A high-resolution two-dimensional ultrasonic detector using plasmonic crystals

Project Plan

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Table of Contents

PROBLEM STATEMNT

High-amplitude focused ultrasound can provide localized perturbation in liquids and tissues by inducing shock, cavitation, and heat deposition. Such mechanical and thermal disturbances have been widely used to deliver targeted impacts to cells and tissues for biomedical therapy: for example, trans-membrane drug delivery, neural activity modulation in brain, and thrombolysis.

The purpose of our project is to develop a 2D array of optoacoustic detectors based on the property of high-amplitude focused ultrasound. Our contribution consists of three main parts: Optical plasmonic sensor and fiber tip sensor, labview program for Textronic scope and motorized stage, optical setup.

SYSTEM BLOCK DIAGRAM

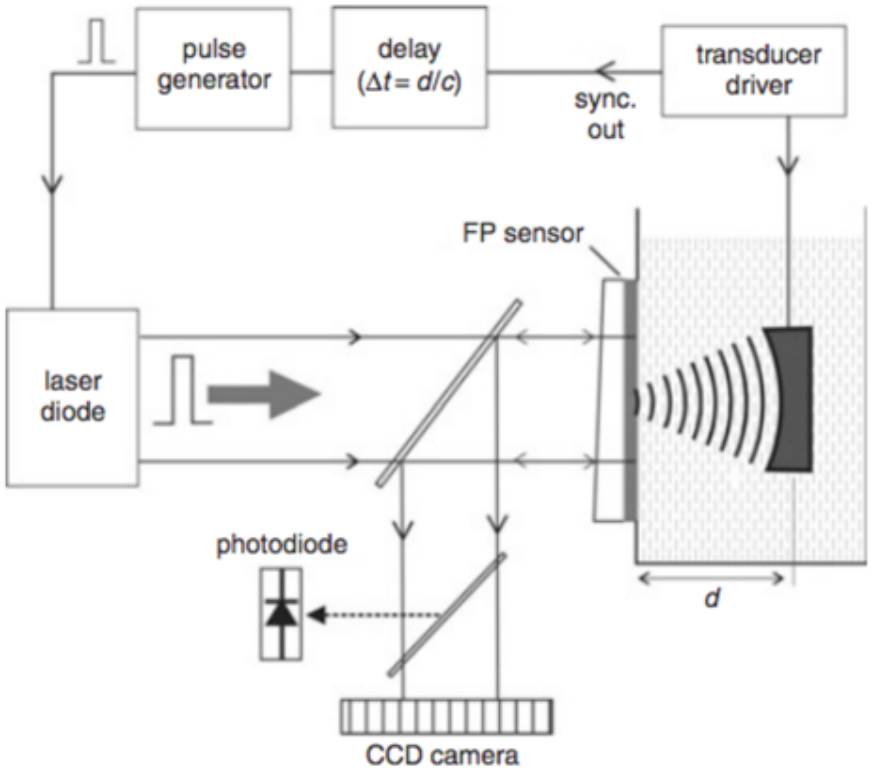

Fig. 1 2D optical ultrasound field mapping system

SYSTEM DESCRIPTION

This senior design project aims to develop a 2D array of optoacoustic detectors. The optoacoustic detector consists of a planar plasmonic crystal sturecure, which exhibits enhanced optical transmission at a particular resonant wavelength. Acoustic displacement of the plasminc sensor results in a measureble change of the resonant wavelength. We will build a near infrared imaging system using a CCD camera, a moduled laser diode, and a delay generator, to interrogate the ultrasound field. In order to obtain high sensitivity and hgih frequency detection, the team will explore the nanoscale interface between photonics and acoustics.

STANDARDS USED

Project Management Standards

A clear standard for deliverables is laid out by our advisor. We met every week with the advisor to examine the progress of the project and to determine any needed changes to the scope of the project.

Software Standards

Labview: Code used as key part in the procedure of converting signal and remote control

Solidworks: design a sample holder

Hardware Standards

Micro Fabrication Standards

A specific standard provided by our advisor is used in the procedure of micro fabrication. This process includes initial cleaning procedure of the materials and lab safety training.

System setup standards

A normative usage with laser system is required for each member in the group in order to avoid any eyes' injury.

DELIVERBALE

First Semester

- Using Solidworks software to design a sample holder.
- Using 3D printer to print the sample design of the holder, the material for 3D printer is plastic.

- Go to machine shop to fix the sample holder if there is any problem with the product.
- Complete labview program for Textronic Scope and motorized stage
- Complete Sensor fabrication (Plasmonic sensor and fiber tip sensor)
- Complete Documentation and webpage

Second Semester

- Assess performance from first semester and make any required adjustments
- Test the equipment to check the equipment is eligible to work or not.
- Prepare to the final presentation and paper.

SPECIFICATIONS

- The new systems designed by this project as well as the improvements to the existing systems will all be expected to meet the following criteria.
- The image can be sinusoidal on the screen.
- The labview can control the frequency of wave.
- Sample preparation

  The sample can make sure that the water will not flow across the water container.

  The sample holder should be lifted by four legs on the lab table.

MEASUREMENT SETUP / CONTROL SOFTWARE

Make sure the PDMS is at the bottom of the water container. The wire should connect to the PDMS.

Make sure there are images at the scope. We can see the image and the shape can be controlled by different frequency of acoustic generator.

EXPERIMENT DESIGN

The sample holder is designed by solidworks and it can be printed by 3D printer.

Members should use labview to simulate the environment to test the result

PDMS should be cut in order to fit the bottom hold in the sample holder.

All devices will be peaked as a whole system. All of the measurement and control instruments will be controlled by computer software programmed in LabVIEW. We also use oscilloscope to check the result.

MEASUREMENT EQUIPMENT

The scope related to the oscillator can tell us the move of acoustic wave.

SOFTWARE & CONTROLS

Our senior design mainly need to write the code of remote control and signal converting from the oscilloscope using matlab. Finally all the data will be collected and showed in the computer graphically. Additionally, we need to finish all the code and get an interface for it even make it to be a .exe file.

USER INTERFACE DESCR IPTION

HARDWARE

Mainly it needs to assemble all the parts which include photo detector, CCD camera, sample holder with fiber tip sensor, and laser diode. We need to connect in appropriate ways to make laser in expect ways.

Easy assembly. It can't be completely pre-assembled because of the setup, but it should be made as easy as possible.

SOFTWARE

The software will have a graphical user interface with signal displayed of presents real-time current measured.

CONTROL & AUTO MATION

Labview is connected to oscilloscope with standard program. The thickness of PDMS should be changed in different lab environment.

Every member of the group project is expected to remain up-to-date with all facets of the project. In order to ensure that the project plan is carried out successfully, each group

member has been designated to a particular role as to preserve the group's stability and maximize work efficiency. Our group has decided on the following roles:

RESOURCE REQUIREMENTS

Resource	How will we get it?	Estimated cost
accoustic generator	Ebay	$30
Sample holder	3D printer	$80

PROJECT SCHEDULE

- Sep. 14: preparation for the project.
- Oct,14: Start work assignment for each members.
- Nov,14: Testing the result for the first stage
- Dec14: Fix the error
- Jan,15: Debug
- Feb,15:Testing for the second stage
- March,15:Debug
- April,15:prepare for the final presentation
- May,15:Prepare to show the final solution.

RISKS TO THE PROJECT TIME LINE

The only risk for us is we would focus a single problem for too long, then we would miss some other detail in the project. We are the people who like study very much. In fact, we can finish the project in 2 month. However, when we find some error happen, we would spend a long time on studying it. Thus, we really enjoy the process of doing the project. We plan to finish the project at the early of February.

PHYSICAL DANGERS

The only risk in this project is the damage from acoustic generator. The 1K frequency of generator can hurt the feeling of ear.

MARKETING $ LITERATURE SURVEY

The idea of this senior design project will impact many fronts, such as health care (e.g., ultrasonic imaging diagnosis and therapy) and industry applications (e.g., non-destructive damage detection).

LABOR

- Wenbing Ma
  - Labview program for Textronic Scope and motorized stage
  - Optical setup
- Jiangxiang Zhang
  - Sensor fabrication (Plasmonic sensor and fiber tip sensor)
  - Optical setup
- Xuan Zhang
  - Documentation and webpage
  - Sample holder
- Zhikai Cui
  - Labview program for Textronic Scope and motorized stage
  - Sensor fabrication (Plasmonic sensor and fiber tip sensor)
- Chenyin Liu
  - Documentation and webpage
  - Sample holder

CONTACT INFORMATION

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