Accepted Manuscript

Laser Speckle Jitter Correction in Plant Fluorescence Lifetime Extraction

Jing Min, Le Jing, Hua Deng-xin, He Ting-yao, Zhou Chun-yan

PII: S0263-2241(18)30876-5
DOI: https://doi.org/10.1016/j.measurement.2018.09.042
Reference: MEASUR 5900

To appear in: *Measurement*

Received Date: 14 February 2018
Revised Date: 12 September 2018
Accepted Date: 16 September 2018

Please cite this article as: J. Min, L. Jing, H. Deng-xin, H. Ting-yao, Z. Chun-yan, Laser Speckle Jitter Correction in Plant Fluorescence Lifetime Extraction, *Measurement* (2018), doi: https://doi.org/10.1016/j.measurement.2018.09.042

Laser Speckle Jitter Correction in Plant Fluorescence Lifetime Extraction

Jing Min[1)2)] Le Jing[1)] Hua Deng-xin[†1)] He Ting-yao[1)] Zhou Chun-yan[1)]

1) School of Mechanical and Precision Instrument Engineering, Xi'an University of Technology, Xi'an 710048, China

2) School of Mechanical engineering, Shaanxi University of Technology,Hanzhong 723000,China

Abstract: To minimize the influence of laser speckle jitter from a non-ideal measurement environment on fluorescence-lifetime imaging microscopy (FLIM), a cross-correlation analysis method was proposed based on the changes in displacement in the fluorescence particle inverse calculation. The displacement of each pixel in sequential images was obtained from the displacement of the laser speckle, using a fast Fourier transform cross-correlation analysis. Through the use of an accurate time-gated time resolution, FLIM was applied to investigate the test point displacement affected by the laser speckle jitter. The fluorescence intensity of the test points was then replaced based on the intensity of the displacement points. The fluorescence lifetime can finally be calculated using the iterative deconvolution algorithm. Experimental results show that the average relative error of the inverted fluorescence lifetime is less than 30%, and the effective rate of the test points without the lifetime is greater than 18%. We believe that the proposed method can provide valuable guidance toward improving the accuracy of a fluorescence-lifetime measurement.

Keywords: cross-correlation analysis; fluorescence lifetime imaging; displacement vector; inversion; average relative error

1. Introduction

Machine vision technology is a computer simulation of the human visual function in electronics providing automatic image-based detection and analysis. With the rapid development of electronics and image processing technologies, machine vision technology has been widely used in medical electronics [1, 2], industrial [3-5], agricultural [6], and remote satellite monitoring [7, 8]. In recent years, remote sensing applied to the electronics monitoring of plants has become an important topic in the field of environmental studies and agricultural research internationally. Remote sensing monitoring can provide changes in the physiology of large area of plants in real time, not only effectively preventing and controlling crop diseases and insects, and promoting crop production and management, but also improving the efficiency of agricultural production. Synthetic aperture radar (SAR) technology uses microwaves that can penetrate through clouds, haze, and light rain, and thus, SAR backscattering signals obtained from radar satellites are less influenced by weather conditions, and can provide a better temporal coverage [9]. SAR imaging systems have the most popular remote sensing techniques in the past decades because they can provide all-time all-weather data over large areas with a high spatial resolution [10].The texture analysis of SAR images and video is the most current and challenging issue in the modern SAR field [11-13].

Laser radar (Lidar) is a type of active remote sensing technology using a laser as a light source, which monitors objects by detecting the radiation signal generated through an interaction between