

Light intensity dependence during dynamic laser speckle measurements

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This work evaluated the influence of laser intensity in a non-biological phenomenon, the paint-drying. The laser intensity was varied by means of a semi-filtering. Images were analysed by means of numerical processing and the results showed that the quantity of light influenced the final information. A new protocol to weight the traditional procedure presented reliable results.

1 Introduction

The dynamic laser speckle is a well known technique to measure the changes in a surface illuminated by a laser [3]. There are many applications of this technique that is known as biospeckle when the application happens in biological material, such as in agriculture [4]. The way we use to measure the level of changes present in the speckle patterns is related to graphical [1, 5] and numerical [[2, 7, 6] approaches. Among the methods Fujii procedure [5] is the only one that promotes the weight of the level of gray in the analysis, however without any prove that this weighting helps the independence of the level of light. Thus in this study we evaluated the influence of the weighting process in the numerical methods known as Inertia Moment (IM) and Absolute Value of the Differences (AVD).

2 Methods

The test of light influence in the dynamic laser speckle analysis was done using a drying paint, considered homogeneous, with two areas of different illumination as presented in Fig. 1.

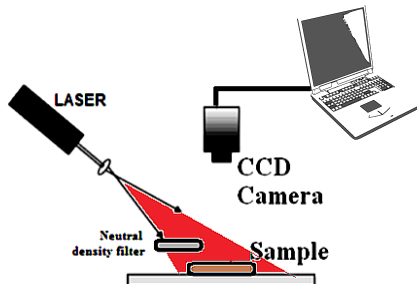


Fig. 1 Experimental configuration of a drying paint surface with a laser and a neutral filter creating two portions with distinct illumination in the point of view of the camera.)

One example of the outcome image is presented in

Fig. 2.

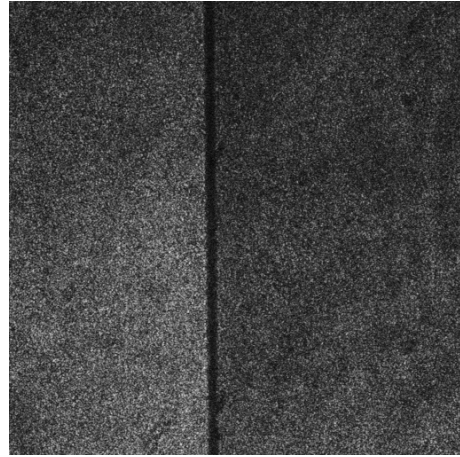


Fig. 2 Speckle pattern of a drying paint in a surface illuminated by a laser and a neutral filter creating two portions with distinct levels of illumination in the point of view of the camera.)

One center line of the collection of images of a drying paint was analysed, where each point in time was evaluated by the Inertia Moment and Absolute Value of the Differences, presented in Eq. 1 and in Eq. 2.

$$IM = \sum \sum \frac{M_{ij}}{Norm} (i - j)^2 \quad (1)$$

Where the term *Norm* is related to the normalization of the matrix $M(i,j)$. We use two normalizations, the first related to the normalization of each line of the $M(i,j)$, also named *Arizaga* [2], and the other related to the whole $M(i,j)$, named here as *Cardoso* [8].

$$AVD = \sum \sum \frac{M_{ij}}{Norm} |i - j| \quad (2)$$

The proposed change in the IM, Eq. 1, to reduce the influence of the level of illumination, is the pres-

ence of a denominator such as Fujii method, and presented in 3.

$$IM = \frac{\sum \sum M_{ij} (i-j)^2}{\sum \sum i+j} \quad (3)$$

While the AVD with the same change, that is, the inclusion of the denominator is presented in 4.

$$AVD = \frac{\sum \sum M_{ij} |i-j|}{\sum \sum i+j} \quad (4)$$

3 Results and Discussions

The results presented the influence of the level of light in the traditional methods to analyse the dynamic laser speckle, as it can be seen in Fig. 3. The jump in the interface, as well as the different levels of activity in a material considered as homogeneous prove that influence of light. And it happens to IM and AVD.

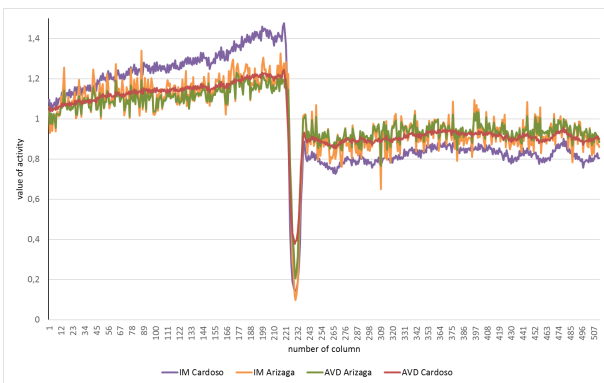


Fig. 3 The processing of one line over two portions of different illumination presented in Inertia Moment and Absolute Value of the Differences light dependence.

In Figure 4 the results represent the outcome of the IM and AVD with the introduced weighting in the denominator. The values maintained in a restricted envelope without any jump between one area to another. Both IM and AVD presented improvements when the weighting is introduced.

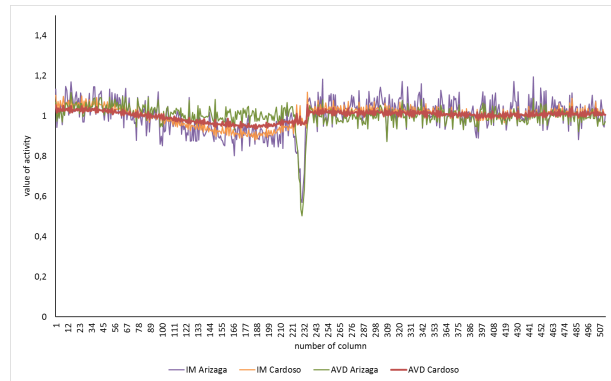


Fig. 4 The processing of one line over two portions of different illumination presented with Inertia Moment and Absolute Value of the Differences modified by a weighting the reduction of the light dependence.

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5 Bibliography

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