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Chapter 20

Techniques to Digitally Preserve the Historical Film of a Space Agency*

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Abstract

Space agencies around the world document many projects using video. In the founding years of humans in space, film cameras were popularly used to record tests, setups, activities in space, and broadcast media for television. The film was often replicated to store multiple copies of film and share the information with multiple parties. This film is the original artifact of the space agencies, and documents the progression of the program. The film archives of space history require attention. The reels of 8 mm, 16 mm, and 55 mm film from half a century ago are showing wear. In an effort to preserve the delicate and aging film at the University of Alabama in Huntsville, students and archivists are developing unique, low-cost, and deployable solutions to digitally secure the video archives. UAHuntsville has approximately 1,300 hours of film from the iconic moments of United States aerospace history. By forming a rapid and low cost solution, libraries such as the UAHuntsville Library are able to commit to recording such a vast collection. The digital media format is ideal for the film to be shared with people today and secured for future generations. Moreover, by developing a low-cost and rapid solution, other archives may consider investing in the required tech-

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nologies and resources. I will discuss the technologies considered at UAHuntsville. I will show the process to convert film to digital media.

Indentifying the Need

Walking through the library at the University of Alabama in Huntsville is a great experience. When entering, one sees a great use of technology. Both digital classrooms and digital labs are within steps of the front door. In the core of the main floor stands a coffee shop and relaxed study area. The floors above contain a standard assortment of articles, books, and other media. This is the modern library.

"Take the elevator to the basement." It starts like a rumor. A student will hear of the awesome archives in the basement of the library. Past the coffee shop and down one level is home to fantastic local history. Being Rocket City, USA, many personal donations have been made to the library. Recent artifacts collected have been from the Space Shuttle program, especially the Space Shuttle Main Engine (SSME) development. The collection extends to include Skylab microgravity videos on 16 mm film, 55 mm film and magnetic tape.

Figure 20–1: Label of 16 mm film canister, Skylab Collection.

In smaller quantity is a collection of random 16 mm and 8 mm film, which includes fascinating photography of early American rocket development testing, orbital operations, and lunar Apollo activities. Much of this is from NASA and is a copy of the original as noted on the case. A unique film was discovered from Peenemünde, Germany of the A4 rocket testing.

This film is meeting two major challenges. The film is degrading due to time and storage conditions. The air in Huntsville, Alabama, can promote the degradation of the film over the course of decades. If the container was contaminated when closed decades ago, the film could be damaged. Age and UV exposure contribute to the film being very fragile. The oldest artifacts are in fact too delicate to drive through the normal 16 mm projector.

The second challenge in finding film projectors in operational conditional operation. For example of three 16 mm projectors acquired, one is in operational condition. The team must also acquire hardware that is compatible with some proprietary film and mag-tape.

Mechanisms of Digitization

To digitize is to take a film clip or magnetic tape image and receive it with a digital sensor. For film, there has to be some optical translation of the image. The UAHuntsville team has two processes for this translation: direct projection and reflective projection. See Figure 20–2.

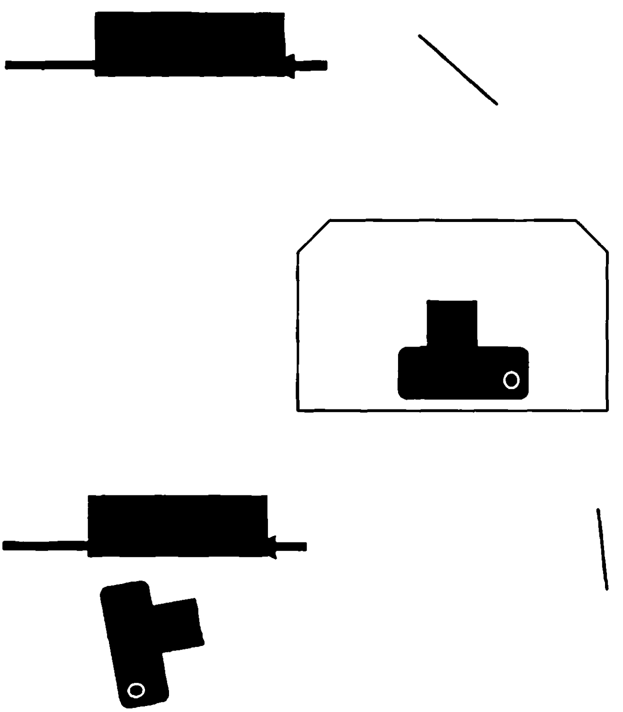

Figure 20–2: Diagrams of direct projection (top) and reflective projection (bottom).

In direct projection the film projector is directed to a mirror which directs the image to an opaque film. A digital camera is used to record the image through the film. The mirror must have the reflective surface on the front of the glass; otherwise a double reflection is possible where the image is repeated just a few millimeters offset from the original. The mirror inverts the image, which speeds up the production time of the final video. Finally, a hood can be installed around the camera to hold the opaque film and block other light from the transmission. Any light in excess of the projector should be considered noise.

In reflective projection, the projector should be set up for projection to an audience. The projection screen should be of high quality as to avoid losses due to debris or poor reflection. A digital camera should be set up to record the screen. Having the projection angle head on and the camera as head-on as possible will promote the best image transfer. The angle relationship is necessary to avoid skew of the transfer image.

The size requirements of the two projection systems are based on the projector of choice. The setup scale is based on the focal length of the projector.

Other mechanisms of digitization were considered. A popular option is to clip short segments of frames and scan them using a photo scanner. Software is used to build the images into a movie. This method provides high quality movies. This option was not used due to the requirement for the film to be clipped often and the need to process the estimated 1,300 hours of film at UAHuntsville.
There is a device that automatically processes film through an imaging camera frame by frame, called a telecine machine. This technology is available commercially, which is currently not an option for the UAH project.

Successes

Success in digitization should be judged comparing three factors. First, cost is a major limiting factor. Currently, the team has invested in an $800 digital camera that can be used for high-definition video and still images using a variety of DSLR EF lenses.

Second, processing speed should be of high importance. As mentioned earlier, UAH has 1,300 hours of film to process. The minimum speed of digitization should be half of real-time of the film original. This is to ensure the processing is completed in a reasonable timeframe.

Third, the quality must be considered. Watching a film directly from the reel can be a surreal experience. This was especially evident when the UAH team watched film from the lunar rover. Observers compared the normal projection to watching the best 3D movies today. This quality can be equated to a cost when converting. A high-quality film should be recorded at highest resolution. Similarly, low-quality film should not require or utilize highest resolution photography. However, to effectively complete conversion of a collection, the proper technique and quality should be chosen when starting the conversion process.

The UAH team has used both direct projection and reflective projection techniques. The quality was judged as similar to each other when using the same image sensor. Both methods provided transfer speeds at real-time.

Limitations

The UAH team has identified two major limitations to the film conversion process. First, there is a lack of inventory of the films. Currently, the collections at UAH are expansive. A basic library inventory does exist, however the information available is limited to what is on the film case. See Figure 20–1.

There is a huge risk with the reel not being matched properly with the film case. This renders the inventory, the basic or advanced, irrelevant.

The second major limitation is projector availability. The film at UAH is stored on a variety of media. The film is in 8 mm (Eastman Kodak), Super 8 (Eastman Kodak), 16 mm, and 35 mm. There are also magnetic tape movies. These are 51 mm, VCR, and other tape sizes. Each of these media types requires a different projector or player.

The Camera

The camera used by the UAH team is the Canon Rebel T3i. This 18 megapixel DSLR camera has full HD 1080 P high-definition video. The camera is set to movie mode. It is important to set the shutter speed to 1/30 seconds. This feature of such a large shutter speed in filming eliminates the majority of the cross lines. See Figure 20–3.

The T3i was the camera of choice. Of the personally owned and university cameras available, the T3i was the only one with adjustable shutter speed.

To further match the shutter speed of the projector with the camera, the team attempted power source manipulation of the projector. We simply utilized a variac at about the 70 percent setting. This, in combination with the 1/30 shutter speed made the cross lines disappear completely. Using the variac did reduce the light intensity, which was judged as too much of a compromise in the videography.

Figure 20–3: Horizontal lines are visible when the refresh rate of the projector and receiver are not fully in phase. These lines appear to move slowly down the screen.

Future Work

The UAH team feels like the film being digitized required the best technologies for film transfer. Due to the limited budget of such a project, the UAH team will challenge an optical engineering senior design team to develop a telecine machine for each of the film sizes. The UAH team will begin investigating the magnetic tape videos and secure the required translation hardware.

Senior design project teams will be given the following challenge requirements:

1. Create an automatic imaging system
2. Must individually image and advance frames
3. Must be compatible with 8 mm (or Super 8, 16 mm, or 35 mm) film
4. Must prioritize image quality and include complete frame
5. Ensure automatic operation for entire reel, approximately 25 minutes each
6. Must not distort image
7. Audio need not be recovered from film.

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About the Author

Mark Becnel is a graduate student at the University of Alabama in Huntsville, Alabama. He is pursuing a Master of Science Degree in aerospace engineering with a focus on electric propulsion. Prior to UAH, he earned a Bachelor of Science in physics from the University of New Orleans, Louisiana. His immediate goals include completing thesis work developing the inertial electrostatic confinement diffusion thruster at UAHuntsville and Marshall Space Flight Center, Huntsville, Alabama. Becnel is a volunteer member of the film digitizing team.

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