60-HERTZ ELECTROMAGNETIC FIELD DETECTOR/INTERFACE SYSTEM

Project Proposal

February 8, 2012

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ECE 445 Spring 2012

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INTRODUCTION

Description

Ambient electromagnetic radiation can be a curse in many applications where electronic instrumentation is involved; the motivation for this project stems from such a problem. 60-Hertz (60-Hz) radiation can introduce false signals into electro-encephalogram (EEG) readings, commonly used in the field of neuroscience. 60-Hz radiation is present almost everywhere in the United States, because power generation and transmission is done at that frequency. The first aim of this project is to create a portable 60-Hz electromagnetic radiation detection device that can be easily used to pinpoint areas of high energy density. The second part of this project is aimed at developing a haptic feedback system that utilizes micro-transducers to deliver the field intensity information to the human body through its sense of touch. The applications of this project, however, extend far beyond locating hotspots for proper equipment placement; such a system would facilitate the three-dimensional mapping of static extremely low frequency (ELF) electromagnetic radiation fields in and around structures, which would make it possible to study the effects of ELF radiation on flora and fauna, for example. The haptic feedback system would also make it possible for human beings to experience a new “sense” through the existing sense of touch; the integration of these senses may open up new avenues of research in the field of neuroscience as well.

Benefits

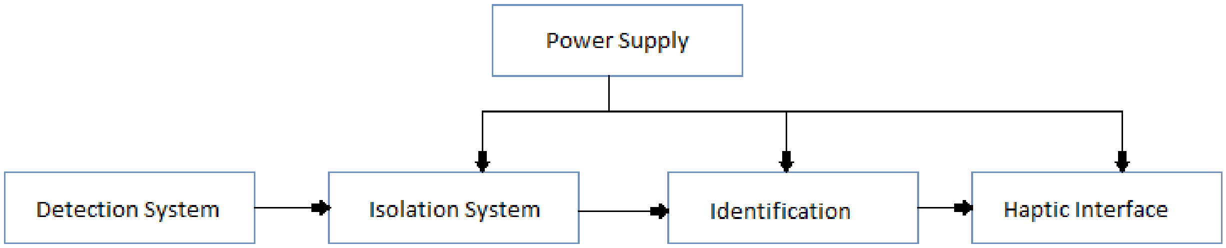
- Detection of 60-Hertz radiation using a compact device
- Intuitive user interface through haptic feedback
- Provides a base for a wide variety of mapping applications
- Modular system eases future modification
- Provides a platform for further research into augmented sensory systems

Features

- Static 3-axis coil configuration for complete detection
- Haptic feedback user interface
- Visual LED interface

DESIGN

Block Diagram



Block Descriptions

Power Supply: The power requirements for the entire circuit will be supplied by a regulated battery source.

Input: None
Output: 5V DC

Detection System: The detection system will comprise of an inductive coil, tuned to be resonant around 60-Hz; the system may contain a ferromagnetic core to increase inductance.

Input: Multi-frequency electromagnetic radiation
Output: Multi-frequency current

Isolation System: The isolation system will comprise of an amplifier and a band-pass filter, to isolate and boost the strength of the 60-Hz radiation detected.

Input: Multi-frequency current
Output: Amplified 60-Hz current

Identification: To identify the intensity of the radiation, an envelope detector will be utilized to determine the amplitude of the boosted signal.

Input: Amplified 60-Hz current
Output: Amplitude of input signal

Haptic Interface: The haptic interface will comprise of a micro-transducer, which will change frequency and/or intensity based upon the amplitude of the boosted signal. A microcontroller may be utilized to smooth out any sudden spikes in the signal as well as implement the control system for the transducer.

Input: Amplitude of input signal
Output: Vibrations with frequency/intensity proportional to input

Performance Requirements

- Detection of 60-Hz electromagnetic radiation at least one foot away from a source.
- 99% filtering of frequencies other 60-Hz
- Continuous, differentiable output signal to micro-transducer

VERIFICATION

Testing Procedure

The circuit will be tested module by module, and as each module is constructed, in order to optimize the build process. The detection system will be tested by taking spectrum readings of background radiation close to 60-Hz sources. The isolation system will be tested by comparing generated input spectra to output spectra, to confirm proper filter and amplifier operation. The identification system will be tested by verifying the output amplitudes of various generated signals. The haptic interface will be tested by generating analog outputs and verifying the frequency of the vibrations. As more rigorous performance specifications are constructed, the testing procedure will be altered to thoroughly check the success of those requirements.

Tolerance Analysis

The functionality of this system is crucially dependent upon the isolation module; without the proper performance of this component, the user may be delivered false intensity information. If the isolation circuit fails to isolate and amplify only the 60-Hz radiation, the amplitude information that the user receives will be incorrect.

In order to verify that the isolation module is working as designed, it will be subject to a host of various known input signals, modulated and un-modulated, some with DC components, in order to verify that it outputs only the portion of the input signal oscillating at 60-Hz.

COST AND SCHEDULE

Cost Analysis

Labor Cost

Billable Hours Per Week Per Engineer	Weeks Of Contract Per Engineer	Total Billable Hours Per Engineer	Multiplicity Factor	Per Hour Billing Rate Per Person	Total Contract Cost
10	13	130	2.5	$35	$11,375.00
No. Of Engineers in Team					3
Total Labor Cost Of Project					$34,125.00

Parts Cost

Parts Required	Quantity	Unit Cost	Total Cost + Shipping
Tactaid VBW32 Skin Transducer	1	$79.00	$85.00
Ferrite Core	3	$3.00	$12.00
22 Gauge Wire	10 Feet	$0.30 Per Feet	$3.00
LED	2	$0.15	$0.30
TL082 Opamp	1	$3.00	$5.00
2N3904 NPN BJT	3	$2.00	$10.00
LM 741 Op-amp	6	$0.25	$3.00
Rectifier Diode	1	$0.15	$0.15
Resistors	15	$0.10	$1.50
Capacitors	10	$0.10	$1.00
Microcontroller	1	$30.00	$30.00
Bread Board	1	$5.00	$5.00
PCB	1	$10.00	$10.00
Total Parts Cost of Project			$165.95

Total Cost of Project: $34,290.95

Schedule

Week	Date	Task	Person In Charge
1	2/6/2012	Write Proposal	Gaurav Jaina
		Amplifier Design	Kuei-Cheng Hsiang
		Filter Design	Gaurav Jaina
		Microcontroller Configuration	Bhaskar Vaidya
2	2/13/2012	Decide Parts for Hardware Modules	Gaurav Jaina
		Design User Interface	Kuei-Cheng Hsiang
		Design Overview	Bhaskar Vaidya
3	2/20/2012	Design Review	Bhaskar Vaidya
		Order Parts	Gaurav Jaina
4	2/27/2012	Build Coil Antenna	Kuei-Cheng Hsiang
		Build Filter	Gaurav Jaina
5	3/5/2012	Build Amplifier	Gaurav Jaina
		Test Signal Pick Up	Kuei-Cheng Hsiang
6	3/12/2012	Connect Signal to Control System	Kuei-Cheng Hsiang
		Program Microcontroller	Bhaskar Vaidya
		Set Up User Interface	Gaurav Jaina
8	3/19/2012	Spring Break	
9	3/26/2012	Make and Test All connections	Kuei-Cheng Hsiang
		Mock Up Demo	Bhaskar Vaidya
10	4/2/2012	Mock Presentation	Gaurav Jaina
11	4/9/2012	Tweak Design, Check for Possible Improvements	Gaurav Jaina
		Debug If any errors	Kuei-Cheng Hsiang
12	4/16/2012	Resolve if any problem remains	Bhaskar Vaidya
		Prepare Presentation	Gaurav Jaina
		Prepare Final Paper	Kuei-Cheng Hsiang
13	4/23/2012	Presentation	Gaurav Jaina
		Demo	Bhaskar Vaidya
14	4/30/2012	Final Paper	Kuei-Cheng Hsiang