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Performance Evaluation of Friction Stir Welding using Machine Learning Approaches

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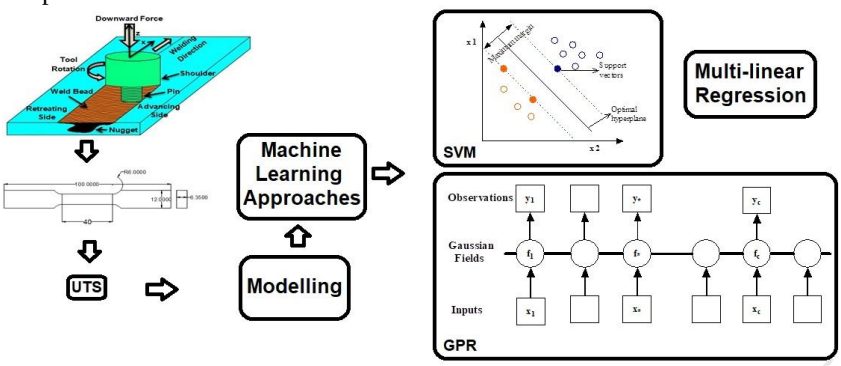
Graphical abstract



Abstract

The aim of the present study is to evaluate the potential of sophisticated machine learning methodologies, i.e. Gaussian process (GPR) regression, support vector machining (SVM), and multi-linear regression (MLR) for ultimate tensile strength (UTS) of friction stir welded joint. Three regression models are developed on the above methodologies. These models are projected to study the incongruity between the experimental and predicted outcomes and preferred the preeminent model according to their evaluation parameter performances. Out of 25 readings, 19 readings are selected for training models whereas remaining is used for testing models. Input process parameters consist of rotational speed (rpm), and feed rate (mm/min) whereas UTS is considered as output. Two kernel functions i.e. Pearson VII (PUK) and radial based kernel function (RBF) are used with both GPR and SVM regression. It is concluded that the GPR approach works better than SVM and MLR techniques. Therefore, GPR approach is used successfully for predicting the UTS of FS welded joint.

Keywords: Ultimate tensile strength, aussian process regression, support vector machining, multi-linear regression, Pearson VII, radial based kernel function.

1. Introduction

The demand of aluminium alloys is increasing in the area of aerospace, shipbuilding, automotive, transport, military and other many industries owing to their unique features, i.e., high strength to weight ratio, high formability, excellent corrosion resistance, etc. However, as similar to ferrous alloys the joining of aluminium alloys by conventional processes are very problematic due to high thermal conductivity, aluminium oxide formation , high thermal expansion, hydrogen solubility, etc.[1]. Aluminium has high thermal and electrical conductivity so more intense heat to be employed during fusion or resistance welding of this metal. This results in variation of mechanical and metallurgical properties of the joint changed. Furthermore, aluminium has high coefficient of thermal expansion and therefore tacking is mandatory before welding operation to make the weld uniform [2]. Sometimes due to the occurrence of solidification cracking during fusion welding of aluminium alloys, these