UNIFIED PARAMETRIC AND NONPARAMETRIC ICA ALGORITHMS FOR HYBRID SOURCE SIGNALS AND STABILITY ANALYSIS

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ABSTRACT. *How to choose a model as the score functions of the unknown source signals is a basic and important problem in most independent component analysis (ICA) algorithms. This is usually achieved based on the parametric and nonparametric density estimation approaches. The purpose of this paper is to develop two novel unified parametric and nonparametric ICA algorithms, which enable us to separate hybrid source signals including symmetric and asymmetric distributions with self-adaptive score functions. They are derived from the parameterized asymmetric generalized Gaussian density (AGGD) model and GGD kernel based generalized k-nearest neighbor (GKNN) nonparametric estimation. In the unified parametric AGGD ICA algorithm, the parameters of the score function is chosen adaptively by estimating the high order statistics of the separating signals, at the same time, the stability of the algorithm is proven. However, in the unified nonparametric ICA algorithm, the parameters of the score function is chosen by the GGD kernel estimation based GKNN nonparametric method. Compared with conventional ICA algorithms, the two given methods can separate a wide range of source signals using only one unified density model separately. Simulations confirm the effectiveness and performance of the proposed algorithms.*
Keywords: Independent component analysis (ICA), Blind source separation (BSS), K-nearest neighbor nonparametric estimation, GGD, Natural gradient, Score function

1. **Introduction.** Independent Component Analysis (ICA) is a typical and important Blind Source Separation (BSS) method which is to recover source signals which are considered statistically independent given only the outputs of a number of sensor mixed signals. It has become a highly popular research topic in statistical signal processing (SP) and unsupervised neural network (NN) [1,2]. After Comon [3] gave a good insight into ICA problem from the statistical point of view, there has emerged a set of efficient ICA algorithms. Generally speaking, two main routes to achieve the solution of linear ICA problem are parametric and nonparametric methods.

There are some parametric ICA algorithms, such as the information maximization (Infomax) [4] and its extension [5], the FastICA algorithm [6], the Flexible Score Function algorithm [7,8] etc. The original Infomax algorithm [4] has a perfect performance when the sources have symmetric super-Gaussian distributions, but fails to separate sources that have negative kurtosis. An extended Infomax ICA algorithm [5] has been proposed to satisfy the symmetric distribution sources. But these algorithms developed for estimating