In this research, a hierarchical framework that exploits the use of a novel source signal separation technique is posed and explored. This framework takes advantage of the Guided Under-determined Source Signal Separation (GUSSS) in combination with a hierarchical system using confidences and Support Vector Machines (SVM) in order to form a novel approach to pattern recognition. The hierarchy, as deployed with the source signal separation, is named Hierarchical Guided Under-determined Source Signal Separation (HiGUSSS). The HiGUSSS system has the ability to recognize patterns in mixtures of signals with very high accuracy and is evaluated in three different applications: recognition of muscle patterns for assistive technology, detection of vocal dysfunction using sEMG signals, and root phenotyping using terahertz (THz) signals. The experimental results presented in this thesis demonstrate the advantages of the improved GUSSS method by expanding it to new applications while achieving better classification results than traditional classifiers such as SVM.