PROJECT PROPOSAL - EXAMPLES

The following examples are drawn from past student reports, and illustrate how the general guidelines can be applied to a variety of design projects. They should help you get a sense of what is expected for the *final* Project Proposal document. The technical details have been removed in order to highlight the report structure and organization as opposed to the technical content or writing style. These examples have not been properly formatted with the appropriate use of tables, bullets, references, etc.

Example #1: Controller for Frequency Modulated Spectroscopy

Executive Summary

This project involves building a system that modulates light in the 0.1Hz to 50kHz range and detects the reflected light through the patient's tissue at multiple distances...

The system consists of three main modules: an Optoelectronics Module, a Real-Time Signal Processing Module and a Graphical User Interface module. The Optoelectronics Module generates an optical signal using laser diodes... The Real-Time Signal Processing Module performs the spectral analysis, peak detection and power measurements. Graphical User Interface (GUI) module commands the Master Controller and the USB controller....

A validation test of the prototype involves generating and detecting an optical pulse, analyzing, and displaying the captured pulse and displaying the time- and frequency-domain results on a laptop computer.

The project plan involves completing the design of the modules by ..., with the testing taking priority in the winter term. The total cost of the project is now approximately $XX (after we successfully obtained $XX from our industrial sponsors). The remaining cost is covered by our supervisor's research grants.

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Example #2: Secure watermark-based multimedia authentication system

Executive Summary

The widespread use of digital media has led to an increased demand for digital content protection mechanisms. This project investigates the use of watermarking as a means to protect digital content, and proposes a secure watermark-based multimedia authentication system that will allow a user to embed and authenticate imperceptible, inseparable messages in an image.

The watermark-based authentication process can involves two steps:
(1) Embedding a watermark onto an image according to a user's specifications
(2) Verifying a watermarked image according to a user's sensitivity parameters

The proposed design uses a semi-fragile embedding method, which is more flexible than a strictly fragile or robust method. *(a further, corresponding description of the design of the verification step)*

To validate our system, we will use images from a sample library that are embedded with a watermark. Various "attacks" will be made to copies of the watermarked images. We will measure the false positive and negative rates which are defined as ... To verify our imperceptibility requirement, we will measure...

The system will be coded using Matlab, since the prototype software invokes pre-defined Matlab Image Processing functions. A weakness of this design is the fact that it may not be easily portable, since a full version of Matlab with the Image Processing Toolbox installed is necessary to run the program.

One of the main project risks is that it may be infeasible to run all the necessary tests to control the behavior and accuracy of the system. To mitigate this risk, two sets of benchmark tests will be created: a core set, which must be successfully completed by the project's end, and a supplementary set that will be completed if time permits. No budget has been allocated for this project, as all of the required software is available at the University of Toronto computer labs.

Project Description

Background and Motivation

The use of new engineering technologies in the biomedical field to further medical research and treatment is a growing trend. An important trend is the use of light in the diagnosis and treatment of various illnesses…

Currently, diffused reflection of un-modulated, spectrally resolved light can only give information on the main tissue chromophores… This information is of limited value because the biochemical constituencies of the tissue are not effectively analyzed.

It is believed that using modulated light will allow us to extract additional information from the time-variant chromophore concentration in cancer patient's tissue. Through testing of various tissue states, noise that is common to all tissues can be eliminated, providing valuable information to researchers and medical professionals.

In this project, we hope to improve the diagnostics of cancers through the collection of biochemical and functional information from patients using modulated light.

Project Goal

Our project goal is to build an experimental frequency- modulated reflectance spectroscopy instrument which transmits and modulates laser light through optic fibers and then detects and processes the reflected light through the patient's tissue.

Project Description

Background and Motivation

Recent hardware and software advancements have made it possible for consumers to create, share, and manipulate multimedia data. The major obstacle associated with these new technologies, however, is how to ensure that this digital content is used appropriately…. Content owners are seeking technologies that promise to protect their rights.

The first line of defense most content owners seek is cryptography…. The downfall to this method is that while cryptography can protect content in transit, the content is not protected after decryption and the pirate is free to distribute illegal copies.

There is a need to find an alternative, or a complement to cryptography – one that protects the content after decryption. Watermarking fulfills this need because it embeds information within the content itself….

The application that we will focus on will be the use of watermarks for content authentication…

Project Goal

In this project we will be examining a currently existing watermark-based authentication algorithm for still images. We will be creating a graphical user interface for this program, which will allow the user to determine the exact degree of error to tolerate…. We will also be extending the algorithm, currently existing only for still images, to video.

Project Requirements

- The instrument shall be capable of generating modulated light in the 0.1Hz to 50kHz range… It must also detect optical signals with light intensities ranging from …
- The instrument must be able to perform spectral analysis with a resolution of …., and a dynamic range of …
- The user interface must allow the user to adjust the following parameters … and should allow the user to enter the operator name, the date and the purpose of the experiment being conducted.
- …

Validation and Acceptance Tests

The table below shows the test procedures that will be used to ensure that the instrument adheres to the requirements specified above…

Module	Resources Needed	Verification Procedures	Acceptance/Tolerance Levels
Optoelectronics	Standard Test Equipment	Input reference signals from a function generator will be used to modulate the light from 0.1Hz to 50kHz. This modulated light will be directly coupled to a photodetector through each of the 16 optical fibers. Test 1: Find the modulation depth of each source fiber by probing on the oscilloscope. Test 2: Find the attenuation in each fiber.	The voltage swing and frequency will be verified on the output of this module (tolerance level +/-5% of reference signal)

Project Requirements

Functional Requirements
1. User shall be capable of determining input parameters to control performance of the algorithm…
2. User shall obtain a performance summary after processing the image…
3. Program shall have search facility to allow user to choose a particular image…
4. The invalid image shall be marked in the manipulated portion…
5. User shall be able to select a specific portion of the image to embed the watermark….

Constraints
1. Watermarks shall be inseparable from the content in which they are embedded…
2. The algorithm shall be able to protect against additions or deletions of image portions as low as 8x8 pixels…

Objectives
1. Watermarks must be imperceptible (watermarked images must be visually identical to image prior to watermarking)…

Validation and Acceptance Tests

In order to verify that the results of our project are correct and meet the project requirements, we will use images from a sample image library. These images will be embedded with a watermark, and various "attacks" will be made to copies of the watermarked images… Since it will be known to us which manipulations are valid and invalid, we can obtain a false positive rate by …, and the false negative rate by ….

To verify our imperceptibility requirement, we can measure … between the original and watermarked image. To do this we will use … to determine if the measured value is sufficiently small…

We will run through some functional verification testing to ensure that all the inputs, menu options, and outputs are displaying and working correctly on the user interface.

Technical Design

Possible Solutions and Design Alternatives

There are several key design criteria that must be considered when deciding on the final design for our system… For the signal processing hardware, the design criteria include the following… For the Graphical User Interface, the design criteria are… There are three main areas where major design variations are possible. The first is the type of algorithm used on the FPGA to analyze the data. The two alternative algorithms being considered are… The second possible implementation variation is the type of interface between the user's computer and the device itself…
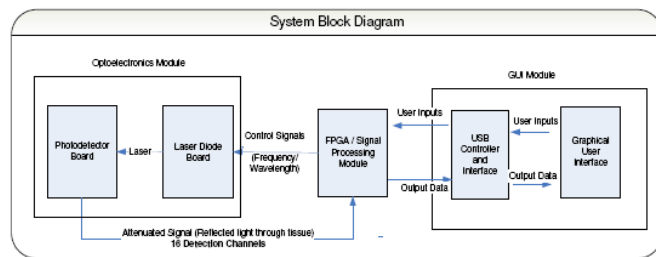
System-level Overview

Figure 1: System block diagram of Frequency –Modulated Reflectance Spectroscopy Instrument

The design is divided into three parts, namely the Optoelectronics Module, the Signal Processing Module and the Graphical User Interface (GUI) module. The reflected light from, two distances to the source, will be analyzed for signal attenuation by realtime signal processing hardware… The GUI then displays the processed data to the clinician.

Technical Design

Possible Solutions and Design Alternatives

1. Coding the algorithm in Matlab/Java/C

    There are several strategies that we are exploring to implement the algorithm and interface. Developing the interface in Matlab would be advantageous since… Although Java can create more user-friendly GUIs and C can provide more processing power to handle high resolution images, the effectiveness of the algorithm may be mitigated when converted to Java or C…

2. Input Parameters

    Each sequence of input parameters determined by the user will result in unique false positive and false negative values… We may therefore have to specify only a few allowable input parameter values due to the sheer number of tests that would be required for too many parameter values. The other option would be to…

System-level Overview

The secure watermark-based multimedia authentication system that we propose can be split up into two main processes:

(1) Embedding the watermark onto the image:…
(2) Verifying a watermarked image:…

Figure 2: System-Level Block Diagram of Digital Watermarking System

Module-level Descriptions

Optoelectronics module: The purpose of the Optoelectronics module is to provide an interface to transmit light to the patient's tissue and to capture the reflected light using the photodetector arrays… The output of this module will be the converted electrical signals detected on each optical fiber channel... the main components of this module are a laser diode board which generates the optical signal and a photodetector board which detects the attenuated optical signal.

GUI module: The purpose of the GUI module is …. The module receives the following data from … and outputs the following data to …
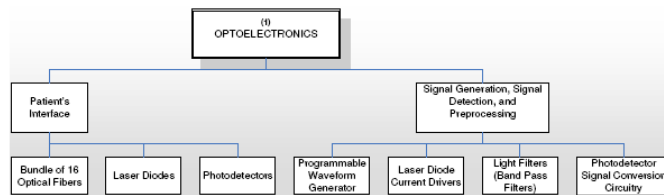

Figure 2: Overview of Optoelectronics Module

Assessment of Proposed Solution

We believe this is the most effective system given the necessary trade-offs because it allows the most flexibility in future designs when the number of channels increases beyond 16 channels. The choice of an FPGA for signal processing over DSP processors is based on the fact that… Although a DSP processor provides higher computation speed, the signals to be analyzed are in the frequency range of 0.1Hz to 50kHz….Since speed is not the most crucial requirement, an FPGA-based platform is sufficient.

The other trade-off in the system occurs within the FPGA. The FFT-based algorithm will be slower than the RMS power algorithm due to its higher complexity. However, it is more effective in high-noise systems and allows … to be added in the future to eliminate ….

Module-level Descriptions

Graphical User Interface Modules
The graphical user interface (GUI) modules are the main modules that permit a user to navigate from one component to another. Each component of the system-level design has separate GUI modules that allow the user to change input parameters and view progress….

Control Modules
The control modules are used to retrieve information from the different GUI modules and either store the information or pass it to other modules in the system….

Signal Processing Modules
These modules perform the required manipulations and processing of the images throughout the system….

Assessment of Proposed Solution

The goal of our project is to design a user interface to enable a user to accomplish two tasks:
1. To embed a watermark, according to the user's desired embedding distortion and location specifications
2. To allow the user to determine the sensitivity of the verification algorithm to legitimate and illegitimate distortions.

Our design has accomplished this goal by providing the following solutions for all of our project requirements….

Our design is based on semi-fragile embedding. This method has been chosen over the fragile and robust watermarking methods because …. If a fragile technique is implemented, legitimate distortions could … If, on the other hand, we used a robust embedding method… For security considerations we require a tradeoff between these fragile and robust techniques, leading us to choose a semi-fragile embedding method.

One weakness of our design is its inability to…. Since many of the algorithm's functions call other functions which are only found in …, not all users will be capable of running….

Work Plan

Feasibility Assessment

Skills and Resources:
There are a number of skills that will be essential to complete the project:
1. Knowledge of VHDL and C++ coding
2. Knowledge of digital signal processing techniques...

There are also a number of resources which will be required:...
1. Access to a biophotonics lab and an electronics lab at Princess Margaret Hospital
2. Quartus II software for FPGA programming (donated by Altera)
3. A/D converters, photodetectors, laser diodes, signal generators, and oscilloscope

As of writing this report, all the required resources have been secured.

Risk Assessment:
Given the size and scope of the project, there are a number of potential problems that could cause difficulties for our design. These difficulties center mostly around the fact that we will be designing our own board for the system… The unknown strength of the input signal is also a major risk.

Work Plan

Feasibility Assessment

Skills and Resources:
We have started investigating the topic of digital watermarking to gain the background knowledge... This background knowledge is being obtained through ....

We will need to obtain a physical copy of the prototype software... We will also need to work with the graduate student who is knowledgeable in the structure and use of the software. We will need the technical tools required to run MATLAB scripts and develop software applications on Windows systems in the ECF laboratories. The majority of the development work and testing will be done on ..., and so, no budget is required.

Risk Assessment:
One of the risks involved with this project is that its scope may be too large; however, if this happens, we can scale down the project by… There are also risks that it may take longer to convert the existing algorithms…and that the performance of our application may not be robust enough to handle the frame rate of video multimedia files. If this happens, we can … and limit the application's functionality to still images.