Date:	August 21, 2006
To:	Intel Foundation
From:	Chris Kuryak, University of Texas at Austin
Re:	Undergraduate Research Project Progress Report 3

Project Overview

The project I worked on this summer involved the creation of three-dimensional (3D) objects using microstereolithography (µSL). The overall purpose of µSL is to create complex microstructures for use in micro electromechanical systems (MEMS). For example, µSL can produce extremely small springs to be used in microscopic machinery. My project involved two main tasks. First, I had to create a resistive bypass for a projector lens. Second, I designed and built a secondary µSL system with higher resolution for the University of Texas at Austin.

Work Completed

Background

To sum up how a µSL sytem works, one must think of a normal projection system used in classrooms or in business meetings. The image that is produced from a projector is usually cast upon a screen or wall for easy viewing. In the case of µSL, the image is cast upon a curable resin surface using a Digital Micromirror Device (DMD). A UV light is then exposed onto this surface causing the light area of the resin to solidify, while the dark area remains a liquid. This process is performed several times on top of itself to create a 3D object. Figure 1 shows the overall setup of a µSL system.

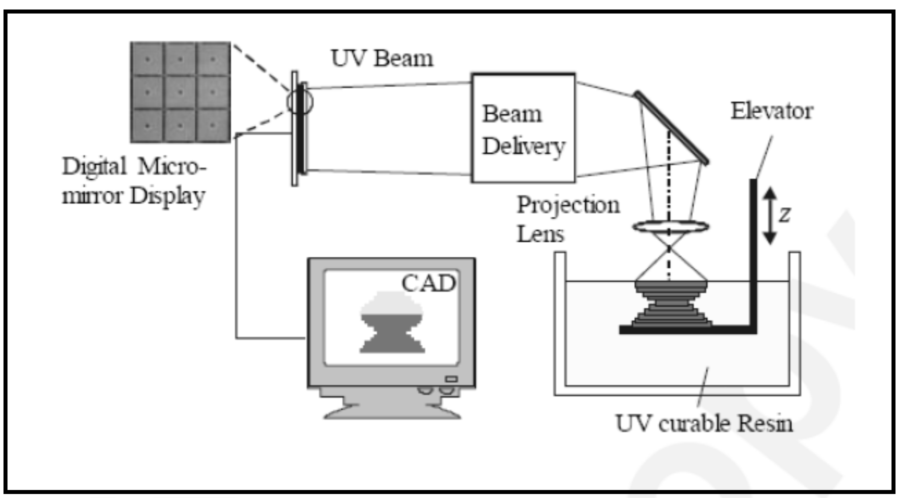

Figure 1. Cheng Sun, et. al., "Projection Microstereolithography Using Digital Micro-mirror Dynamic Mask", *Sensors and Actuators A*

Resistive Bypass

My first assignment was to create a bypass for the original projector light bulb. Originally, we were using the DMD chip in a commercial projector for our system. However, in order for the DMD chip to work, the projector light bulb must have been on. This presented a problem because projector lamps have a finite lifetime and are very expensive to replace (~$250). So to trick the projector into thinking that the light bulb was still engaged, I replaced it with a nine resistors in parallel. The resistors combine to create a total resistance equal to that of the projector light bulb. So now the DMD chip would operate without the projector light bulb having to turn on.

However, the downside to this replacement was that the resistors got very hot because they were dissipating the same amount of energy as the original light bulb. Thus, I had to create a platform for the resistors to rest upon and protect them from surrounding objects. A metallic platform could not be used because it would conduct heat to its surroundings and present a possible hazard. A platform comprised of readily available polymer could also not be used because it would melt under the heat of the resistors. My best option was to go with a ceramic platform due to its low conductivity and high melting temperature. After searching for many readily available ceramic components, a brick turned out to be the cheapest and most effective solution. Lastly, since the resistors were getting quite hot, I built a simple wind tunnel using PVC pipe and a small table fan enhance the air convection and dissipate heat more efficiently. See Figure 2.

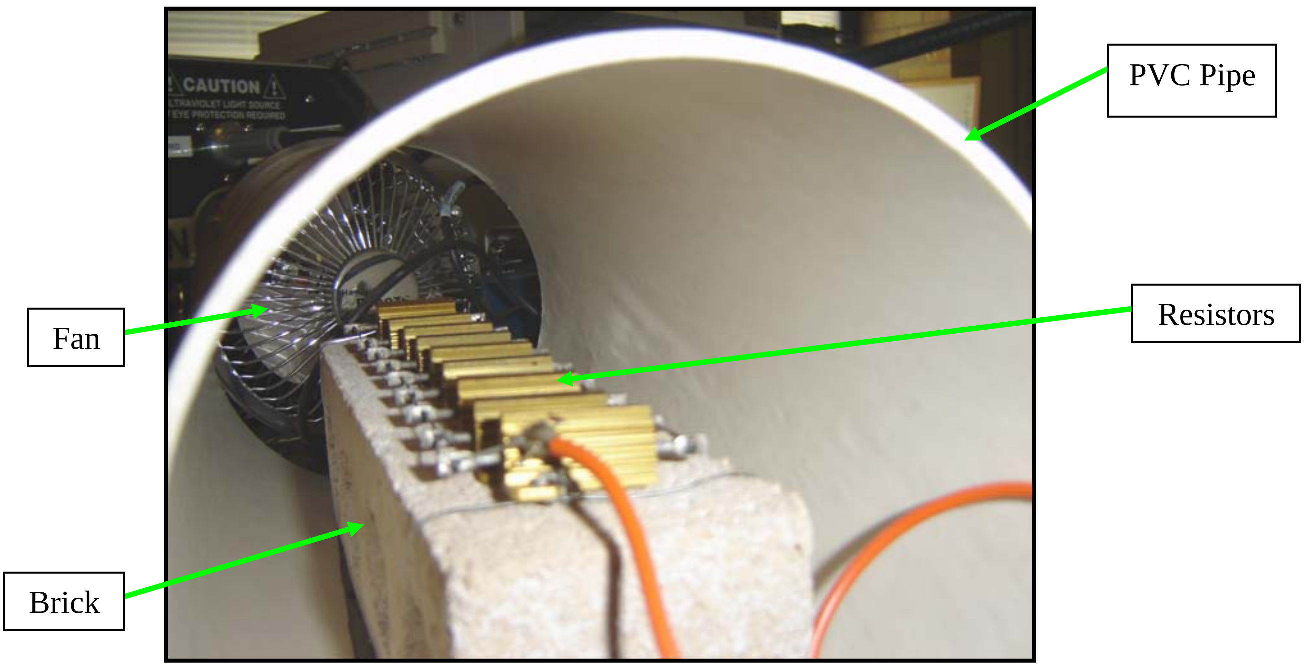

Figure 2. Resistive Bypass System for Projector Lamp

Secondary µSL System

My second assignment was to create a secondary µSL system for use in the University of Texas at Austin laboratory. Since the original system used a DMD housed inside a normal projector system, and was somewhat bulky, it would be advantageous to have a system using a standalone DMD chip. Also, in order to increase the resolution of the projected image, my design would incorporate an imaging lens to focus the UV light onto the curable resin surface. Extensive research was performed with my graduate advisor to find the most effective components. After purchasing this equipment, all necessary mounting had to be constructed to hold the DMD, lens, and light source in the appropriate positions for performing µSL. Using the University of Texas machine shop, I created a platform to mount the DMD. This platform was held up by four poles that could adjust the height of the DMD if necessary. See Figure 3. I then created a breadboard to secure the position of all components. This made it easier to move the components to different positions and then keep them rigidly set in place. See Figure 4.

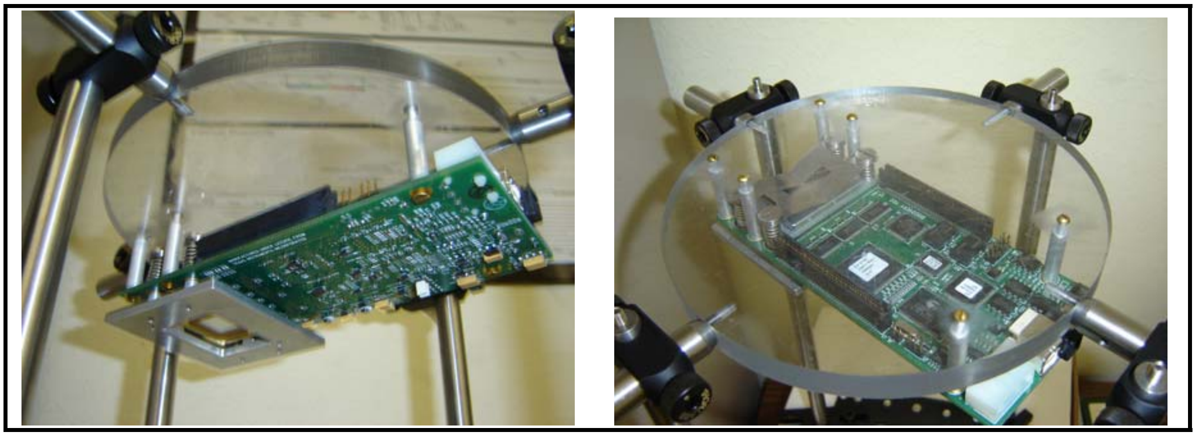

Figure 3. DMD Mounting

Figure 4. DMD Mounted on Breadboard

Lastly, all of the components (lightsource, DMD, lens, imaging platform) were added to the breadboard to test the system and make sure it operated properly. See Figure 5. The light travels out of the fiber optic cable, reflects down off the DMD, through the imaging lens, and then onto the imaging platform. See Figure 6 for an illustration of the light path.

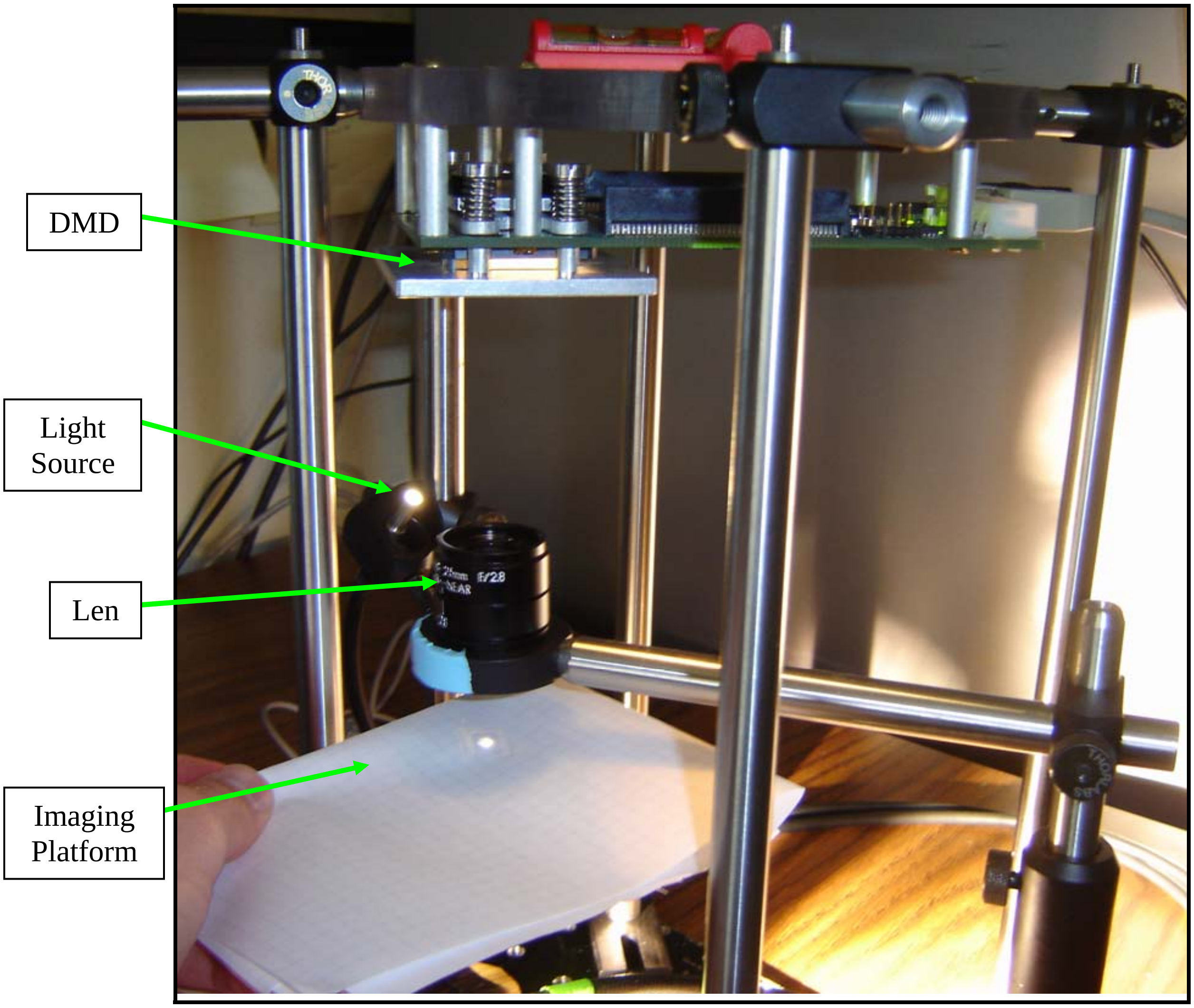

Figure 5. Secondary µSL System Testing

Figure 6. Light Path for µSL System

The test was a success and a crisp image was produced on the platform. Though this is the end of my research at the University of Texas at Austin, the project is not completed. Future work would consist of creating a moving imaging platform, diffusing the light beam to be more uniform, and calculating accurate distances for the lens and platform to produce a focused, nanoscale image.

Final Thoughts on the Project

I was very pleased with the results of my project. I believe that the resistive bypass system was a complete success and very beneficial to the University of Texas at Austin. Though the secondary µSL system is not fully operational yet, I do believe that the work I have completed has provided a sufficient launch to its achievement. All of the experience I have gained in the process will be applicable to research I do later on in my career.