



<b>Thesis Title</b>	<b>Combination of Fuzzy-Kalman Filters to Reduce the Mixed Noise from Images</b>
<b>Research Field</b>	<b>Digital Image Processing</b>
<b>Supervisor Name(s)</b>	<b>Assist. Prof. Dr. Ekhlas Hameed Karam and Dr. Ekbal Hussein Ali</b>
<b>Student Name</b>	<b>Mohammed shakir Mohammed Al-Najar</b>

### Abstract

This work deals with the application of Kalman filtering techniques and fuzzy logic filtering due to the fine results it gives for denoising mixed noise (Gaussian, salt and peppers) in gray and color images, where image filtering has great importance in work fields of life such as medicine, video production, photography, remote sensing, security monitoring, extra.

In this thesis, two structures of hybrid filter techniques for mixed noise reduction in gray and color images are suggested. The first hybrid filter structure combines the two types of fuzzy classical filter .First the symmetrical triangular fuzzy filter with median center (TMED) and second the asymmetrical triangular fuzzy filter with median center (ATMED), each one operates, with Kalman filter. After noisy image has been received, we take window of size 3\*3 sliding over all the noisy image, first applying median filter, then we calculate the value of fuzzy classical filter ( ATMED or TMED). The first median filter and the second fuzzy filter represent the two input at the same time of the predicated and observed state of Kalman filter, the final output from Kalman filter will be back in a recursive model in order to enhance the central pixel of the next noisy image window, and the restoration for fuzzy filter here is done by replacing the noisy pixels.



The second hybrid filter structure combines the Noise Adaptive Fuzzy Switching Median filter (NAFSM) and median filter with Kalman filter, the first sub filter (Kalman filter) reduce the Gaussian noise and represent the first output while the second sub filter (NAFSM) detects the noisy pixels through detection stage then reduces the impulse noise (salt and peppers) and represents the second output, then switching operation between the two output related to the previous decision is made to obtain the final output (denoised pixels), the restoration for fuzzy filter here is done by correcting the noisy pixels.

By using MATLAB software, three objective measures, Mean Square Error (MSE), Signal to Noise Ratio (SNR) and the Correlation (Corr), were used to evaluate the quality of the filtered image. These measures showed that the best noise attenuation results can be achieved by the two suggested hybrid filters structure, this is more than other filters like (Mean filter, Median filter, Kalman filter, (ATMED) filter, (TMED) filter, (MRHF) filter, and (NAFSM) filter).

Finally, the results of this thesis indicate that using both techniques in images provide a good quality, which make its more suitable for image denoising application, the suggested hybrid filters can suppress low, medium, and high levels of mixed noise (Gaussian, salt and peppers) with a varying degree of success depending on the features of an image.