This thesis develops image processing and pattern recognition techniques for enhancement, segmentation and classification of welding defects in radiographic images of weld. In the preprocessing section, we propose two methodologies for de-noising salt-pepper noise, Gaussian noise and both of them. These techniques are employed in digital radiographic images of weld, teeth and knee cap. We compare proposed techniques with some filtering methods by using PSNR, MAE and SSIM. Experimental results show that our method performs much better than other methods and these results were consistent even at a high noise level.

After enhancement, we focus on segmentation and classification of weld defects. For this purpose, we used three algorithms for finding Region of Interest (ROI) in digital radiographic images of weld. Two segmentation techniques are applied to detect defects that appear darker and brighter in ROI of radiographic images of weld. The accuracy of two proposed segmentation techniques are evaluated by PSNR, SSIM and Euclidean distance and compared with region growing and mean shift segmentation method by using ground truth. The experimental and results are shown proposed techniques are better than segmentation methods chosen for comparison.

In order to classify each of the obtained objects, a set of geometrical features is extracted which is then used as input to propose classification method. Initially a set of seven geometric features are defined. These are related to shape, length and positions of defects to the weld seam. All these parameters are calculated automatically in segmented images. We propose two novel automated algorithms of classification into five types of defects: Tungsten inclusion, Gas porosity, Lack of penetration, Incomplete fusion side wall and Undercut. We found Tungsten inclusion from segmentation of defects that appear brighter by TI classification algorithm. Length \((L)\) and Shape \((S)\) features are used in this algorithm. We found other four defects from segmentation of defects that appear darker by DDC algorithm. Gas porosity is a round defect detected by Shape \((S)\) feature in first part of algorithm. We detected three linear defects: Lack of penetration, Incomplete
fusion and Undercut by using five position features $P_1$, $P_2$, $P_3$, $P_4$, and $P_5$ in the second part.

It can be seen from the experimental results, lack of penetration is the best recognized welding defect detection with recognition rate of 98.07%. We compare proposed classification techniques for defect detection with two standard classification methods: Support Vector Machine (SVM) and K-Nearest Neighbor (KNN). Experimental results have shown proposed classification methods have higher accuracy than SVM and KNN.