IMPROVING AUTOMATIC DETECTION OF DEFECTS IN CASTINGS BY APPLYING DAMAGE ESTIMATION TECHNIQUE FOR DIE-CASTING ANALYSIS

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ABSTRACT

In die casting form, the defects such as macro porosity is difficult to control and eliminate for the manufacturer. It is still an on-going test. The pre set casting cycle and die structure outline area is the main focusing part as for as the Current procedures are concerned. To change and relieve the negative impact and to make the process consistent .the procedures for controlling the process might be utilized to progressively change the operational parameters of the procedure. In this work, a limited heat exchange display component has been produced to identify and predict the development of temperatures and the fluid region exemplification in this die casting process. The correlation with plant trial information has been established for the model. A virtual procedure has been established for the given model to recreate the persistent activity of the system. In order to give a reliable representation of this virtual procedure, a nonlinear state-space display is provided based on data from the virtual method. Direct unique conduct with nonlinear static gain is showed from the control factors driven segment. Linear function is dependent by the feed forward-driven segment characterized by framework identification on the virtual procedure.

1. INTRODUCTION

Die casting is one of the most part, connected assembling practice in the die the casting throwing process the liquid metal is infused with strain into the solidified steel dies. It has been lately developed to enable the production of castings that are flawless, have very thin sections, and register a yield approaching even in metals such as aluminum and magnesium. The mould which is made of the metal is filled by upward displacement of molten metal from a sealed melting pot or bath. This displacement is effected by applying relatively low pressure of dry air on the surface of molten metal in the bath. The pressure causes the metal to rise through a central Ceramic riser tube into the die cavity.

The dies are provided ample venting to allow escape of air the pressure is maintained till the metal is solidified when it is released enabling the excess liquid metal to drain down the connecting tube back into the bath. Since this system of upward filling requires no runners and risers, there is rarely any wastage of metal Through so many technological improvements in the metal casting industry have taken place now a days. in recent years, the foundry industry faces increasing demands to achieve higher productivity at minimum cost, even while producing high-quality cast parts of unpredictable shapes. By legitimate determination of a casting strategy with a cautious foundry and metallurgical controls, castings of high caliber are monetarily produced. Among countless methods, one is low and high pressure die-casting.

It has been developed and industrially employed to produce castings of near-net-shape components. The close net shape cast parts are celebrated for their fine points of interest, great surface conditions, complex shapes, and economy. Under the present situation of mechanical improvement, metal casting has moved from a workmanship and specialty industry to the business given science and innovation. The structure of pressure die casting may be measured and quality may be assured due to the systematic development of the pressure die casting manufacturing processes. the foundry man can do the speediest methods for creating castings by the Die casting method with a substantially very higher level of exactness than that ordinarily acquired by sand casting method. Indeed, this strategy is unexcelled for large-scale manufacturing function as various castings can be created quickly effortlessly.

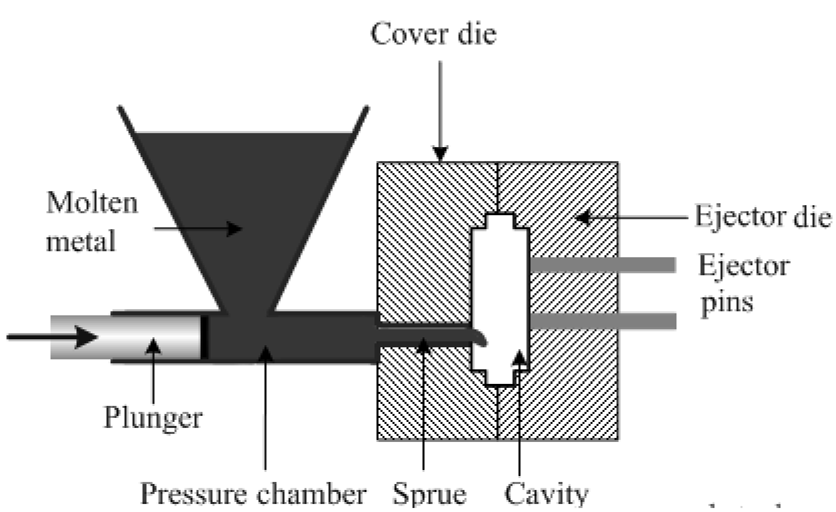

Figure 1: Die Casting

The castings can be made to close tolerances and surface finish. Pressure die casting in aluminum alloy offers means for very rapid production of engineering and other related components even or intricate design. This technique has obvious advantages when a component is required in large quantities. However, for engineering components such as those required for aeronautic space, the defense also, car applications, mechanical properties, and sturdiness are of essential significance. It is in this way basic that the best highlights of configuration ought to be utilized, and ideal casting method with least cost be received. Pressure die-cast items are utilized as a part of the type of segments of different electrical, electronic, mechanical instruments and apparatuses utilized as a part of residential and also industrial fields.

The aim is to develop a modeling die-casting machine for fault detection to improve fault forecasting model accuracy of back propagation neural network (BPNN), an improved prediction method of optimized back propagation neural network based on damage estimation algorithm was proposed design, to solve back propagation neural network problems with constraints. MATLAB should be utilized to code the calculation.

2. PREVIOUS RESEARCH WORKS

The textured surfaces or names can be easily produced by the die casting process without requiring any additional processing. Some of them are reviewed here

Zinc alloys have many merits, such as its low melting point, and the high resistance to oxidation during melting. Furthermore, the service life of the metal mold can be ensured. Moreover, zinc alloy has good casting properties and cannot adhere to the mold easily. Meanwhile, zinc alloy has good deformation resistivity, high strength, and abrasion resistance [1]. In the process of high-pressure die casting, the liquid metal fills the chamber very quickly and solidifies under pressure, so the production efficiency of High-pressure die casting is high and the product dimensional precision is good[2,3,4].Improvement of die-casting die combination use of laser process, for low-pressure die-cast process parameters optimization [5]The most common defect in die casting is gas entrapment, which loosens the metal structure, and reduces the electric conductivity and strength. Therefore, predicting the sizes of gas entrapment defects accurately is highly significant for production to predict the gas entrapment defects accurately. High-pressure die casting process has the characteristics of high filling speed and the great interaction effect between gas and liquid metal.

The gradual improvement of numerical techniques, international and domestic scholars have done many types of research profoundly in the field of numerical recreation by High-pressure die casting [6-10]. The influence of gas phase during the filling process was not considered, such as the hindering effect of the isolated gas to the liquid metal. Adopted direct finite difference method to portray the shape and area of free surfaces in casting mold filling forms, and the investigation shows that last porosities in high-pressure die castings are dependent on both gas entrapment through mold filling process and pressure transfer within solidification period [11-13] the operations of cool runner method and hot runner system simulated High-pressure die casting process based on smoothed particle hydrodynamics algorithm, which belongs to Lagrangian simulation techniques, and the results demonstrate that simulations can be done so many times in order to get large-scale automotive castings and it provides a high degree of accuracy[14,15]. Al-Si-Mg die-casting aluminum alloy[16], A nucleation model that correlated the cooling rate with the nucleation density of magnesium alloys during solidification of the process, Magnesium Die-Casting Alloys for Elevated Temperature[17] what's more, the model can likewise uncover the dendrite morphology with highlights of optional and ternary dendrite branches. As observed from the important references, single-stage stream display is regularly connected to the recreation of High-weight die casting filling process at the exhibit. With regards to the immense impact of the gas stage to the High-pressure die casting filling process, gas-liquid multiphase flow model is of great value for simulating the High-pressure die casting filling process [18-20].

An overview of the actual status of technology is described in the current work, where both critical aspects and potential advantages are evidenced. Specific attention is paid to the quality requirements from the end users, as well as to the achievable production rate, the process monitoring and control, and the European and worldwide scenario. So It is very crucial to have control and learning of the stream of the liquid and warmth exchange at the metal-die interface. Estimations of the Temperature in the sprinter divider amid high-weight die casting of two aluminum material combinations, AlSi4 and AlSi9, were recorded. During the examination, it was found that the scone measure, the solidification behavior of the metal, alloy and pressure are highly influenced the measured temperature profiles [21, 22, and 23].

As for as the die casting industries are concerned, many company manufacturers have company-specific methods of modularization in their construction departments. The design engineers have the capability of making the dies are so strong. A holistic methodology of making the design is not yet established. In order to improve this current situation, the layout of modular die methodology has been developed. Die to cast is a widely used well high-technology method of manufacturing process which is both energy intensive and capital. Even there are several environmental and economic advantages to die casting; the energy consumption is very high required to cast products warrants attention. Within a die casting process, design and Operational decisions can have a significant impact on the total energy use and emission of equivalent carbon dioxide. The model support decision-makers evaluating the most possible design, investment, and operational decisions, such as the purchasing of new machinery etc. Data elements are very necessary to implement the model which is specified and they are the necessary reference data for analyzing computing the emissions related to energy fuel consumption.

3. MATERIALS AND METHODS

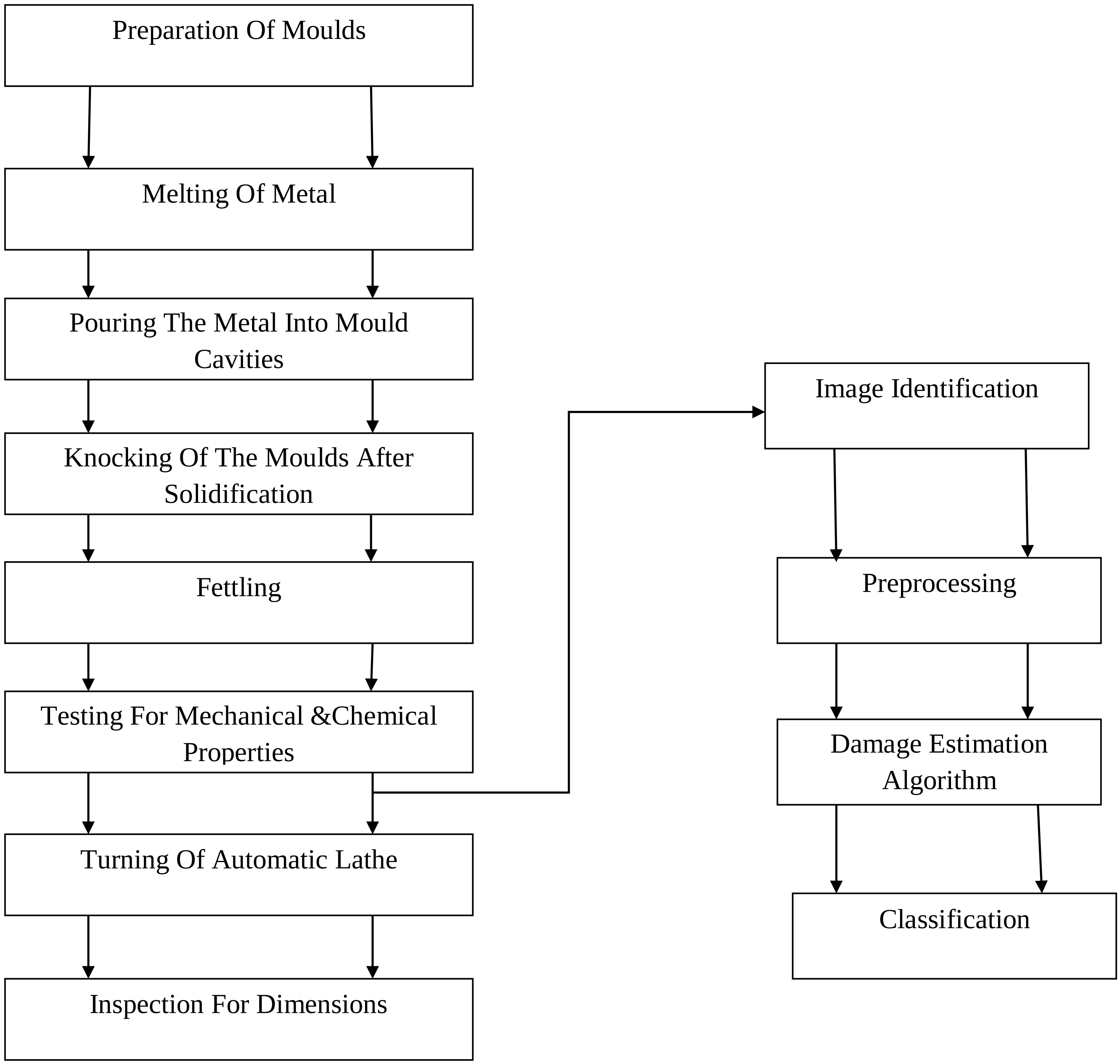

Figure.3 Casting Defect Analysis and Detection

The proposed work adopts a new Damage Estimation Algorithm for the multi-view image registration and classification. In the image analysis step included is defect detection, defect segmentation, feature extraction, defect classification. The first task is to capture image from the plant. After capturing of an image, the first step is detection to find out the defects on the metal surface, if the difference between the reference and target image is over the given threshold. Noise is present in an image which is to be reduced using the filter. Then the particular features like area features, color functions that could be used for creating the classification model are extracted.

3.1 CONSTRUCTION AND VERIFICATION OF PRACTICABLE DAMAGE ESTIMATION ALGORITHM

In this study, we construct the damage estimation algorithm which estimates the damage caused by repetitive use of a product. To satisfy the following requirements for practicality, the proposed damage estimation algorithm is constructed. Estimation of damage can be analyzed. Corresponding to the product that is configured with a plurality of materials. The linear cumulative damage law enables us to estimate the fatigue life of a structure that receives a service load to which the stress amplitude changes with time. Thus, becomes possible to estimate the damage for each node or element in a finite element model and estimating of the area composed of a different material becomes possible.

3.1.1. Damage Evaluation Using Linear Cumulative Damage Law

The linear cumulative damage law considers a state in which the stresses of various amplitudes occur at random as those sums from which stress of different amplitude as in s1, s2, . . . , si are individually repeated, allowing the fatigue life to be estimated. As a concrete procedure, first it is assumed that a stress amplitude, such as s1, s2, . . . , or si occurs in the structure. Next, the number of repetitions until the tip ruptures is referred to from the S-N curve for an individual stress amplitude and it is assumed N1, N2, . . . , Ni. Then, the damage values that occur when these stress amplitudes are repeated respectively in times of n1, n2, . . . , ni is n1=N1, n2=N2, . . . , ni=Ni. The damage value is obtained by calculating the damage sum of two values. Finally, the damage value is given by Eq. (1),

$$D = \frac{n1}{N1} + \frac{n2}{N2} + \cdots + \frac{ni}{Ni} = \sum_{i=1}^{k} \frac{ni}{Ni} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where k is the number of stress amplitudes.

Fig 3.1.1: (a) Input Image (b) Preprocessing Image

3.1.2. Damage Estimation Algorithm

The linear cumulative damage law is applied to the finite element model used in the structure analysis. At this time, when we refer to stress, we must choose either element stress or node stress. In this study, we adopt node stress which doesn't receive change in element size easily. The Eq. (1) is defined as follows to explain the flow of this algorithm.

$$D1 = \frac{n1}{N1} \dots\dots\dots\dots..(2)$$

Eq. (2) Is a damage value D1 when the stress occurs under a certain loading condition. First, the node stress s node is calculated by the analysis and the repeated time until the rupture N node corresponding to this s node is obtained from the S-N curve. Next, the repeated time of the stress amplitude, that is, the damage value, is calculated using the repeated time under the targeted loading condition.

Therefore, Eq. (2) can be rewritten as follows.

$$D1(j) = \frac{n1}{N1(\sigma j)} \quad (j = 1,2, \dots\dots, T) \dots\dots\dots\dots\dots\dots\dots.(3)$$

Where T is the total number of nodes on the finite element model. The loading condition is then changed, and the damage value of each term is calculated.

$$D(j) = D1(j) + D2(j) + \cdots Di(j)$$
$$= \frac{n1}{N1(\sigma j)} + \frac{n2}{N2(\sigma j)} + \cdots + \frac{ni}{Ni(\sigma j)}$$

$$\sum_{i=1}^{k} \frac{ni}{Ni(\sigma j)} (j = 1,2, \dots., T) \dots \dots \dots \dots \dots (4)$$

The damage value of each node on the finite element model can be calculated by using Eq. (4). It only has to obtain the repeated time until the rupture Ni using the S-N curve corresponding to material in the node, because the product is usually composed of plural materials.

Fig 3.1.2: (B) input image

4. RESULTS AND DISCUSSION

To optimize the Die casting process parameters for minimum casting defect the data were generated randomly by providing a higher limit and lower limit of the process parameters and applying a normalization formula which was shown earlier. The results are applicable to some extent for a specific number of data. MATLAB is a specialized registering and creative environment for algorithm advancement. It coordinates algorithm, representation, and programming in a simple to-utilize environment where issues and arrangements have communicated in the original numerical documentation. One of the upsides of working in MATLAB is that capacities work on whole varieties of information, not simply on single scalar qualities.

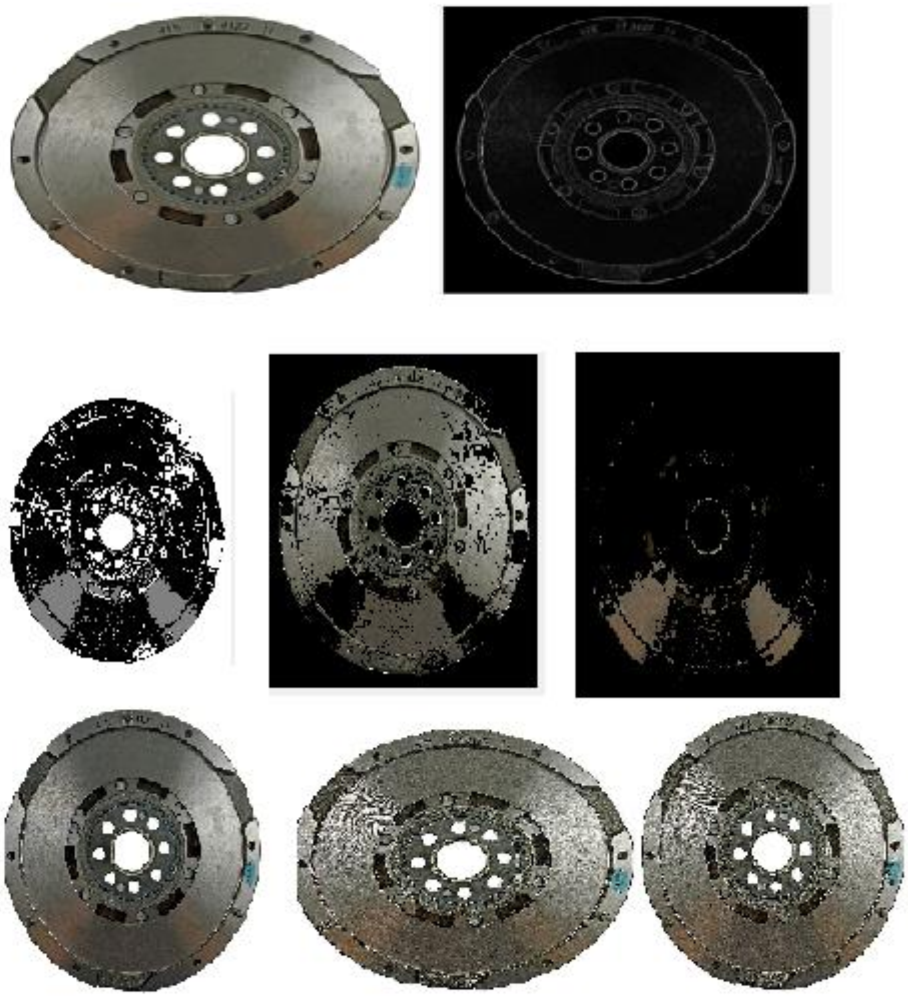

Fig. 4. Die casting simulation results

4.1 PERFORMANCE COMPARISON

Table 1. Comparison of optimal control values

Factor analysis function	optimal Yield strength				optimal S/N ratio			
	Taguchi	GA	MOE	DET	Taguchi	GA	MOE	DET
1	151	140	136	136	45.9181	44.3550	43.2774	43.2022
2	159	152	147	144	45.9181	44.3550	43.7108	43.5012
3	165	157	152	147	45.9181	44.3550	44.0022	43. 8169
4	161	158	154	150	46.2181	44.6550	44.2022	44.0022
5	165	160	158	154	46.8181	44.7550	44.3022	44.1034

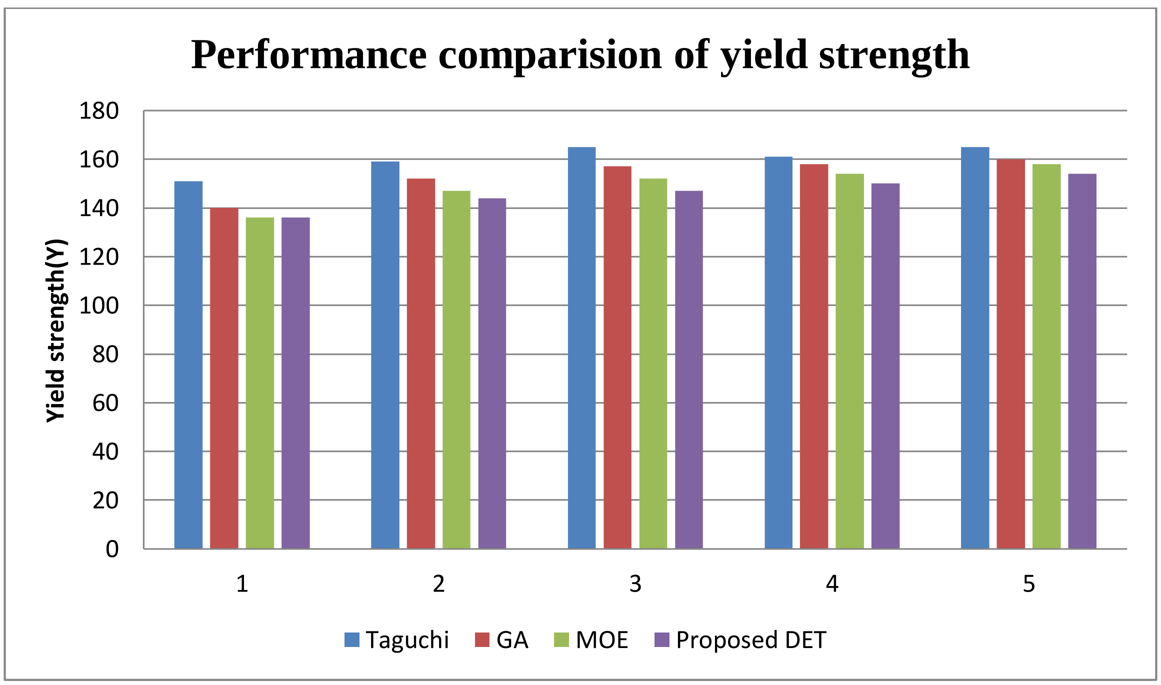

Fig. 4.1.Performance comparison of Yield strength

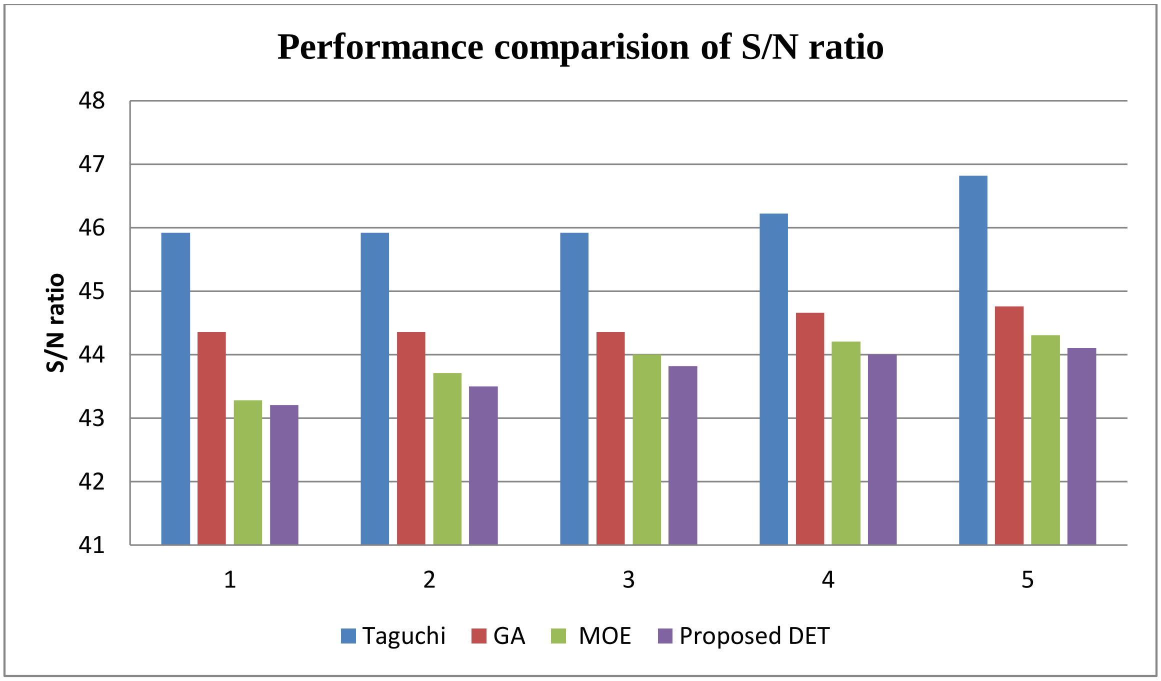

Fig. 4.2.Performance comparison of S/N ratio

Toward the begin, the measure of the abatement in Rejection rate esteems for given speed is generally same by each one of the three models. Regardless, in case one watches almost, it is obvious that Proposed model can cover the turning instrument much better than anything that of various models. Despite the similarities, each process may better suit a particular application, depending on the property requirements, casting size, production rate and design complexity The proposed controller show worked for controlling information current to proposed controller utilizing various controller methods individually. The synopsis of the approval after effects of those models is introduced in Table 2. Toward the begin, the measure of the reduction in RMS esteems for given speed is generally same by each one of the three models. Regardless, if one watches about, it is obvious that Proposed model can cover the turning instrument much better than anything that of various models.

Table 2 performance comparison results

Temperature in Celcius	% of Reduction in RMS Value			Proposed RMS Value
	TAGUCHI	GA	MCRC	DET
35	78.8	71.9	84.0	88.5
45	56.5	56.6	58.5	60.3
75	33.1	31.5	35.3	38.4

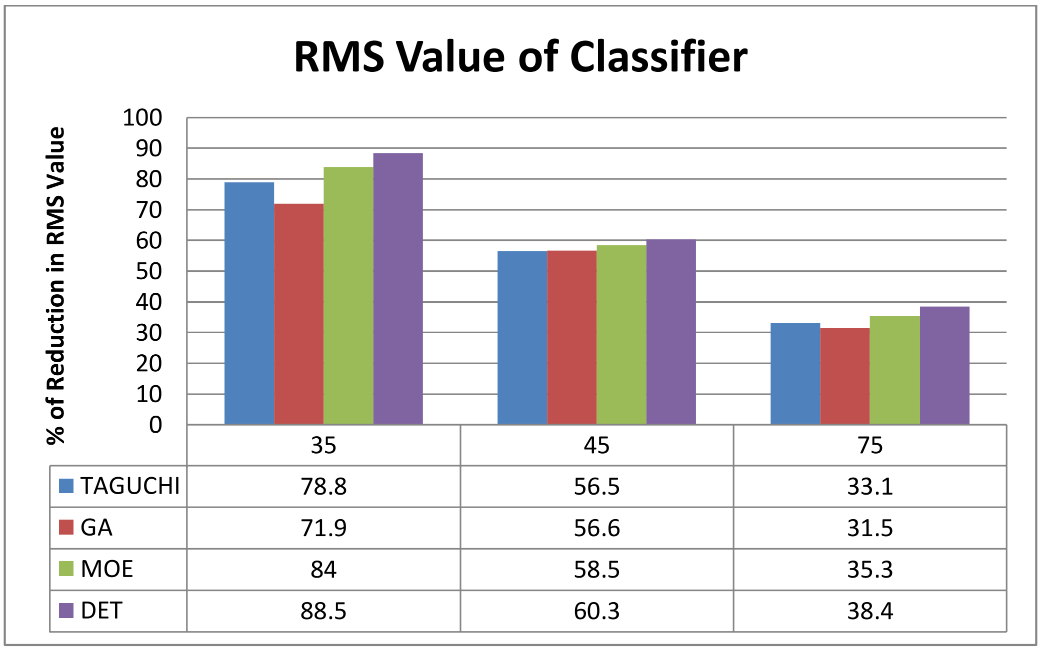

Figure 4.3. RMS Value of different controller

CONCLUSION

In this effort of an approach is suggested how to monitor and control the quality of parts in die casting industry using a neural net for control. A central element of this approach, the image recognition with neural networks has been presented an approach even on low end embedded process control computers. As future work, the whole scenario has to be realized on a test die casting facility. This includes the image recognition part as well as the control of the heating and cooling areas in the mold. It has to be shown that the image recognition delivers sufficiently reliable results and also that the control via heating and cooling areas will improve product quality and will reduce the scrap percentage. After this approach has shown to be successful in experimental casting facility further studies have to be undertaken if this approach can be deployed in a series production environment. The feasibility of the transparent part of the mold will have to be considered as well as the costs have to be calculated for the additional technical equipment.

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