CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
J1405

Project Title
A Computer Program to Track and Count Particle Trails

Abstract

Objectives/Goals
The purpose of this project was to develop a fast and accurate computer program to track and count the trails of charged particles in a cloud chamber video.

Methods/Materials
Various cloud chambers were constructed using a container, isopropyl alcohol, dry ice, and a polonium-210 source. Videos were recorded of the resulting alpha particle trails in the alcohol vapor. Because the quality of these recordings was insufficient for processing, four videos were obtained from UC Santa Barbara's Senior Physics Lab. Next, an algorithm was developed to track and count moving and dissipating vapor trails in digital recordings. It was then implemented using OpenCV's Python package. Options were added to change the configuration of the counter to optimize for various alcohol vapor conditions within the cloud chamber. The program was then run on each of the four videos multiple times and the counts and times were recorded. In addition, multiple manual counts were performed on each video for comparison. Finally, "aided" manual counts were conducted to count the number of trails the program missed and the number that were counted more than once.

Results
The algorithm was able to correctly identify trails a large percentage of the time and tally a reasonable count. The program's count was, on average, within 0.7% of the best obtainable ("aided") count, whereas manually, on average, only 59% of the trails were counted, even with the video slowed to 3 FPS. However, on average, 14.1% of the trails counted by the program were duplicates and 14.8% were missed. The manual counts took, on average, about four times as long to complete as the program count.

Conclusions/Discussion
The computer program is substantially faster and more accurate than manual tallying. The low manual counts (which recorded less than 60% of the actual trails) were unexpected. With repeated manual attempts, it became clear that lowering the frame rate below 3 FPS resulted in a loss of ability to distinguish between old and new trails; consequently, more accurate manual counts were not achievable. When viewing a video that had been processed by the program that had rectangles highlighting the identified trails, it was clear that the computer program was able to identify more trails per frame than a human doing a manual count. The speed with which the program counted the trails was unsurprising.

Summary Statement
In this project, a computerized image processing system was developed to reliably track and count charged particle trails in cloud chamber videos.

Help Received
Obtained cloud chamber videos from Dr. Deborah Fygenson at UCSB; Received advice on cloud chamber construction from Dr. Wing Howard To; General guidance from science teacher Ms. Kim Miller; General introduction to OpenCV from father, Dr. Mark Grosen; Help gluing board from mother