VIGRE CAMD Summer Internship Report
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This past summer from June 2009 – August 2009 we worked in Tomography with Les Butler, a Chemistry professor at LSU, and Kyungmin Ham, a postdoctoral researcher at LSU, for the Center for Advanced Microstructures and Devices (CAMD). We met approximately 2-3 days per week throughout the summer and averaged 6 hours of work on these days. We frequently met at the Visualization Center in the Middleton Library on the LSU campus.

Our first meeting was at CAMD where we toured the facility and saw the type of work that is done. Our second meeting was later that week at the Middleton library where we saw the 3-D modeling constructed from the data accumulated at CAMD. Dr. Butler gave us several books at this meeting as background reading for a basis of understanding what Tomography is about. At this point we were not entirely sure what direction to go. During the next few weeks we met with Imtiaz Hossain, a facilitator at the Visualization Center who has a math background and has also worked with Dr. Butler on Tomography projects in the past.

Our next meeting with Dr. Butler was a few weeks later at CAMD when we nailed down the direction of our project. Recently Dr. Butler had been researching flame retardant materials mixed into plastics. The data Dr. Butler had given us was of a piece of plastic that was being heated. This data tracked six time frames over the course of ten minutes. Initially Dr. Butler wanted to track how quickly the flame retardant dissolved into the plastic. The difficulty was that the plastic moved as it was being heated. So the flame retardant materials, which are composed of very small particles, were difficult to track.

The first step was converting the data into a format that we could read in Avizo, a commonly used visualization software for 3-D modeling. Dr. Butler had written some computer code in Mathematica in the past and we altered the code to convert a portion of the data. We decided to focus on the air bubbles present in the plastic. Because these bubbles were the largest objects within the plastic they were easier to track than the flame retardant. At this point we selected a portion of the data that fully contained four bubbles as they moved through the six time frames.

Half way through the summer we met again at the Middleton Library with Kyungmin Ham. She helped us with the Mathematica code. We also were able to show her the 3-D modeling we had done up to that point. We decided that our task for the remainder of the summer would be to fully construct all four bubbles in each of the six time frames. When constructing these bubbles we would isolate them from the rest of the data so that the overall movement of the plastic could be tracked. The ultimate goal was to track the flame retardant material and tracking the bubbles could be used to achieve this goal.

The majority of the time we spent on the project was during the last half of the summer. We met frequently with Imtiaz Hossain at the Visualization Center. It was fairly difficult to construct these bubbles. The key breakthrough was when Imtiaz Hossain suggested that we convert the data out of Avizo and into another 3-D modeling program called SNAP. With SNAP we were able to smooth out the data and alter the intensities of certain portions of the data. We were also able to grow the bubble from the inside out. After many hours we had finally constructed all four bubbles throughout the six time frames, 24 in all.

About two weeks before classes started in the Fall we had our final meeting with Les Butler, Kyungmin Ham, and Imtiaz Hossain. During this meeting we had a discussion drawing together what we had learned about the data and the direction that Dr. Butler wanted to take the project. What we had seen was the bubbles were all moving in a specific direction, expanding, and becoming more spherical. Our suggestion to him was to track portions of the data centered around specific bubbles. Then he could easily see how the flame retardant close to the bubbles was dissolving.

There were two last things Dr. Butler asked us to do with the remainder of the summer. The first of which was to find the centroids of all 24 bubbles. The second regarded a mistake that was made at the beginning of the summer which we only discovered during this final meeting. In the Mathematica code Dr. Butler had accidently weighted the values of portions of the data locally instead of globally. This caused striations within the images. As a result there were cracks in the bubbles. This was the reason that constructing the bubbles was so difficult during the last half of the summer.

This mistake turned out to be the most educational portion of the project from our end. We could physically see what the bubbles were supposed to look like, but the computer only saw the data itself. This was the reason the SNAP program was so vital. As we mentioned earlier the SNAP program gave us the option of growing these bubbles. We could use the data to create an outer shell for the bubbles to grow inside. By altering intensities we could "fill in" the holes of the shell. However even after altering the intensities there were still unavoidable cracks. These cracks in the outer shell caused the bubbles to leak outside of the shell as they grew. By varying the rate at which the bubbles grew and positioning them appropriately we were able to avoid this problem and smooth out the surface near the cracks. In the end were able to construct all 24 bubbles so that their surfaces were completely smooth.

In conclusion, there is a distinction between what a human eye can intuitively see and what a computer acknowledges simply as cold hard facts. What our work entailed this summer was bridging the data with our intuition to produce a product that was meaningful.