

本期目录 | 下期目录 | 过刊浏览 | 高级检索

[打印本页] [关闭]

现代应用光学

重复脉冲激光造成扫描型CCD背景条纹的规律

张震*, 周孟莲, 蔡跃, 张检民, 韦成华

西北核技术研究所 激光与物质相互作用国家重点实验室, 陕西 西安 710024

摘要: 为了描述重复脉冲激光使扫描型CCD输出视频产生背景条纹的规律, 基于这种背景条纹现象的产生机理对理想矩形脉冲激光产生的条纹建立了数学描述模型。通过该模型, 可根据相机的时间延迟积分级数、单级积分时间和激光脉冲的脉宽、脉冲重复周期等参量之间的关系来判断背景条纹能否出现并计算背景条纹的尺寸参量, 计算精确度为1 pixel。利用重复皮秒脉冲激光和日光灯分别辐照扫描型CCD进行了实验, 验证了上述模型计算结果的正确性。在该模型的基础上, 结合背景光强与脉冲散射光强的关系, 给出了条纹可见度的表达式, 并通过实验验证了该表达式所反映出的条纹可见度随着相关参量变化的规律。

关键词: 激光辐照 重复脉冲激光 背景条纹 扫描型CCD

Law of Background Fringes in Video of Scanning CCD Induced by Repetitive Pulse Lasers

ZHANG Zhen*, ZHOU Meng-lian, CAI Yue, ZHANG Jian-min, WEI Cheng-hua

State Key Laboratory of Laser Interaction with Matter, Northwest Institute of Nuclear Technology, Xi'an 710024, China

Abstract: In order to obtain the generating law of background fringes in the video of a scanning CCD camera induced by repetitive pulse lasers, a mathematic model describing fringes induced by repetitive square pulse lasers is established. In this model, the relation of camera parameters including stage number of time delay integrations, integration time of one stage as well as laser pulse width and laser repetitive period can be used to estimate whether the fringes appear or not and to calculate what is the dimensions of fringes, in which the precision of calculation is 1 pixel. An experiment is performed by using repetitive picosecond pulse lasers and a fluorescent lamp to irradiate the scanning CCD camera respectively, and the results validate the correction of estimation and calculation based on the model. Finally, combing the intensity relation of background light and scattered laser with the model, the visibility expression of fringes is given, which is also validated in the experiment.

Keywords: laser irradiation Repetitive pulse laser Background fringes Scanning CCD

收稿日期 2013-01-21 修回日期 2013-03-18 网络版发布日期 2013-07-15

基金项目:

激光与物质相互作用国家重点实验室创新基金资助项目

通讯作者: 张震

作者简介: 张震(1981-), 男, 山东日照人, 博士, 助理研究员, 2003年于山东师范大学获得学士学位, 2005年, 2010年于国防科学技术大学分别获得硕士、博士学位, 现主要从事光电探测器激光辐照效应的研究。

作者Email: zhyc8@126.com

参考文献:

- [1]刘秉琦, 周斌, 武东生, 等. 双通道激光主动探测系统[J]. 光学精密工程, 2012, 20(2): 241-246. LIU B Q, ZHOU B, WU D SH, et al.. Dual-channel active laser detection system [J]. Opt. Precision Eng., 2012, 20(2): 241-246. (in Chinese) [2]张磊, 郭劲. 分体式激光扩束系统平行度测量装置的设计[J]. 光学精密工程, 2012, 20(4): 789-795. ZHANG L, GUO J. Design of parallelism measuring equipment for laser beams from independent laser expanding beam system [J]. Opt. Precision Eng., 2012, 20(4): 789-795. (in Chinese) [3]邱冬冬, 张震, 王睿, 等. 脉冲激光对CCD成像器件的破坏机理研究[J]. 光学学报, 2011, 31(2): 0214006-1-0214006-5. QIU D D, ZHANG ZH, WANG R, et al.. Mechanism research of pulse-laser induced damage to CCD imaging devices [J]. Acta Opt. Sin., 2011, 31(2): 0214006-1-0214006-5. (in Chinese) [4]毕娟, 张喜和, 倪晓武. 长脉冲激光对组成CCD图像传感器的MOS光敏单元的硬破坏机理研究[J]. 物理学报, 2011, 60(11): 114210-1-114210-6. BI J, ZHANG X H, NI X W. Mechanism for long pulse laser-induced hard damage to the MOS pixel of CCD image sensor [J]. Acta Phys. Sin., 2011, 60(11): 114210-1-114210-6. (in Chinese) [5]蔡跃, 叶锡生, 马志亮, 等. 170ps激光脉冲辐照可见光面阵Si-CCD的实验[J]. 光学精密工程, 2011, 19(2): 457-462. CAI Y, YE X SH, MA ZH L, et al.. Experiment of 170 ps laser pulse irradiation effect on visible plane array Si-CCD [J]. Opt. Precision Eng., 2011, 19(2): 457-462. (in Chinese) [6]王明, 王挺峰, 邵俊峰. 面阵CCD相机的飞秒激光损伤分析[J]. 中国光学, 2013, 6(1): 96-102. WANG M, WANG T F, SHAO J F. Analysis of femtosecond laser induced damage to array CCD camera [J]. Chinese Optics, 2013, 6(1): 96-102. (in Chinese) [7]邵立, 汪亚夫, 宋伟. 连续激光干扰CCD成像研究[J]. 激光杂志, 2012, 33(2): 38-40. SHAO L, WANG Y F, SONG W. Research on CW laser jamming CCD imaging [J]. Laser Journal, 2012, 33(2): 38-40. (in Chinese) [8]JIANG T, ZHANG Z, CHENG X A, et al.. Study on vertical bright line image of CCD camera irradiated by laser [J]. SPIE, 2010, 7656: 76561A-1-76561A-5. [9]张震, 江天, 程湘爱, 等. CCD强光串扰效应的串扰线缺口现象及其机制[J]. 强激光与粒子束, 2010, 22(7): 1505-1510. ZHANG ZH, JIANG T, CHENG X A, et al.. Gap on crosstalk line about CCD crosstalk effect induced by intense light and its mechanism [J]. High Power Laser and Particle Beams, 2010, 22(7): 1505-1510. (in Chinese) [10]张震, 程湘爱, 姜宗福. 强光致CCD过饱和和效应机理分析[J]. 强激光与粒子束, 2010, 22(2): 233-237. ZHANG ZH, CHENG X A, JIANG Z F. Mechanism analysis of CCD excessive saturation effect induced by intense laser [J]. High Power Laser and Particle Beams, 2010, 22(2): 233-237.

(in Chinese) [11]张震, 程湘爱, 姜宗福. 等. 高重复脉冲激光引起CCD视频中的动态次光斑现象研究[J]. 应用激光, 2010, 30(1): 45-49. ZHANG ZH, CHENG X A, JIANG Z F, et al.. Investigation into the dynamical subordinate facula in the video of the CCD irradiated by high repetition pulses laser [J]. Applied Laser, 2010, 30(1): 45-49. (in Chinese) [12]张震, 程湘爱, 江天, 等. 重频激光辐照面阵CCD的主光斑丢失现象及其原因[J]. 红外与激光工程, 2010, 39(Supp.): 429-432. ZHANG ZH, CHENG X A, JIANG T, et al.. Disappearing of main spots in the video of CCD camera being irradiated by repetition pulse laser and its