CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

S0913

Project Title

Developing a Low Cost Method of Detecting Nuclear Magnetic Resonance

Abstract

Objectives/Goals

Nuclear magnetic resonance (NMR) provides us with the ability to nondestructively image the internal properties of materials. Being able to portably apply such a technology at a low cost would open up the ability for field researchers to examine the substance composition of material which cannot be removed from their environment for an extended period of time. The purpose of this project was to design a prototype to test whether we could still obtain a signal, even with a nonuniform magnet, which is a major problem with signal quality in NMR.

Methods/Materials

The methods we used to bring down the cost of developing an NMR revolved mainly around having a small, non-uniform magnet with a strength of .43 Tesla (T). We used a radiofrequency generator to create pulses necessary for NMR usage. In order to regulate the length and delay of the pulses, we created three separate timer circuits. We also created circuits to amplify both the frequency inputted as well as received in order to compensate for the magnet strength. The received signal is then filtered to remove unwanted interference and directed to an oscilloscope and observed for analysis. The circuits were constructed from individual components, which lowered the manufacturing costs to under $400. We used a sample of water to test the viability of our method. The large number of hydrogen protons in the water would ideally display a noticeable change in received frequency.

Results

The prototype was successful in receiving and displaying signal from the resonance of hydrogen protons in the water sample. The signal strength observed lasted about 5 µs and included a noticeable change in signal height.

Conclusions/Discussion

A smaller MRI is plausible with a magnet strength of .43T. It has the potential to be applicable in field research and integrated into machines for imaging using smaller and less uniform magnets. Possible ways to improve both the design and signal quality would include using a more precise radiofrequency generator as well as having a higher quality coil to detect resonance and reduce interference observed through the system.

Summary Statement

This project explores the possible implementation of a smaller, less uniform magnetic field in NMR in order to save costs and increase transportability.

Help Received

Large permanent magnet donated by Weston Anderson