Total solar eclipse 360-degree personal VR and planetarium dome-video for educational outreach

Elizabeth Dowell, Andrew Petersen, Sheri Trbovich, William Dowell, John E. Sohl, Murielle Shallbetter;
Dept. of Physics, Weber State University, Ogden, UT
Ron Proctor; Clark Planetarium, Salt Lake City, UT

YouTube Garmin VIRB 360
2017 Full Eclipse 2X Speed

Introduction & Background

It is impossible to know how many people viewed the 2017 total solar eclipse. Approximately 12 million people live in the eclipse path with 200 million within a day's drive, if 2% of those made the trek, then we can assume that 20 million people witnessed this event. Viewed another way, that means that 94% of the US population did not witness totality. This outreach project attempts to address this statistic.

Multiple 360° cameras and several stabilization systems were tested and flown with the goal of obtaining high resolution images of both the total solar eclipse and of Moon's shadow moving across Earth. The resulting videos are being produced for personal Virtual Reality (VR) viewing on smartphones and tablets. A version is also being produced for international distribution to planetarium domes. To survive the large scale projection on a planetarium dome, the video must be stable, have high resolution and high frame rate.

Video from 2 to 6 cameras must be stitched together to create the full sphere experience. We tested three camera systems that had the specifications needed: the Garmin VIRB 360, two back-to-back Kodak PIXPRO SP360s, and six GoPro Sessions in a WetHot360 camera rig.

Camera Systems Tested

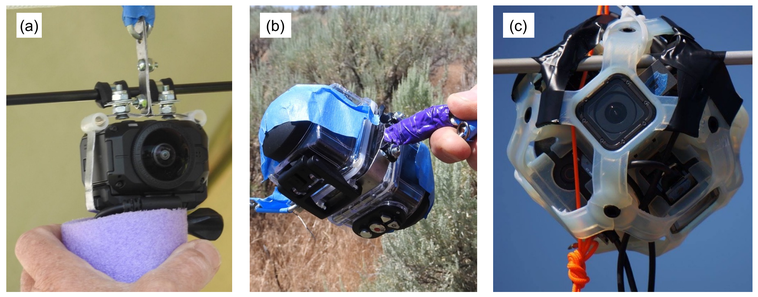

Figure 1. The cameras shown are ready for flight with hands and other objects included for scale. (a) Garmin VIRB 360 comes in its own housing. (b) Two Kodak PIXPRO SP360 cameras in the back-to-back dual camera housing accessory. (c) Six GoPro Session cameras in a WetHot360 mount.

Software

We tried many programs for stitching and stabilizing the raw video. For stitching the footage, we tried Kodak's proprietary PIXPRO 360 Stitch, VideoStitch Studio, and Kolor Autopano Video. We used Kodak's PIXPRO 360 Stitch because of its simple compatibility with the Kodak cameras. For the other cameras we chose VideoStitch Studio over Kolor Autopano Video after testing our footage in the programs' demo versions. VideoStitch Studio allows us to work with many different camera configurations, including the WetHot360 GoPro Session Rig.

Stabilization was tested with VideoStitch Studio and Adobe Skybox, a VR plugin for the Adobe Suite, which allows the programs to be compatible with 360 video formats. We found both these stabilization programs to be capable, but Adobe was significantly faster and resulted in more uniform stabilization. In the future we plan to test Garmin's VIRB Edit program, which allows us to stitch and stabilize the footage using GPS and accelerometer data recorded by the VIRB 360 rather than using motion capture systems.

Stabilization Systems Tested

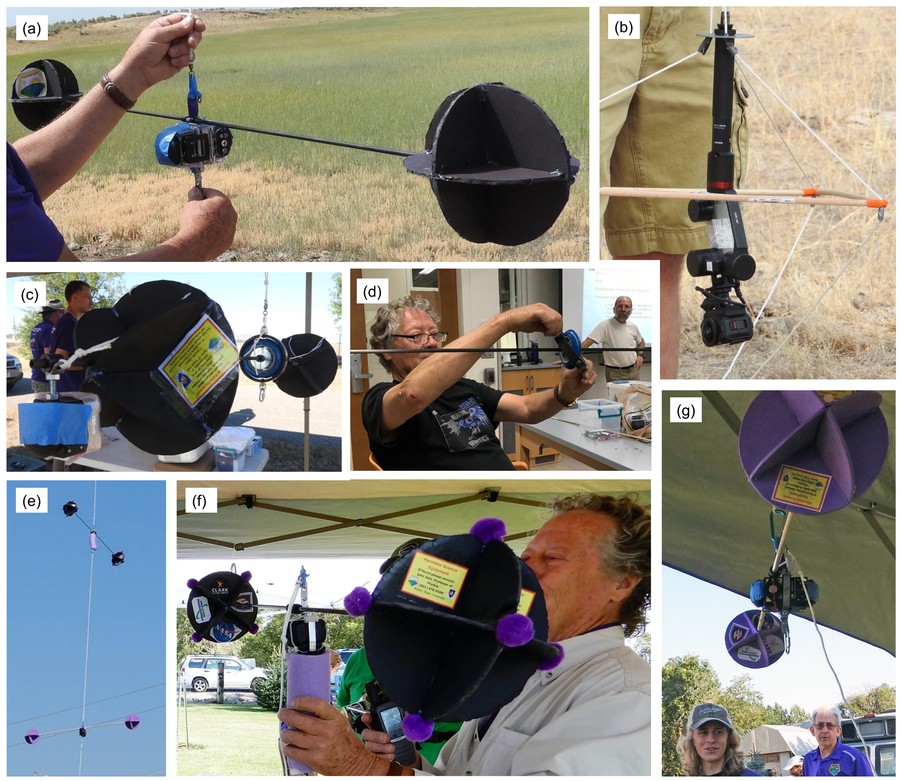

Figure 2. We tried both active and passive stabilization systems. The passive systems (a) involved various booms with masses on each end. The active system (b) was heavy and could easily get stuck in an unstable state where it would start flip flopping. We tried to use the two Kodak cameras as mass (c) but there was too much twist in the system and we were unable to stitch the videos. We also found that the system using a roller blade wheel bearing (d) as a gimbal was very smooth but needed too much damping to work well. Our final configuration to stabilize the Kodak and Garmin systems was to mount the cameras in the middle of a passive boom with somewhat large light weights at each end. (e, f, g)

Smartphone VR Viewers

We tested several different smartphone holding VR viewers made of plastic and cardboard and found that the Google Cardboard V2 type headsets are remarkably good at giving first time viewers an immersive experience of the eclipse from the perspective of the balloon. While no one unit is perfect, the V2 headsets allow for control of the video with a capacitive push button. However, a limiting factor of the cardboard is the inability to adjust the lenses for both pupil and focal distance.

Status & Conclusions

Preliminary VR video was produced and is available online. The full dome video will take significantly longer, but is in progress. We found the combination that worked best for us was the Garmin VIRB 360 camera, a simple boom stabilization system with ball bearing swivels, VideoStitch software and the Google Cardboard V2 headset for smartphones.

Sample Results, VIRB 360

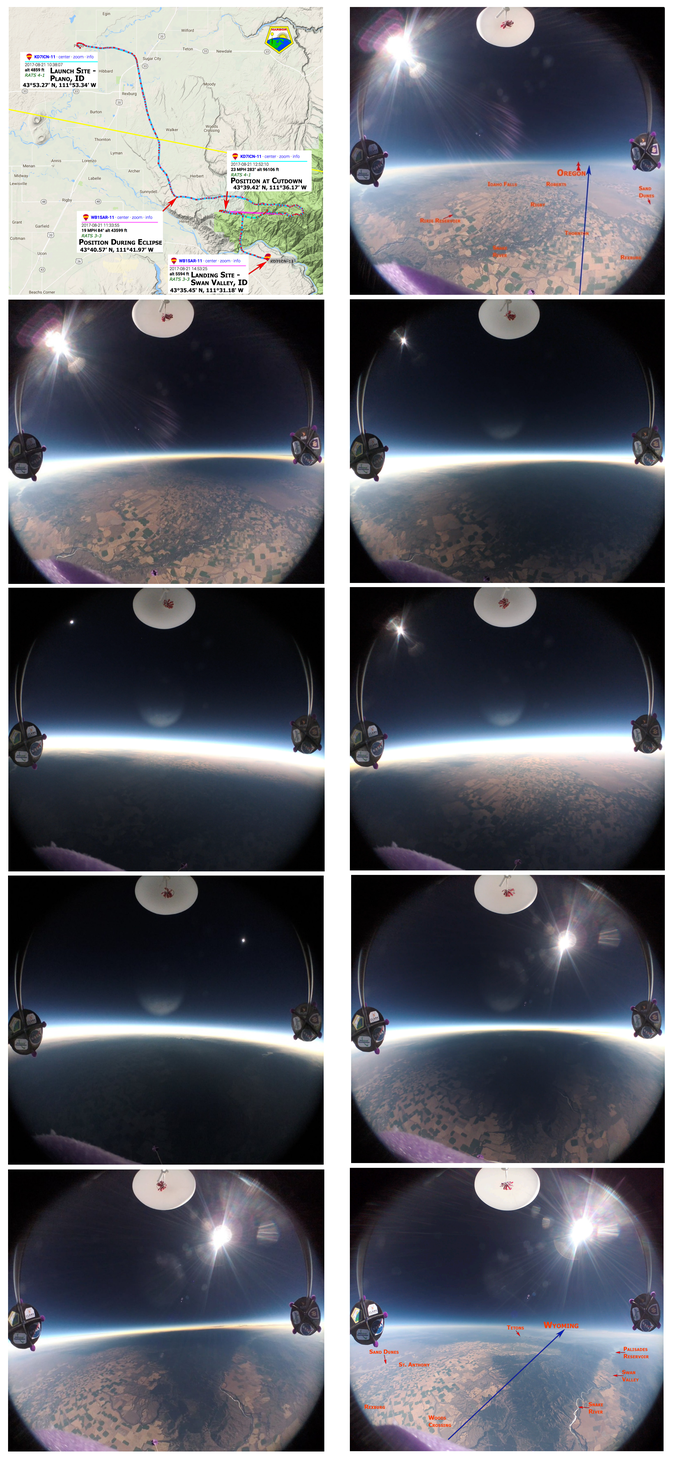

Figure 3. Still images from the Garmin VIRB 360 flight video at an altitude of 13 km and SSE of Rexburg, ID, with annotation added on the first and last image. The first five VIRB images are looking west at the approaching shadow. The last four images are looking east.