



SE498 Parallel Computing

Lab 5: Using parallel computing to enhance archival film footage

Due: November 16, 2013 23:59

1. Objectives

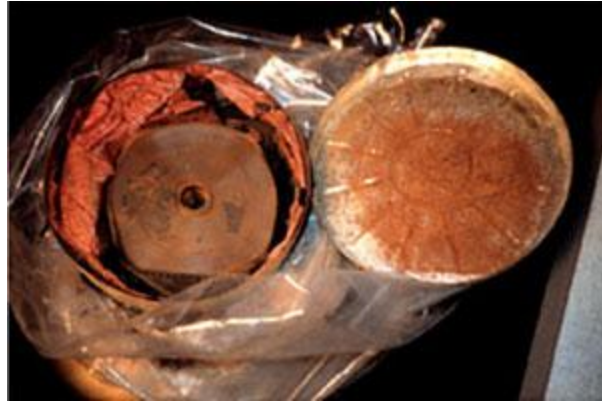
- Construct a hybrid MPI/OpenAcc or MPI/OpenMP program which enhances film footage
- Analyze the performance improvement of parallelizing a system

2. Introduction

Restoring old films is a big industry. Over the past 100 years, many thousands of movies have been made. In some cases, they have been very carefully archived and stored, and beautiful DVD copies can be made from the archive with little or no effort. In other cases, the films have significantly degraded over the years, leading to massive restoration efforts. For example, when Star Wars was re-released to theaters in 1997, significant restoration was necessary, as the original negatives had faded. (<http://secrethistoryofstarwars.com/savingstarwars.html>) Other old films, such as the Wizard of Oz or Fantasia have gone through similar processes.



When restoring damaged film, there are many things that need to be taken into account. If the film is a color film, it is important that the colors be restored to the appropriate vibrancy. The amount of restoration needed varies with the original stock used for the film. Films shot in 1930's through 1950's used a process called Technicolor. This process involved three strips of film going through the camera simultaneously, each one capturing one of the three primary colors. Prints were then made for distribution by contact printing. Beautiful images can be made from these negatives. However, sometimes there are problems. Because the film is old, and because there are three different pieces of film, it is possible that the film may shrink at different rates, yielding image alignment and fringing problems. To restore this, a computer automatically scales the three images so that they are the same size. Barring this, other problems can occur as well. Films made prior to 1951 were printed on nitrate stick. Nitrate stock degraded very quickly if not kept under proper conditions, causing fires and other damage.

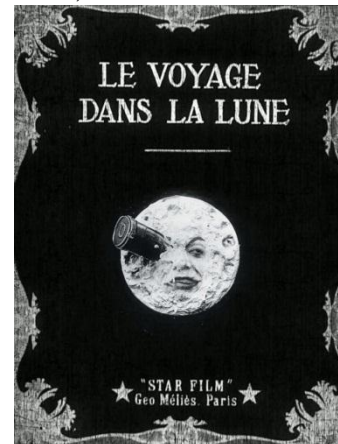


A sample nitrate film container which has had extensive damage.

Thus, when a film is restored, a lot of computer processing may be required. In this lab, we are going to use some of the existing image processing routines and other materials to “restore” an existing movie.

The movie we are going to “restore”, “Le Voyage dans la lune”, was theatrically released in 1902 and is in the public domain. Quoting from rottentomatoes.com,

“A Trip to the Moon is the most famous of the over 500 short films produced by cinema pioneer Georges Méliès between 1896 and 1912, and its signature image of a bullet-shaped rocket lodging itself in the eye of a smirking moon is one of the most recognizable images in cinema history. An accomplished magician, Méliès moved from simple recordings of his stage shows to dazzling fantasy epics which were among the first narrative films ever made. These “trick films” combined fantastic yarns, intricate painted sets, and elaborate costumes with such simple but effective special effects as slow motion, dissolves, and superimpositions. Like Méliès’s



other long films of the period, Trip to the Moon is composed of a series of tableaux, each featuring chaotic action and multiple camera tricks photographed with a stubbornly static camera, which work together to tell a simple story. It proved sensationally popular with audiences, though Edwin S. Porter’s The Great Train Robbery rode a slightly more sophisticated narrative to greater success the following year. As one of the earliest examples of cinematic fantasy, A Trip to the Moon paved the way for such filmic flights of fancy as The Wizard of Oz and Star Wars, as it proved that the seduction of the audience through special effects has roots deeper than the blockbusters of the Seventies. “

Our restoration is going to include two parts. First and foremost, we desire to remove “shot noise” from the image. Shot noise occurs when there is a scratch or something else which appears on a single frame of the film. For example, a piece of dirt on the film will show up as a



smudge on one frame. To remove this type of noise, we will employ a time based median filter. In class, we discussed median filtering of pixels to remove noise from an image. In this case, we will median filter as well, but we will median filter over time, comparing the grayscale value of the current pixel with the grayscale value of the pixel in the previous frame and the next frame. This will help to remove this type of noise.

We also will want to ensure that the contrast of the film is appropriate. To do this, we will want to stretch the contrast of the image so that the entire contrast range is used. This will be done to each frame as part of processing.

We also will want to sharpen the image. Sharpening the image involves using a convolution operation and a set of coefficients which result in increased contrast in the image. A set of

coefficients for sharpening might include

$$\begin{array}{ccc} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{array}$$

Lastly, we will want to adjust the hue of the image. Films of this vintage were typically not grayscale, but instead were printed in sepia, which results in a brown tinge to the image.

3. Lab activities

For this lab, you can work on either the Glenn or Oakley cluster. To begin, you will write a program which will read a set of frames in that are provided to you. The frames are in bitmap format and are of a fixed size.

Once the images are read in, they should be sent via MPI to the processors that are going to work on them. For example, you might send frames 0 – 11 to core 1, frames 10 – 21 to core 2, etc. Once the cores have the frames, send most likely via an MPI send message, each core will start median filtering the frames over time. This will be done using either openMP or openACC; it is your choice. Sharpening will occur based on each frame, as will a contrast stretch, and the hue adjustment.

When this is done, the process will send the enhanced frames to another MPI process which will be responsible for writing them out to a file. Given that files take a long time to write out, it may make sense for there to be multiple MPI processes dedicated to writing the files to the file media.

The output of the process will be a set of bmp files which you can then download to your local PC and the ffmpeg program to create a movie out of them.

4. Deliverables

Each lab team is responsible for submitting a report with the following

1. What did you learn by doing this lab?
2. What things went right and wrong when doing this lab?
3. What were your greatest challenges in completing this lab?



4. What kind of speedups were you able to obtain by parallelizing this process? Which varied more, adding more openMP cores / openACC processes or increasing the number of MPI nodes? Plot this over a small number of variables.
5. What conclusions can you draw from this experience?

Additionally, each team is responsible for submitting a tar.gz file which contains all code and executable and a working job script which can be submitted on the OSC cluster.

You also should upload your final filtered mp4 movie to the course website as well.