Automated Sample Tracking System for Tomography: Microscope Imaging

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LA-SiGMA
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Abstract

In an effort to gain more information from vertical burn tests and improve the efficiency with which they are performed, a motorized apparatus with an attached microscope was engineered to maintain view of a sample at all times despite movement while burning. Using image processing in Mathematica combined with LabVIEW programming, linear translation stages moved the sample in response to images attained in real-time from the microscope. Thus, the sample always remained in view of the microscope as well as an X-ray beam despite a small field of view and the possibility of sample contortion. This tracking method will be used in the future to study not only flame retardants, but the charging of lithium ion batteries and the anatomy of laboratory mice.

Introduction

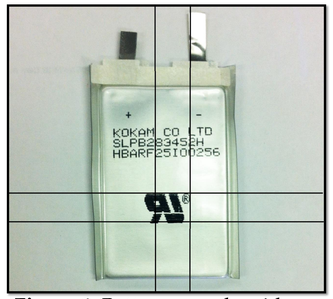

Figure 1: Battery sample with intersecting lines depicting the miniscule 3 mm² field of view

Problems with the UL-94 Standard for Analyzing Samples

- No indication of chemical data that determines whether a sample is an adequate flame retardant
- No high-resolution imaging possible
- Small field of view with microscope and X-ray (**Figure 1 and 2**)
- Ring clamp does not prevent contortion of sample (**Figure 3**)

Figure 2: Actual microscope image capture of battery shown in **Figure 1**

Figure 3: Flame retardant sample beginning to warp under heat

Objective

Engineer a machine with the capability of tracking moving samples and attaining chemical data from them efficiently despite an extremely small field of view

Materials and Methods

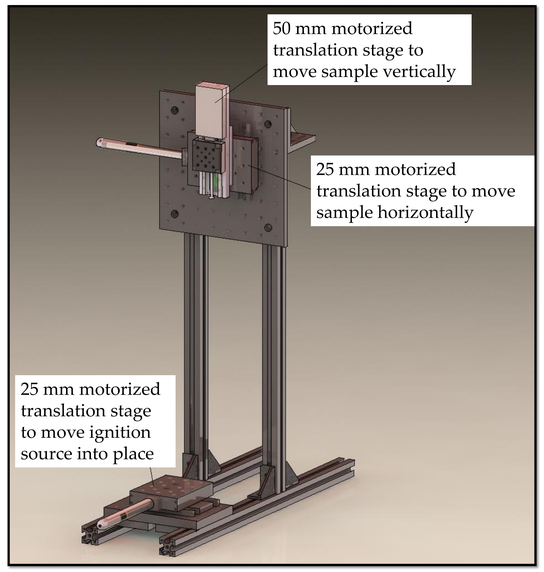

Figure 4

The Original SolidWorks Design (above)

- Does not depict the additional rail that was later added to hold the Point Grey Flea®3 microscope camera or the 25 mm translation stage with standard micrometer that was attached to the camera to facilitate focusing

Mathematica

- Used in conjunction with the Flea®3 microscope camera to process the real-time images and ascertain sample position

LabVIEW

- Received sample position and sent movement commands to the Thorlabs motors

Results and Discussion

Image Processing

- Managed by Mathematica
- Real-time image of sample (**Figure 5**) divided into several smaller images and binarized to detect its edges (**Figure 6**)
- Individual images examined for the presence of white, indicating an edge
- Presence of white in certain partitions signaled the motors to move the sample back into its proper position

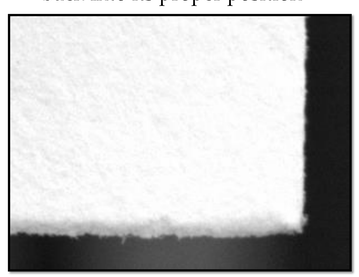

Figure 5: Microscope image capture of the bottom right corner of a test sample

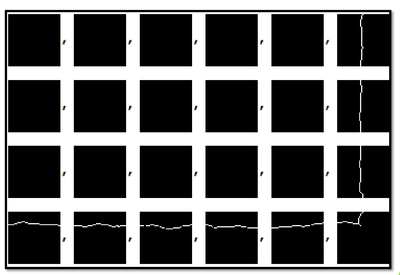

Figure 6: Partitioning the image and detecting the sample's edges

Results and Discussion (cont.)

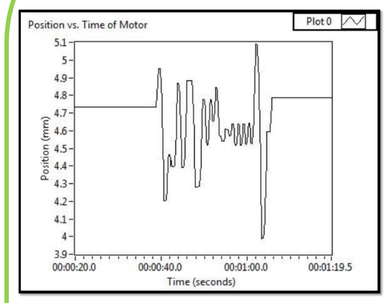

Figure 7: Position-time graph of functional motor movement

System Integration and Motor Control

- Signal from image processing transmitted through a separate computer running LabVIEW and Thorlabs APT software
- Hexadecimal commands initially to be sent without Thorlabs APT sofware, but result was erratic motor movement and broken actuator
- TCP/IP communication implemented to facilitate interaction between the computers
- Successful trials using non-burning samples
- Yet to be tested with burning samples, but projected results are positive

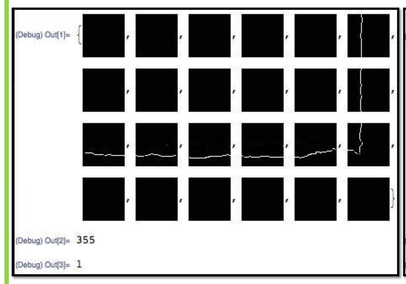

Figure 8: Output of 1 indicating that sample is above its proper position

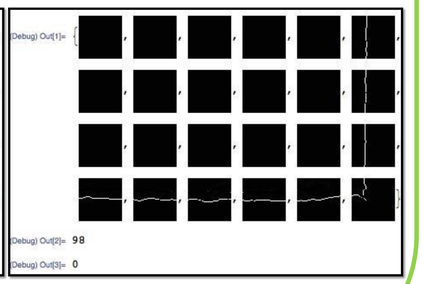

Figure 9: Output of 0 indicating that sample is in its proper position vertically

Conclusion

- Functional motor movement achieved based on acquired visual data
- Future plans include testing with a burning sample and implementing a high-resolution X-ray interferometer[1],[2] with a 3 mm² field of view
- Will be an effective and efficient method of testing samples in the laboratory for both physical and chemical data

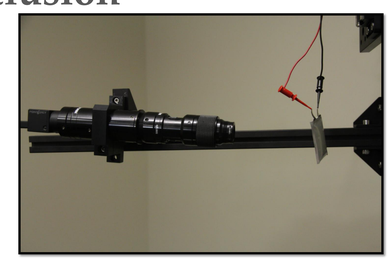

Figure 10: Fully assembled machine with long working distance microscope aimed at battery sample

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References

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