Projection Lens Contrast Modeling for High Dynamic Range Projectors

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ABSTRACT

Contrast in high dynamic range projection lenses is critically affected by stray light within the lens. This is caused by ghost reflections from lens element surfaces, scattered light reflected from the lens interior (metal housings, spacers, lens element edges, stops etc), quality of lens polishing (surface roughness) and contamination on the surface of lens elements. In this paper we report on the process of modeling stray light and how it can be reduced to maximise projection contrast.

Primary Author BIO

Russ Hudyma joined Navitar as Chief Technology Officer in February 2016 after the company acquired Hyperion Development, where he served as managing partner for over 15 years. Russ has a bachelor's and master's degree in optics from the University of Rochester. He is an accomplished optical engineer, physicist and scientist, with experience in advanced design, analysis and modeling of lithographic optical systems. He has published more than 20 papers on microlithography and related topics, holds or has applied for more than 30 U.S. and foreign patents, and teaches a popular SPIE short course entitled, "Optical Design in the Ultraviolet."

As managing partner of Hyperion Development, Russ spearheaded the creation of intellectual property resulting in 100+ patents either currently issued or pending. He developed and patented new catoptric design forms that will be the basis of future commercial extreme ultraviolet (EUV) lithographic printing tools in excess of 0.3 NA and commercial immersion lithographic printing tools in excess of 1.0 NA, developed new dioptric design forms for high-dry and immersion ArF lithography, designed novel compact extended range zooms for multispectral (VIS thru MWIR) and dual-band (MWIR-LWIR) image acquisition and targeting, and developed SVD-based algorithms to align complex optical systems. He also developed and reduced to practice product families of 4K & 5K taking lenses for digital cinematography and a series of 2D/3D projection zoom lenses for DLP and SXRD digital cinema.

Prior to starting Hyperion Development, Russ was a Physicist at Lawrence Livermore National Laboratory where he developed novel optical projection concepts for the extreme ultraviolet (EUV) lithographic printing. While at LLNL, Russ was responsible for the final design and analysis of Engineering Test Stand (ETS) and Micro Exposure Tool (MET) Projection Systems. The body of work included optical design, tolerance analysis, detailed error budgeting, and analysis of lithographic performance using Prolith. He contributed to the developed of high accuracy, non-actinic interferometric test sets for both EUV components and EUV systems that exceeded program accuracy goals and developed and patented novel six-mirror anastigmatic catoptric design forms that define the fundamental imaging architecture for EUV lithographic printing tools used today for high volume manufacture.

Prior to his work with LLNL, Russ was a Staff Scientist at the Santa Barbara Research Center in Coleta, CA. He led the engineering model (EM) optical development team on the HRMSI (High Resolution Multispectral Stereo Imager) program and directed the development and delivery of the MODIS On-Board Calibrators (Solar Diffuser, Solar Diffuser Stability Monitor, Blackbody, and Spectroradiometric Calibration Assembly). Russ's technical contributions included advanced unobscured telescope concepts for the Advanced Land Remote Sensing System (Landsat 8), Fourier transform spectrometer (FTS) development for next generation weather sounding requirements (NPOESS), and concept definition for the Mars Infrared Imaging Radiometer (MIRIR).