A new Computer Aided System for the detection of Nodules in Lung CT exams

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This work describes the development of a new Computer Aided system (CAD) for the detection of nodules in CT scans of the lung, employing Computer Vision and Pattern Recognition techniques. The system consists of three steps: pre-processing, filtering and False Positive Reduction (FPR). The pre-processing step is dedicated to lung segmentation, and it is mainly based on Gray Level Histogram Thresholding, Seeded Region Growing and Mathematical Morphology. The second and third steps are aimed at detecting nodule-like signals – the filtering step - and at separating these signals into true and false nodules - the FPR step. The main characteristics of the CAD system are: 1) an original and iterative use of the Fast Radial filter, able to detect signals with circular symmetry in CT images; 2) the novel use of a filter based on the Scale-Space theory, able to locate circular signals of a given size, 3) the logical AND of the previous two filters. The iterative application of the Fast Radial filter approximately eliminates one third of the 2D False Positives with respect to the use of a single Fast Radial filter, whilst the Scale-Space based filter cuts 10% to 20% of the 2D False Positives found by the Fast Radial algorithm. The next steps of the system are: 4) a procedure to group signals across adjacent slices, to obtain collections of two dimensional signals corresponding to single 3D candidate nodules, be they true or false ones; 5) a coarse FPR phase, based on length across slices, volume and inclination of 3D candidate nodules, and 6) the fine FPR phase, based on the supervised classifier Support Vector Machine (SVM), fed with Gray Level features extracted from Regions Of Interest located around each signal, whose size and position have been determined by means of the Scale-Space based filter. The system has reached promising results, being able to detect 80% of nodules with 34 FP/Patient, or 65% of nodules with 6 FP/Patient, estimated with a Cross-Validation procedure over 34 nodules of 17 patients, with diameter between 3 and 10 mm, and with slice thickness 5 mm and reconstruction increment 3 mm.