

# A TWO-STAGE CLASSIFICATION APPROACH FOR THE IDENTIFICATION OF CALCIFIED COMPONENTS IN ATHEROSCLEROTIC LESIONS OF THE CAROTID ARTERY IN COMPUTED TOMOGRAPHY ANGIOGRAPHY IMAGES

*Danilo Samuel Jodas<sup>(1)</sup>, Aledir Silveira Pereira<sup>(2)</sup>, João Manuel R. S. Tavares<sup>(3)</sup>*

<sup>(1)</sup>CAPES Foundation, Ministry of Education of Brazil, Brazil  
*danilojodas@gmail.com*

<sup>(2)</sup>Universidade Estadual Paulista “Júlio de Mesquita Filho”, Brazil  
*aledir@sjrp.unesp.br*

<sup>(3)</sup>Inst. de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial,  
Fac. de Engenharia, Universidade do Porto, Portugal  
*tavares@fe.up.pt*

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**Summary:** The assessment of atherosclerotic lesions in medical images represents an important step towards the evaluation of the disease progression. The identification of atherosclerotic plaque components and analysis of their morphology plays an important role in predicting the occurrence of future cardiovascular events. In this article, we present the classification of regions representing calcified components in Computed Tomography Angiography (CTA) images of the carotid artery. The proposed classification model consists of two main stages: the classification per pixel and the classification per region. The features extracted from each pixel within the carotid artery are submitted to four classifiers to determine the correct class, i.e., calcification or non-calcification. Then, geometric and intensity features extracted from each candidate region resulting from the pixel classification step are submitted to the classification per region step to determine the regions representing the correct calcified components of the atherosclerotic lesion under analysis. Additionally, four approaches regarding the removal of outliers from the training and testing datasets, and the use of the distances of each pixel to the contours of the lumen and carotid wall regions are performed to assess their influence on the final classification results. To evaluate the accuracy of the classification, the results of the proposed classification model were compared to ground truths of the calcified components obtained from micro Computed Tomography images of the excised atherosclerotic plaques that were registered with in vivo CTA images. The Spearman correlation coefficients obtained by the Linear Discriminant Classifier were greater than 0.80 for the relative volume of the calcified components. In addition, the mean values of the absolute error between the relative volumes of the classified calcifications and those calculated from the corresponding ground truths were less than 3%. Improvements in the classification results were also achieved by the proposed classification per region stage. Hence, the new classification model showed to be effective in identifying the regions that represent the true calcified components among the candidate regions previously classified by the pixel classification step, proving to be adequate as an auxiliary diagnostic tool to identify and evaluate calcifications in atherosclerotic lesions in CTA images.