Abstract

Electron beam welding process is a state-of-the-art technology, which is used for fabrication mostly in strategic and space-exploration industries. As a result, much remains still to be learnt about the process and technology, as most of the knowledge regarding electron beam is considered to be classified. Soft computing-based approach was adopted to generate results directly for the end-users based on some previously collected experimental data. It will be a welder's delight, in whatever welding method one uses, to weld two pieces having maximum penetration with a minimum of weld width. In this thesis, a systematic study was conducted as per a design of experiment (DOE) matrix. Statistical regression analysis was carried out to establish input-output relationships of the process. A binary-coded genetic algorithm (GA) with a penalty approach was effectively utilized to minimize the weld fusion area after ensuring a maximum weld penetration. The weld fusion zone in conventional welding is generally found to be parabolic in nature, whereas that in electron beam welding does have a dagger-like shape. Such a complicated shape was modeled using both back-propagation neural network (BPNN) and genetic algorithm tuned neural network (GANN). The next contribution of this thesis is in the field of data clustering. A modified clustering algorithm was developed, which could result in clusters more compact than those obtained in fuzzy C-means (FCM) algorithm, and more distinct than those obtained in entropy-based fuzzy clustering (EFC) algorithm. Clustering algorithms were also successfully utilized in Radial Basis Function Neural Networks (RBFNNs). The RBFNN developed based on the modified clustering algorithm was found to outperform those with the conventional clustering algorithms, namely FCM and EFC. The concept was implemented for both forward and reverse mappings. The above investigations were successfully carried out on ASS-304 stainless steel and Al-1100 aluminum alloy plates.

Keywords: Electron beam welding; Genetic algorithm; Penalty approach; Back-Propagation Neural Network; Genetic Algorithm tuned Neural Network; Radial Basis Function Neural Network; Forward and Reverse mappings.