C37 A Uniform Method for Visual Analysis and Comparison of Airbag Deployments

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After attending this presentation, attendees will understand some of the techniques used to test automotive airbags. Attendees will be presented with an optimized testing protocol for high speed imaging of airbag deployments, which simplifies post-test analysis and allows for easier comparison with other deployment tests.

This presentation will impact the forensic community and/or humanity by demonstrating the use of a standard protocol for high-speed image acquisition of static airbag tests would benefit the automotive engineering community because it would result in better analysis and understanding of airbag deployment characteristics. Forensic engineers and scientists would be better able to identify mechanisms of airbag related injuries. Consequently, it could benefit humanity as engineers and forensic scientists work together to develop safer and more effective airbags.

A protocol for airbag tests has been established that may be helpful to the testing community at large. High-speed image analysis is an important part of identifying airbag deployment characteristics. Unfortunately, those who test airbags can often use widely varied techniques and equipment when it comes to acquiring high-speed images and analyzing them. Videos and films from different sources, therefore, cannot be easily compared. Expensive software may be needed just to derive basic data. The protocol proposed here allows for simpler and more accurate analysis, as well as easier comparison of similar tests.

The methodology for recording airbag deployments can vary from lab to lab. The frame rates of the high-speed video and films systems can differ, as can the camera positions and lenses used. In order to get meaningful measurement data, some amount of photogrammetry is necessary. Measurements of varying accuracy can be derived using software packages that use data such as lens focal length, camera location, and objects or markers of known scale in the shot. Unfortunately, when these videos or films are shared with other researchers, all the additional data necessary to make accurate photogrammetric measurements may not be made available. Consequently, it may not be possible to independently validate the deployment data or compare results with other airbag tests.

With these problems in mind, the authors sought to create an optimized testing protocol for high-speed image acquisition of static airbag deployments. The resulting protocol, along with the considerations and advantages behind it, are discussed.

A permanent airbag fixture was developed. The fixture was constructed of reinforced heavy gauge steel. The mounting plate was designed to allow a load cell to be mounted between the fixture and the airbag to measure reaction force during deployment.

Three primary camera positions are used. Each one is perpendicular to a plane running through the center of the airbag. One camera is focused on the side of the airbag, another is focused on the front the airbag, and the third is mounted overhead, looking down at the top of the airbag. Thus, the cameras are positioned along three axes relative to the center of the airbag. The side and front view cameras are placed at a distance of at least 20 feet (6.1 meters) from the center of the airbag. Telephoto lenses are attached to the cameras in order to create a narrow field of view and compress perspective. This reduces the amount of error when attempting to measure objects that are not on the same plane. The overhead camera is placed as high as possible for the same reason.

Ideally one would like to use the highest frame rate possible to record airbag deployments, but most high-speed video cameras today require the operator to compromise between resolution and speed. Typically the operator must reduce the frame size (resolution) in order gain speed. Speeds of 1000 frames per second or higher are recommended for airbag testing. The test protocol calls for frame rates of 2,500-4000 frames per second depending on the test. The cameras are also phase locked to each other so that images from each camera are synchronized.

A solid black backdrop is used as a background to each of the primary camera views. Others have used grids or no background at all, which can make post-test analysis more difficult. Using a solid black backdrop provides good contrast between the background and the airbag fabric, making it easier for automated image analysis software to identify the airbag contour.

Prior to deployment, a black board with a white measurement grid marked on it is placed at the centerline of the airbag and recorded with each camera. Since the cameras are locked in position, the image of the measurement grid can be recorded and later digitally superimposed on the images of the deploying airbag. This allows for some basic visual analysis of the high-speed video images without image analysis software. It also can be used as a reference scale within the image analysis software.

The airbag and cameras, as well as any data acquisition equipment, are triggered by a synchronized electronic switch. An electronic flash is also triggered to visually denote time zero.

Use of a standard protocol for high-speed image acquisition of static airbag tests would benefit the automotive engineering community because it would result in better analysis and understanding of airbag deployment characteristics. Forensic engineers and scientists would be better able to identify mechanisms of airbag related injuries. Consequently, it could benefit humanity as engineers and forensic scientists work together to develop safer and more effective airbags.

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