Mueller matrix imaging polarimeter with non-ideal retarder calibration

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Abstract: Our proposal is to calibrate the errors due to non-ideal retarders of a dual rotating retarder Mueller matrix imaging polarimeter [1] by taking into account its diattenuation and retardance errors. The algorithm has been described and accuracy of the method has been shown with supporting experimental results.

Even algorithm to calibrate the retardation and azimuthal error already exists [1], our proposal is to take into account the diattenuation errors ($\tau_{max_{1,2}}$, $\tau_{min_{1,2}}$) of the two retarders along with the respective retardance errors (Δ_2, Δ_1). From the experimental set up (Fig.1), output intensity can be described by Stokes vector as:

$$S_{out} = \left[M_{R_2}(5\theta, \Delta_2, \tau_{max_2}, \tau_{min_2}) M_S \; M_{R_1}(\theta, \Delta_1, \tau_{max_1}, \tau_{min_1}) M_p \right] \cdot S_{in} \quad (1)$$

M_{R_1} and M_{R_2} are the Mueller matrix of the retarders with errors parameters. The error parameters has been retrieved by no sample experiment. These values are used to get calibrated the Mueller matrix of the sample. Calibration in each pixel has been done for imaging.

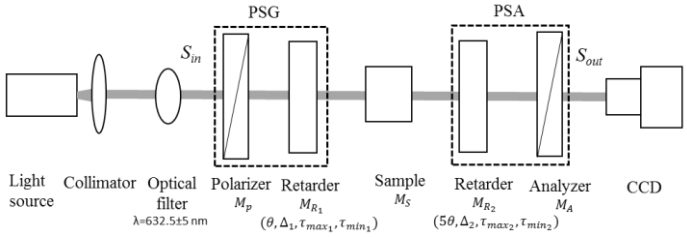

Fig. 1 Experimental setup for dual rotating imaging polarimeter

Experimental results: By implementing the proposed algorithim, diattenuation of two retarders retrieved are 0.004 and 0.001 and retardance are 89° and 88° respectively at the central pixel. Mueller matrix images has been shown in Fig.2. It can be noticed that in m_{22}, m_{33} and m_{44} the error compensation obtained before calibration is in the range from 2% to 5% (1±0.02 to 1±0.05) and after calibration regions obtained reach 0.1% to 2% (1±0.001 to 1±0.02) in the diagonal components of the Mueller matrix image. For the other components the improvement resulted 0.1% to 4% (0±0.001 to 0±0.04).

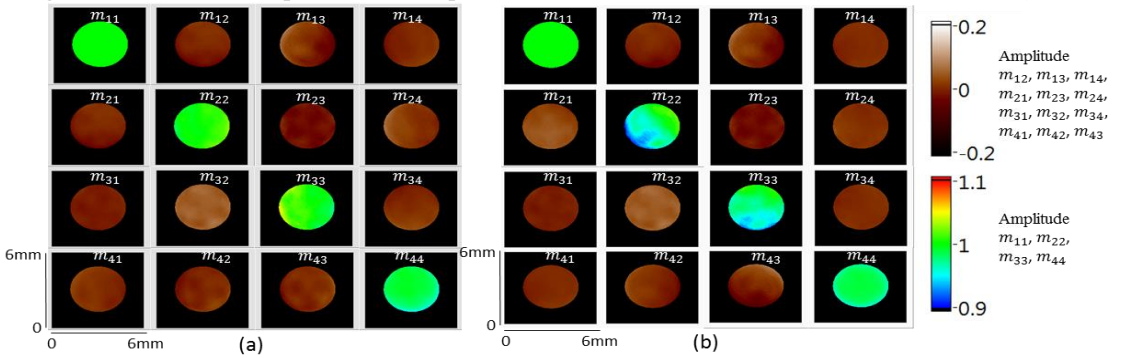

Fig.2: Mueller matrix images for no sample with calibration (a) and without calibration (b).

The experimental results support the increment of accuracy of the Mueller matrix over two dimensional distribution, which assure the accuracy of the algorithm and method.

References:

[1] R.M.A Azzam, Opt. Lett. **2**(6), (1978).
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