A neural network-based approach for dynamic quality prediction in a plastic injection molding process

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Abstract

This paper presents an innovative neural network-based quality prediction system for a plastic injection molding process. A self-organizing map plus a back-propagation neural network (SOM-BPNN) model is proposed for creating a dynamic quality predictor. Three SOM-based dynamic extraction parameters with six manufacturing process parameters and one level of product quality were dedicated to training and testing the proposed system. In addition, Taguchi’s parameter design method was also applied to enhance the neural network performance. For comparison, an additional back-propagation neural network (BPNN) model was constructed for which six process parameters were used for training and testing. The training and testing data for the two models respectively consisted of 120 and 40 samples. Experimental results showed that such a SOM-BPNN-based model can accurately predict the product quality (weight) and can likely be used for various practical applications.

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Keywords: Neural network-based prediction system; Injection molding process; Self-organizing map; Back-propagation neural network; Dynamic quality predictor; Taguchi’s parameter design method

1. Introduction

Plastic injection molding (PIM) is one of the most complex manufacturing processes due to the strong nonlinearities, even though numerous people regard it as a simple and common manufacturing process. This process includes four phases: plasticization, injection, packing, and cooling (Seaman, 1994). In previous injection molding research, many process parameters, such as the melting temperature, mold temperature, injection pressure, injection velocity, injection time, packing pressure, packing time, cooling temperature, and cooling time, were found to possibly influence the quality of injection-molded plastic products (Kurtaran & Erzurumlu, 2006; Zhao & Gao, 1999). Several PIM control process parameters have been used (Chiang & Chang, 2006; Huang & Tai, 2001; Wu & Liang, 2005). Huang and Tai (2001) presented six process parameters (mold temperature, melt temperature, gate dimension, packing pressure, packing time, and injection time) to determine the optimal initial process parameter settings for injection-molded plastic parts with a thin shell feature and under a single quality characteristic (warpage) consideration. Wu and Liang (2005) employed six process parameters (mold temperature, packing pressure, melt temperature, injection velocity, injection acceleration, and packing time) to discuss the effects of process parameters on the weld-line width of an injection-molded plastic product. Chiang and Chang (2006) proposed four control process parameters (mold temperature, melt temperature, injection pressure, and injection time) to determine the optimal initial process parameter settings for an injection-molded plastic part with a thin shell feature in a model with...
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References


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