [7](2)$$

where B is now the field incident on the magnet. In order to produce a detectable force a field gradient of 3.69 Tm^{-1} is required.

The field produced by a long, coreless solenoid is

$$B = \frac{\mu_0}{4\pi}\frac{Ix}{2R} \qquad [7](3)$$

where I is the current in the wire, x is the number of turns of the wire and R is the perpendicular distance from the wire. Equation 3 can then be differentiated to give the gradient of field required for Equation 2.

Ignoring any danger for the moment, touching a fingertip directly to the solenoid will place the magnet 5mm away from the source of the field. If the current through the solenoid wire is taken to be 3A then a length of 615 turns is sufficient to produce a detectable force.

The WHO provides data on the fields produced by various household appliances [8]. If it is assumed that, from a distance, these appliances act as bar magnets their produced fields would be expected to vary with $1/R^2$. The appliances with the highest recorded field, a hair dryer and a vacuum cleaner, have a detectable field gradient at 1.5 – 9.9mm and 4.6 – 7.3mm awat respectively.

Conclusion

It has been shown that an implanted rare-earth magnet would be able to detect magnetic fields common in the household and as such could impart a kind of sixth sense however, this effect seems to be possible over far shorter distances than first person accounts have suggested. Pressure in the skin is detected by structures known as Merkel's discs but the skin also contains structures that specifically detect vibrations. It is possible that these other structures would have an even greater sensitivity to the movement of the internal magnet and would allow the user to sense even smaller fields or similar fields at a distance closer to that that has been reported.

References

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