Practical Advantages of a Universal Geometry Measurement Method

Within the simulation training industry, customers and suppliers of muti-channel display systems spend significant time and dollars, dealing with geometry measurements. For the typical training display system, customers often impose distinct requirements for absolute geometry, relative geometry, and the geometric co-alignment of dots in the blend regions between channels. Today acceptance testing is typically performed using a manually-aimed theodolite and a spreadsheet running on a portable computer. Using this method, the complete measurement of system geometry requires at least several hours and may require several shifts for a many-channel display system such as that used for F-35 training. In addition to time spent making the measurements, significant time is required to prepare and install a system-specific test pattern with extra dots in the blend regions between channels and to prepare a custom spreadsheet that computes metrics based on the specific organization channels and blends.

In this paper we describe a new approach to system geometry measurements that significantly reduces complexity and substantially decreases the time required to make these measurements. Capable automated geometry measurement systems have been available from multiple suppliers in the simulation training industry for more than a decade. While these proprietary systems are used regularly to align multi-channel display systems, they are not used for acceptance testing for reasons including: 1) they are not installed at the eyepoint(s) of the display system; 2) they are not calibrated independently of the display system; and 3) there is little standardization across the suppliers of these systems.

With the proposed method a universal test pattern is defined that contains one alignment dot per square degree and covers an entire sphere. Since the sphere covers any possible window configuration, the same pattern can be used for any display system. The dots in the pattern are color coded in a way that allows a camera system to rapidly identify any of the dots from a single image without the need for other geometry landmarks or labels. With a 60 x 45 degree FOV, the camera is capable of measuring the locations of 2500 dots using a single camera image. Thus, such a system is capable of measuring up to 10,000 alignment dots per minute.

With the goal of developing industry standard practices, we are publishing the metric definitions, test pattern description, and measurement procedure and soliciting stakeholder feedback so that the method can be improved. The use of vetted and published standard measurement procedures is expected to improve consistency from one program to the next and to reduce the complexity of preparing requirements and test plans. The use of stable, objective, and unambiguous requirements and measurement procedures is expected to reduce the risk to suppliers who wish to avoid discrepancies and delays during acceptance testing.

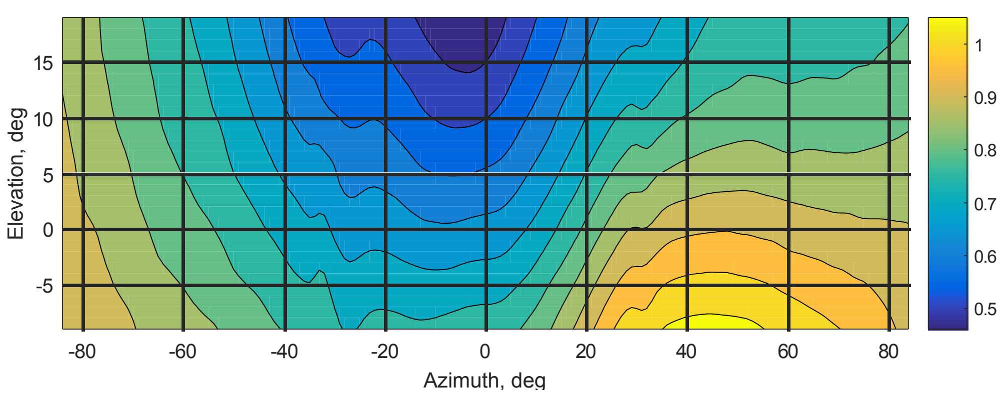

Figure 1. Absolute geometry errors (degrees) for a 3-channel blended display system.

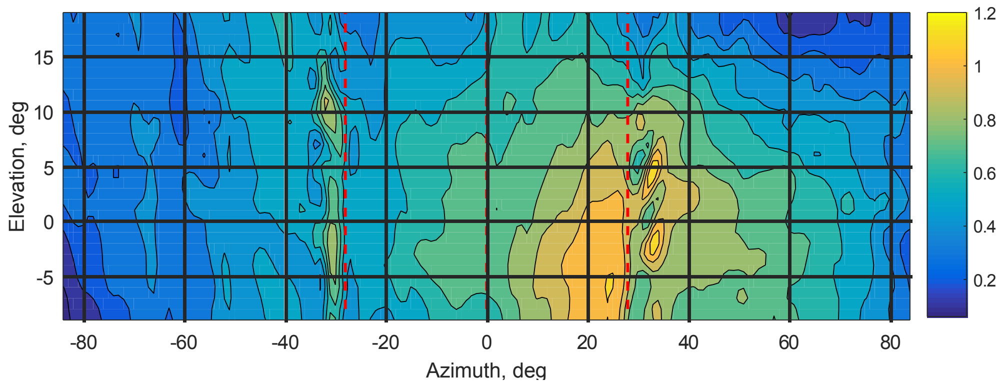

Figure 2. Relative geometry errors (arcmin/degree) for a 3-channel blended display system.

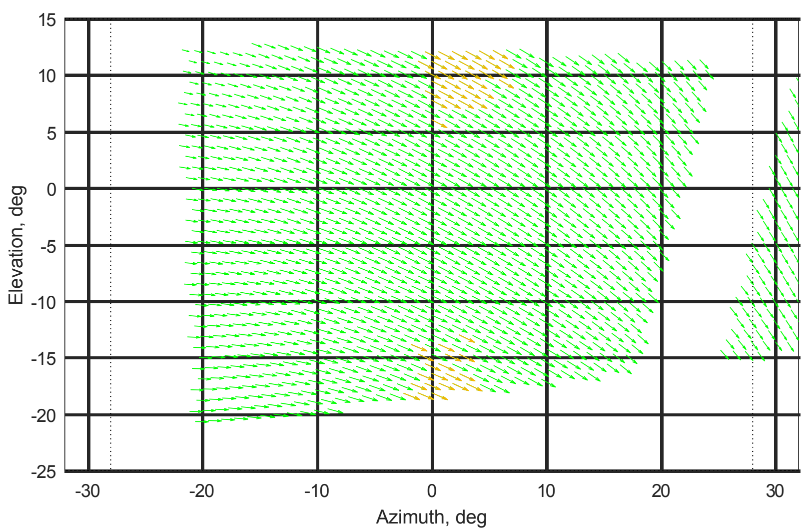

Figure 3. Absolute geometry errors for the center channel of a 3 channel display employing a Mylar collimating mirror. Arrows indicate the magnitude and direction of the geometry errors.

Biography

Dr. Charles J. Lloyd is president of Visual Performance LLC where he addresses research and development challenges relating to training display system requirements.   He has 30 years of experience in display systems and applied vision research at such organizations as Honeywell's Advanced Displays Group, The Lighting Research Center, BARCO Projection Systems, FlightSafety International, and the Air Force Research Laboratory. Charles has published 80 papers in this arena.