ME470/ECE445
Senior Design Proposal

By

Zhanyu Shen
Zhanlun Ye
Zhehao Qi
Xiran Zhang

March 2023

Contents

1. Introduction 1

1.1 Problem 1

1.2 Solution 1

1.3 Visual Aid 1

1.4 High-level requirements list 2

2. Design 2

2.1 Block Diagram 3

2.2 Subsystem Overview 3

2.3 Tolerance Analysis 3

3. Ethics and Safety 4

1. Introduction

1.1 Problem

The normal method to produce a nano film is using typical Langmuir-Blodgett film method in which we will use two barriers to control the film area, tension stress and particles' density and directions. However, the nano film is really small and hard to observe and analysis the situation of the film. Normally we use a lifter to obtain a sample and use microscope to observe its quality. This typical method has a problem that this method is really ineffective and hard to control the system.

1.2 Solution

The project proposed aims to build a miniaturized Langmuir Blodgett trough that is small enough to place under a microscope. This way the microscope can observe the fluidic interfaces and provide information about the real-time changes at the interface. A particular application to observe can be the interfacial assembly of nano particles, induced by the barrier movements, changes in the nano material amount, variation of the fluid composition and condition.

1.3 Visual Aid

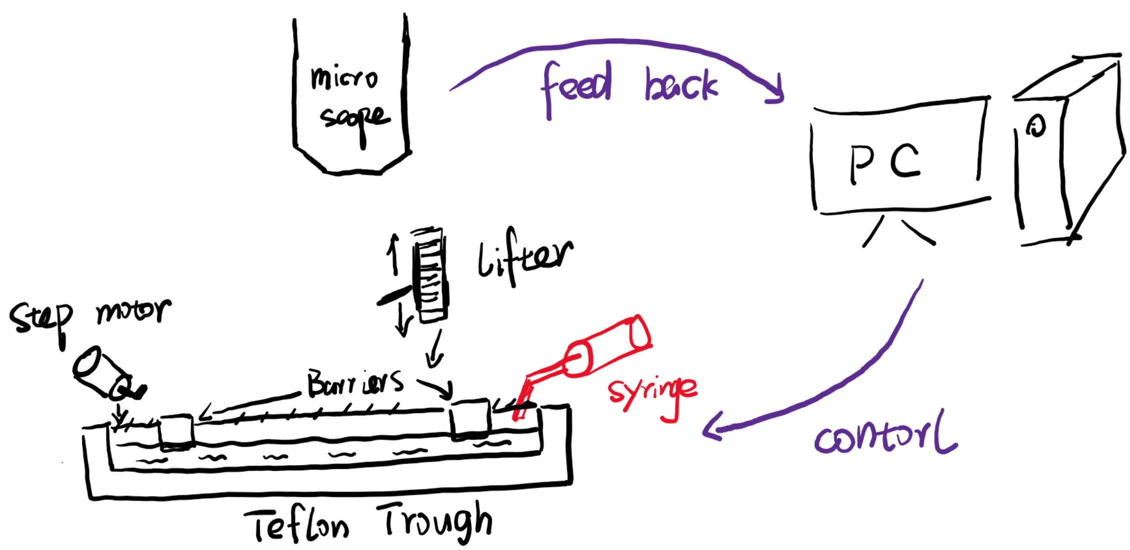


Figure1. overview of the design close loop

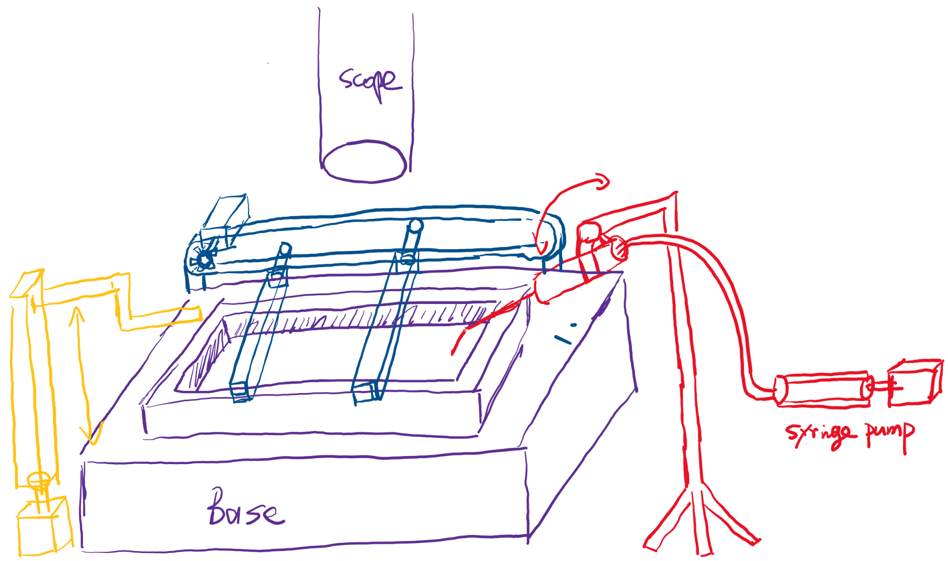


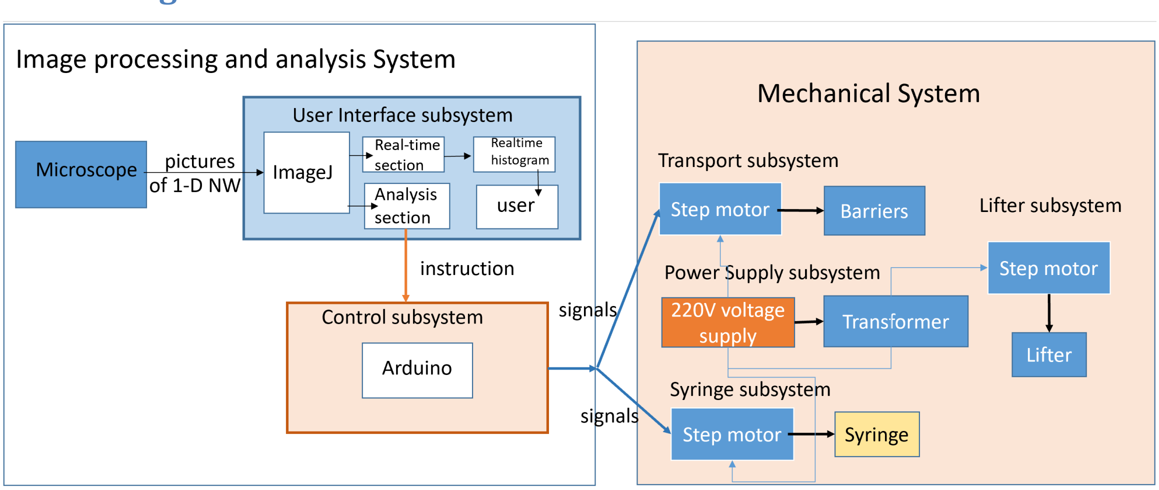
Figure2. Detail Design Sketch

1.4 High Level Requirement List

High-Level Requirement	Description
Barrier Moving Speed	To achieve a better film quality, we need our barriers' moving speed can reach 1mm/min and max to 1cm/min which means we need to set a high gear ration to decelerate our step motor.
Analysis Speed	Our project is relatively safe when design and production. The most significant issue is the sanitation problem. The building material and the testing material are both easily polluted. Thus, we need a dust-free room. Every time we enter the room, we should change to lab coat, clean the dust beneath the shoes. The projector of the microscope easily gets dirty or broken. Our design should guarantee not to touch it. Three motors are used in our design. We should consider its load to avoid any fire issue. The control system is written by computer, which won't cause much safety problems. In general, the design is totally fair to all users.
Size limitation	The space underneath the microscope is limited, we only have 13cm x 22cm x 3cm space. And we will also need to change the objective while operation, so there can't be any objects on the objective changing route.

2. Design

2.1 Block Diagram



2.2 Subsystem Overview

We have two big system in our whole design: 1. Mechanical Control system, 2. Picture Processing system. Mechanical system include barrier moving subsystem; syringe subsystem; lifter subsystem and PTFE trough. The picture processing system include microscope image capture subsytem; image J analysis subsystem and Step motor control subsystem.

2.3 Subsystem Requirements

2.3.1 Mechanical system

Power subsystem should supply continuously 12V DC voltage to transport subsystem.
Transport subsystem must receive the signals from control subsystem then react to the signals, control the motion of the battier or syringe pump.
Lift subsystem can move up and down within 1cm to lift the LB film out the solution.
Syringe subsystem should receive the signal from control subsystem and control the speed of injection by changing the speed of the step motor.

2.3.2 Image Processing system

Microscope will provide pictures of 1-D NW film formed on the water to User interface subsystem. For the user interface subsystem we need to process pictures in 10s. Real-time section should provide real-time histogram to users reflecting density and orientation of particles. Analysis section will output the analyzed motor motion instruction into the control subsystem.
The control subsystem converts the instructions we want the motor to execute into concrete signals and inputs them to the motor.

2.4 Tolerance Analysis

The barriers are driven by a step motor. Thus, their weight is an aspect to affect whether the system can work smoothly. We can used a slider to hold the barriers, largely decreasing the friction. Total friction could be estimated to 10N. And the largest torque of the step motor is 2 Nm. The farthest position is about 0.9m. Thus, the motor can tolerate more than 20N. The barriers will not affect the success of the product.

3. Ethics and Safety

Our project is relatively safe when design and production. The most significant issue is the sanitation problem. The building material and the testing material are both easily polluted. Thus, we need a dust-free room. Every time we enter the room, we should change to lab coat, clean the dust beneath the shoes. The projector of the microscope easily gets dirty or broken. Our design should guarantee not to touch it. Three motors are used in our design. We should consider its load in order to avoid any fire issue. The control system is written by computer, which won't cause much safety problems. In general, the design is totally fair to all users.