METHOD FOR THE OPTIMIZATION OF DATA ACQUISITION TO IMPROVE THE ACCURACY OF A VIDEO-POLARIMETRIC SYSTEM

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Introduction. The analysis of light polarization of is usually carried out using modulation schemes. In this case, optical components rotate at a particular frequency and the unknown output state of light polarization is determined by several measurements. One of the most widespread methods of modulation uses a rotating quarter-wave plate (QWP), and a fixed linear polarizer. Such arrangement makes it important the advancement of efficient calibration techniques. The optimization of the set of measurements is closely related to the improvement of the quality of imaging and henceforth the likelihood of better diagnose.

Actuality. Identification and treatment of cancer are still one of the biggest challenges in modern medicine and has received considerable attention of the researchers [1-3]. The probability of survival increases considerably with early detection. Hitherto, biopsy is the standard technique to diagnose potential lesions. However, this procedure may skip injuries when they are at an early stage.

Polarimetry methods can to improve diagnostic accuracy and to reduce hardware costs [4]. Analysis of video-polarimetry systems can be found in the literature [5], from which one can conclude that they are potentially powerful tools. However, it is very difficult to measure the polarization of light reflected from the samples. Calibration procedures provide an opportunity to minimize the effect of systematic and random errors that occur when moving the optical components. Therefore, the determination of the optimal set of measurement angles is an important task in the development of calibration and measurement processes of video polarimetry devices.

Solution. The Stokes parameters and the level of polarization depict the light polarization. Mueller matrix permits the description of effects of optical elements on the polarization of the light beam. The effect of a set of optical elements on the light polarization is given by the product of individual matrices, with matrices arranged in reverse order. The deviation of the vector ***Θ*** has a different effect on the error of each component of the Stokes vector measured. This difference is shown in fig. 1. For this reason, it is advisable to look for the upper limit of the error instead of the error of each component of the Stokes vector.

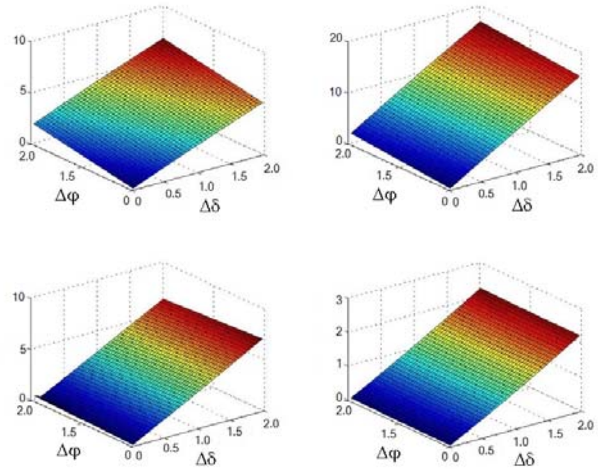

Fig. 1. Comparison of the relative errors on the Stokes parameters due to different offset values

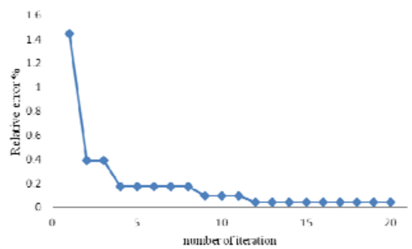

Fig. 2. Evolution of relative error with the number of iteration

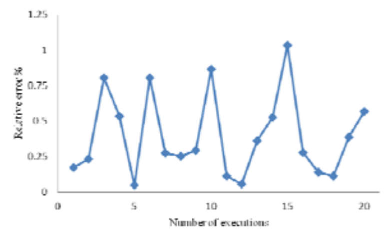

Fig. 3. Variation of the results with the number of executions

The modulation matrix of the polarization state analyzer (PSA) was modeled considering two situations: first without offset of the azimuthal angle of the QWP, and second with a constant offset. The relative error obtained by the application of the proposed algorithm is shown in fig. 2 and fig. 3.

These angles provide the lowest value of the maximum relative error when establishing the parameters of the incoming to the PSA light. In the course of the simulation, it was found that the maximum relative error was as great as 26 for some values of the azimuth angles. This fact shows the positive effect of the application of the method has on the value of the measurements.

The robustness of the algorithm was carried out with a series of executions. At these executions the offset was kept constant and the maximum relative error was compared. The average value of the relative error was 0,39 and a standard deviation of 0,29

Conclusions. The proposed method of optimization of the image data acquisition in video polarimetry based on an evolutionary algorithm allows to minimize the maximum relative error of the parameters of the Stokes vector of the incoming light. The proposed technique can be applied in the assessment of both errors due to mechanical artifacts and image acquisition. The results might be employed to the calibration of imaging polarimetry devices for bio-tissue study.

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АЗИМУТАЛЬНАЯ И РАДИАЛЬНАЯ ПОЛЯРИЗАЦИЯ ЛАЗЕРНОГО ИЗЛУЧЕНИЯ ИНФРАКРАСНОГО И ТЕРАГЕРЦЕВОГО ДИАПАЗОНОВ ДЛИН ВОЛН

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Инфракрасные и терагерцевые лазеры успешно применяются в медицине. При этом нередко возникает потребность в фокусировке лазерного пучка и регулировании глубины его проникновения в биологические объекты. На эти и другие свойства лазерных пучков оказывает существенное влияние поляризация излучения. В данной работе сообщается о разработке и создании устройств, обеспечивающих азимутальную и радиальную поляризацию лазерного излучения инфракрасного и терагерцевого (от 0,1 до 1 мм) диапазонов длин волн.

Разработаны азимутальные и радиальные выходные зеркала для инфракрасных и терагерцевых лазеров. Зеркала представляют собой полосы из металлической пленки, расположенные на прозрачной пластине. Ширина полос и расстояния между ними могут быть как больше, так и меньше длины волны лазерного излучения, в зависимости от величины последней и конкретных задач, решаемых устройством.

Азимутальные зеркала состоят из концентрических колец металлической пленки, радиальные – образованы ее радиальными полосами. Использование таких зеркал позволяет получить лазерные пучки с азимутальной и радиальной поляризацией. При радиальной поляризации вектор поляризации направлен вдоль радиуса пучка в каждой точке его сечения. При азимутальной поляризации вектор поляризации в каждой точке сечения направлен вдоль окружности, центр которой совпадает с центром пучка.

Использование лазерных пучков с различной поляризацией позволяет корректировать свойства лазерного излучения. Радиально поляризованные лазерные пучки интенсивнее поглощаются различными веществами, что усиливает воздействие таких пучков на поверхностные слои биообъектов. Азимутальная поляризация позволяет получить острую фокусировку лазерного пучка, что предпочтительно при точечном воздействии, а также при лазерной резке и сварке микроскопических биообъектов.

Вывод. Источники лазерного излучения с азимутальной или радиальной поляризациями расширяют возможности медицинских лазерных установок.

AZIMUTHAL AND RADIAL POLARIZATION OF THE LASER RADIATION IN INFRARED AND TERAHERTZ WAVE-LENGTH RANGES

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Azimuthal and radial output mirrors for lasers of infrared and terahertz wavelength ranges are designed. Using such mirrors it is possible to obtain laser light of a radial or azimuthal polarization. Laser beams with these types of polarization possess new useful properties. This extends the capability of medical laser systems.