Synthetic Optical Holography Stage Implementation

ECE 445 Project Proposal

TA: Luke Wendt

Team #52

Sung Hun Kim Ye Hyun Kim Hyunjae Cho

September 13, 2016

Table of contents

1. Introduction **3**

    1.1 Statement of Purpose **3**

    1.2 Objectives **3**

2. Design **4**

    2.1 Block Diagram **4**

    2.2 Block Description **5**

3. Requirements and Verification **6**

    3.1 Tolerance Analysis **6**

4. Cost & Schedule **7**

    4.1 Cost Analysis **7**

        4.1.1 Labor **7**

        4.1.2 Parts **7**

        4.1.3 Grand Total **7**

    4.2 Schedule **8**

1. Introduction

1.1. Statement of Purpose

Confocal Microscopy is an optical imaging technique for obtaining high resolution image mostly used in biological science. Confocal microscope uses point illumination method and discards any other stray light. Conventionally, Synthetic Optical Holography (SOH) is used for quantitative phase mapping of confocal microscopy by adding a linearly moving reference mirror. Using this method, the reference mirror needs long travel range for creating a linear-phase synthetic reference wave. Two methods are available to improve this drawback. One method is to oscillate the reference mirror sinusoidally, and the other method is to tilt and change the height of the glass slide where sample is located. Our design uses the method of changing the height and tilt the glass slide by using four piezo-electric controllers, which reduces the travel range compared to the conventional method.

1.2 Objectives

1.2.1 Goals and Benefits

- Implement SOH on a confocal microscope
- Control piezo individually and together
- Improve control accuracy
- Improve repeatability of four piezos
- Reduce the travel range of piezo controllers

1.2.2 Functions and Features

- Able to output stable voltage using voltage regulator
- Control height of the sample
- Ability to tilt the glass top
- Control piezo by using computer controller

2. Design

2.1 Block Diagrams

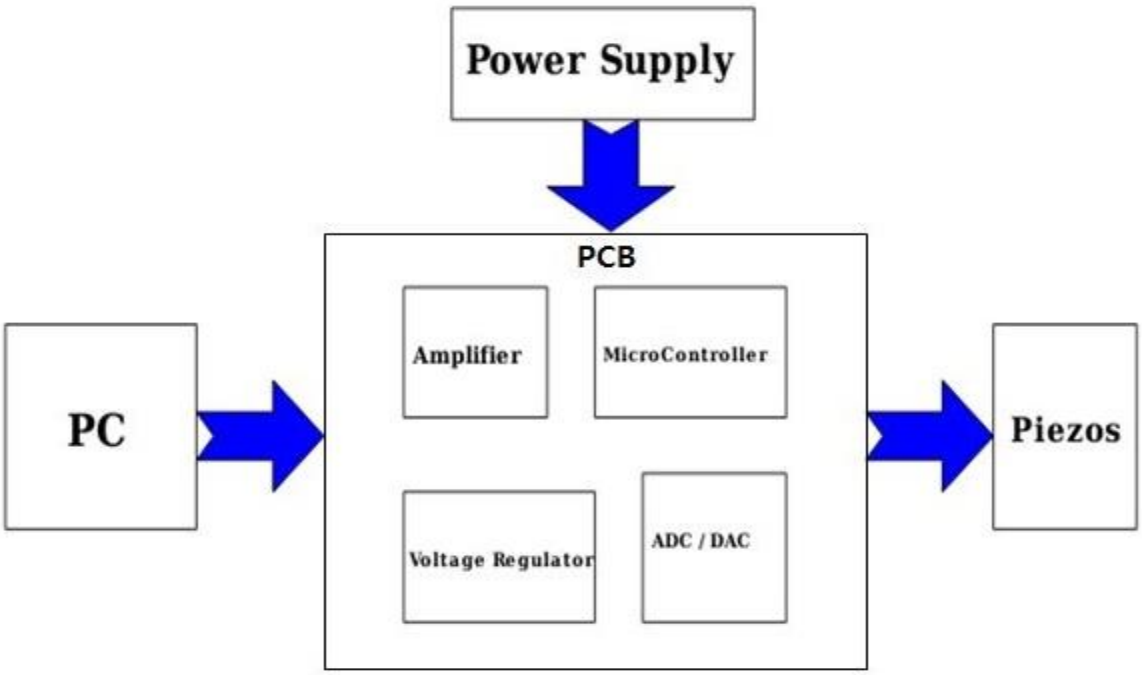

Figure 1. Block Diagram of the system

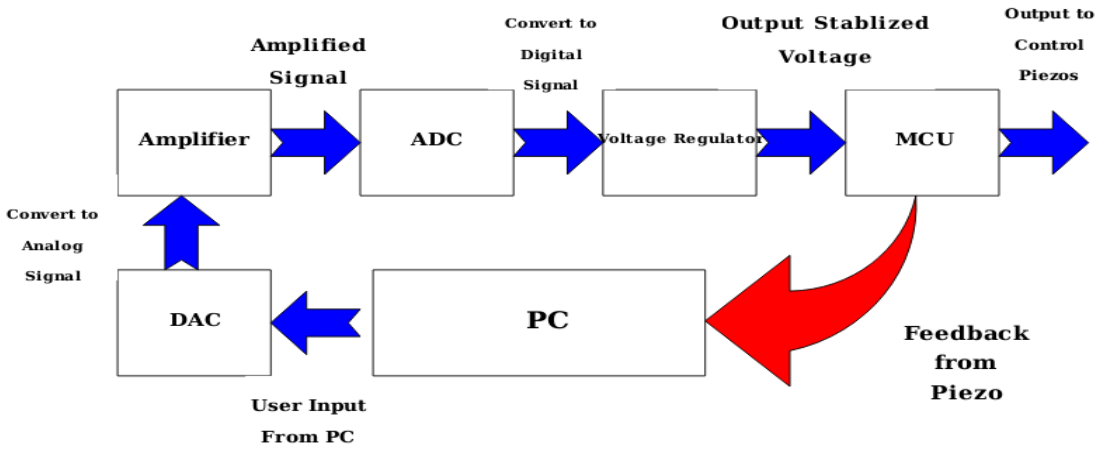

Figure 2. Inside PCB

2.2 Block Descriptions

2.2.1 Microcontroller

Microcontroller enables communication between piezo drivers and computer to enable feedback control of the piezo drivers height adjustment.

2.2.2 PC

User can control the piezo drivers with computer interfaces as input, and PC also serves as a feedback controller.

2.2.3 AD/DA converter

Converts analog signal of piezo drivers to digital signal for PC and converts digital signal from PC to analog signal for piezo drivers.

2.2.4 Voltage Regulator

Converts voltage coming from power supply to voltage that is needed for piezo drivers.

2.2.5 Amplifier

Amplifies power of a signal.

2.2.6 Power Supply

We plan to use plug-in outlet of 110V since piezo drivers have voltage range of -20V to +120V.

2.2.7 Piezo Drivers

Four piezo drivers are used to change the height of the glass top and tilt the glass top.

3.0 Requirements and Verification

Requirement	Verification	Points
1. Piezo Drivers Piezo drivers stable for an hour without drifting 5 nanometers when drivers are lifted	1. Piezo Drivers Measure difference in height of the piezo drivers after an hour using interferometer	40
2. Microcontroller Must be able to control four piezo drivers individually and together	2. Microcontroller Measure the height of individual piezo drivers and compare with the user input height	40
3. Voltage Regulator Peak to peak voltage must be within +/- 5% of the DC voltage	3. Voltage Regulator Measure the peak to peak voltage and DC voltage and check if the peak to peak voltage is within +/-5%	5
4. Amplifier Output voltage must be -20V to +120V	4. Amplifier Measure the output of the Amplifier	5
5. Repeatability Must be within few nanometers	5. Repeatability Measure the variation with interferometer	5
6. Piezo drivers joint Glass top should not change its xy position when the piezo drivers are individually lifted few hundred nanometers and returned to its original position	6. Piezo drivers joint Glass top should not change its xy position when the piezo drivers are lifted 1 micrometers	5

3.1 Tolerance Analysis

The piezo drivers need voltage range from -20V to +120V. The piezo drivers operate from -20 to 80 degrees Celsius. If out of the temperature range, the piezos will malfunction.

During feedback control and rising time must be within 0.1s due to user requirement.

In addition, there are noises introduced during each stage. It may yield undesirable outputs due to rounding off values from the circuit.

4. Cost and Schedule

4.1 Cost analysis

4.1.1 Labor

Student	Hourly Rate	Total Hours Invested	Total*2.5
Hyunjae Cho	$30	250	$18,750
Sung Hun Kim	$30	250	$18,750
Ye Hyun Kim	$30	250	$18,750
		750	$56,250

4.1.2 Parts

Item	Quantity	Cost
Microcontroller	1	$50
Piezo	4	$1,000
USB interface	1	$25
Amplifier	1	$30
Voltage Regulator	1	$20
Sub D 9 pin connector	4	$5
Various Resistors, Inductors, Capacitors, FETs, Transformers, etc.	Varies	$10
Total		$1,140

4.1.3 Grand Total

Section	Total
Labor	$56,250
Parts	$1,140
Grand Total	$57,390

4.2 Schedule

Week	Task	Responsibility
9/12/2016 (Week 1)	Prepare Project Proposal	Ye Hyun Kim
	Consult with Experts	Sung Hun Kim
	Prepare Mock Design Review	Hyunjae Cho
9/19/2016 (Week 2)	Contact Seller & Order parts	Ye Hyun Kim
	Finalize Mock Design Review	Sung Hun Kim
	Build precise logic diagram	Hyunjae Cho
9/26/2016 (Week 3)	Work on jointing piezos with the glass slide	Ye Hyun Kim
	Test Hardware parts (Piezos)	Sung Hun Kim
	Design Control Logic	Hyunjae Cho
10/3/2016 (Week 4)	Program Code for Microcontroller	Ye Hyun Kim
	Run requirements of Piezos	Sung Hun Kim
	Implement Voltage Regulator	Hyunjae Cho
10/10/2016 (Week 5)	Review coding for Microcontroller	Ye Hyun Kim
	Verification test on individual Piezos	Sung Hun Kim
	Implement Amplifiers	Hyunjae Cho
10/17/2016 (Week 6)	Debug Code	Ye Hyun Kim
	Combine 4 Piezos & verification test	Sung Hun Kim
	Assemble external power source for MCU	Hyunjae Cho

10/24/2016 (Week 7)	Finalize Code	Ye Hyun Kim
	Finish assembling all components	Sung Hun Kim
	Run tests on both hardware & software	Hyunjae Cho
10/31/2016 (Week 8)	Check requirements for Repeatability of the system	Ye Hyun Kim
	Prepare for Mock Demo	Sung Hun Kim
	Ensure functionality	Hyunjae Cho
11/7/2016 (Week 9)	Check stability of the Piezo	Ye Hyun Kim
	Finalize Mock Demo	Sung Hun Kim
	Test/Debug whole system	Hyunjae Cho
11/14/2016 (Week 10)	Prepare Presentation	Ye Hyun Kim
	Prepare Final paper	Sung Hun Kim
	Prepare Demonstration	Hyunjae Cho
11/21/2016 (Week 11)	Celebrate Thanks Giving Day	Everyone
11/28/2016 (Week 12)	Final Presentation/Demos	Ye Hyun Kim
	Final Presentation/Demos	Sung Hun Kim
	Final Presentation/Paper	Hyunjae Cho
12/5/2016 (Week 13)	Final Presentation/Demos	Ye Hyun Kim
	Final Presentation/Demos	Sung Hun Kim
	Final Presentation/Paper	Hyunjae Cho