As key mechanical parts in rotating machines, gears are often the heart of a wide range of industrial mechanisms. They are considered as the most important components in several industrial plants such as wind turbines, helicopters, compressors and internal combustion engines. Therefore, a sudden gear malfunctioning may decrease the performance of the entire system and even lead to fatal damage or breakdown. To maintain efficient and safe operations, predictive maintenance based on condition monitoring has received massive attention in recent years. Condition Based Maintenance (CBM) plays a crucial role in maintaining the system in a perfect operational functioning. CBM minimizes maintenance costs by reducing unnecessary planned preventive maintenance where equipment outages are predicted. Many CBM methodologies have been extensively used to monitor the gearbox condition such as acoustic emission, thermal monitoring, chemical analysis, current measurement and vibration analysis. Vibration condition monitoring has attracted substantial research attention worldwide, as the vibrations generated by a gearbox carry a great amount of information regarding its health status. Vibration signals have a non-linear and non-stationary behavior and the defect signature is always embedded in overwhelming and disturbing content, especially in the early stages. In addition, vibration signals are also are buried in a relatively strong non-Gaussian noise which renders the defective frequencies non-dominant in the spectrum compared to discrete components, reducing by that the performance of several signal processing techniques such as Kurtogram. In this Thesis, a modern vibration signal processing method called Autogram has been proposed to address these circumstances. The proposed method has been tested using experimental vibration signals to verify and affirm its detectability and accuracy with respect to Fast Kurtogram in detecting a chipped gear tooth. Despite, Autogram has the ability to perceive the occurrence of a gear failure, but without giving any information about its nature. This is a complex procedure because the defects affecting the gears have the same frequency signature. Thus, the variation in load and speed of the rotating machine will inevitably lead to erroneous detection results. Yet, it is important to discern the anomaly nature because each gear defect has a different consequences on the mechanism's performance. Thus, faults identification and classification seem to be the most difficult challenge for a gear systems. This thesis deals also with this issue by developing a new automatic approach to detect, identify and classify several gear defects. The intelligent method is a combination of Maximal Overlap Discrete ii Wavelet Packet Transform (MODWPT), Entropy and Multilayer Perceptron (MLP) neural network. MODWPT is an alternative decomposition technique with a uniform frequency bandwidth to avoid any difficulties with detection. Entropy is used to build feature matrix in the feature extraction step. Finally, MLP provides a powerful automatic feature classification tool. Experimental test has been conducted on the data sets collected from a gearbox test rig with healthy state and five different gear defects under varied speed and load conditions to show that the novel approach can successfully detect and identify gear defects in all cases. Keywords: Rotating machines, gears, vibration analysis, condition monitoring, feature extraction