A Study on Moldability by Using Fuzzy Logic Based Neural Network(FNN)

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In order to predict the moldability of an injection molded part, a simulation of filling is needed. Short shot is one of the most frequent troubles encountered during injection molding process. The adjustment of process conditions is the most economic way to troubleshoot the problematic short shot in cost and time since the mold doesn't need to be modified at all. But it is difficult to adjust the process conditions appropriately in no times since it requires an empirical knowledge of injection molding. In this paper, the intelligent CAE system synergistically combines fuzzy-neural network(FNN) for heuristic knowledge with CAE programs for analytical knowledge. To evaluate the intelligent algorithms, a cellular phone flip has been chosen as a finite element model and filling analyses have been performed with a commercial CAE software. As the results, the intelligent CAE system drastically reduces the troubleshooting time of short shot in comparison with the expert's conventional way which is similar to the golden section search algorithm.

Keywords : FNN, Injection Molding, Short Shot, CAE, Process Conditions

1. Introduction

A fuzzy neural network(FNN) has been applied to injection molding so that troubleshooting time of short shot can be reduced by finding an appropriate mold temperature as soon as possible. To evaluate the FNN, a cell phone flip has been selected as a model for the application and then computer simulations with a CAE software named C-MOLD have been performed.

2. Application of FNN to Injection Molding

In general, experts of injection molding process adjust the mold temperature to solve short shot by trial and error, which is very demanding in time and cost, and even harder for non-experts to carry out as it depends on empirical knowledge. A FNN has been applied to injection molding process to reduce troubleshooting time of short shot by finding an appropriate increment of the mold temperature quickly. Fig. 1 shows the architecture of the FNN application to injection molding process. In Fig. 1, e is the insufficient quantity of the injection molded part after filling simulation. To speed up learning, an effective strategy has been proposed. The learning of the FNN was executed in two stages as follows.

<u>First stage</u>

The FNN has been trained with the mold temperature data which was obtained from the pre-performed simulation results conducted by Golden Section Search method.

The data have become the target mold temperature. In this stage, fill time and melt temperature was taken into consideration.

<u>Second stage</u>

In the second stage, the learning was performed in direction of reduction of error which is the percentage of the insufficient quantity of an injection molded part. The speed of the learning in this stage was considerably improved since the FNN has been trained in the first stage to generate reasonable mold temperature.

Fig. 2 shows the configuration of the proposed FNN which is a feedforward architecture with five layers.

3. Evaluation of the FNN

3.1 Filling simulation with a CAE tool

To evaluate the FNN, filling simulations of a cell phone flip were conducted instead of experiments in injection molding. The simulations were conducted in two ways; one was based on Golden Section Search method which simulates the expert's behavior in troubleshooting of short shot, and the others on the FNN.

Fig. 3 shows the finite element model of a cell phone flip.

Process conditions used in the simulations are in Table I. As shown in Table I, melt temperature and fill time have the ranges, but not specified because they were used as variables in the simulations. In the case of the cell phone flip, the fill time range was estimated from 0.16(s) to 0.28(s). The simulations were conducted with 10 cases as shown Table II.

3.2 Simulation results

For the simulation data, Fig. 4 graphically shows the iteration number of the two ways for the simulation data.

As shown in Figure 4, average iteration number of filling simulation conducted by Golden Search Method is 5.9 and by the proposed FNN is 1.8.

4. Conclusions

A FNN has been applied to injection molding system to reduce troubleshooting time of short shot. As a result, the trained FNN helped to reduce the troubleshooting time by about 69% within reliable mold temperature range. And the FNN is expected to give not only non-experts but also experts of injection molding an easy and reliable way to determine mold temperature so that short shot can be solve quickly.

References

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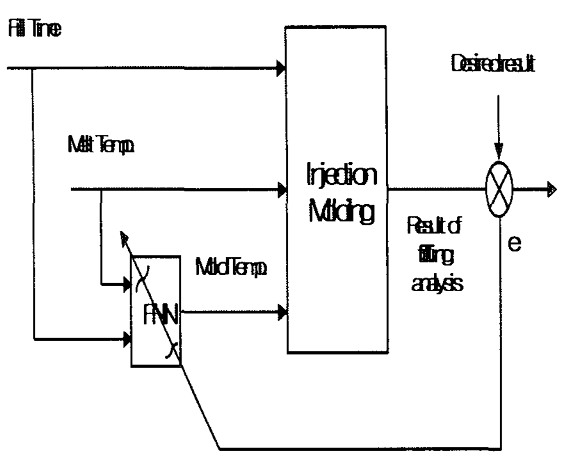

Fig. 1 Schematic diagram of fuzzy logic algorithm application to injection molding

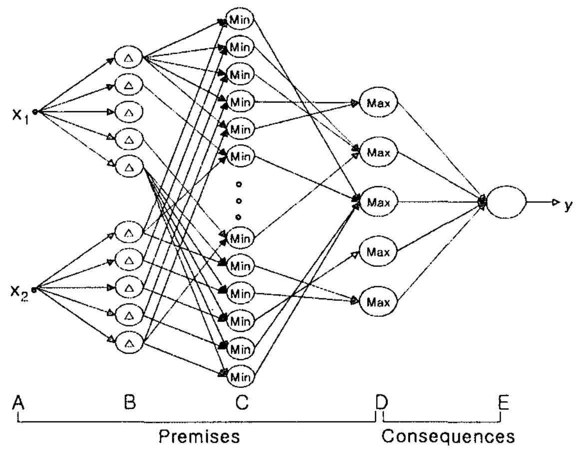

Fig. 2 Architecture of the proposed feedforward FNN

Table I Process conditions

Injection pressure	120 MPa
Packing pressure	100 MPa
Gate type / number	Side gate / 2
Melt temperature	Variable(200～280℃)
Fill time	Variable(0.16～0.28sec)
Mold temperature	Output variable

Table II The simulation data

No.	Fill time (sec)	Melt temperature (℃)
01	0.16	220
02	0.17	260
03	0.18	230
04	0.19	280
05	0.20	240
06	0.21	220
07	0.22	280
08	0.23	230
09	0.24	260
10	0.25	270

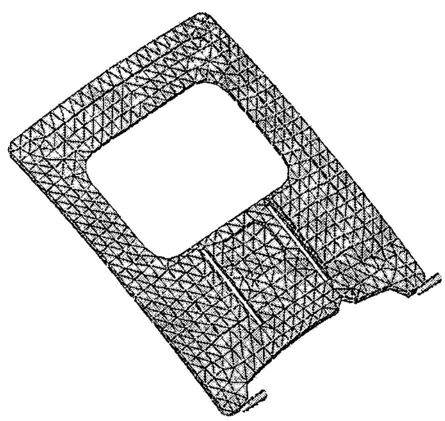

Fig. 3 Finite element model for the simulations

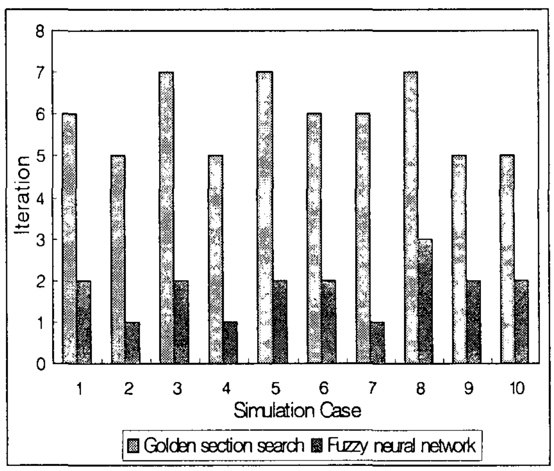

Fig. 4 Iteration number of the simulations