

statistics analysis handling relation between variables. Grey relation analysis is used to perform multiple attributes overall evaluation, the measurement unit is not necessarily be the same. It can easily determine the overall index without consulting utility functions. [10]

GRA is a method for identifying and prioritizing the key factors of a system. It quantifies the influence that an input variable exerts to the output variable by computing the Grey Relational Grades. Grey relation grades are numerical measures of the impact of the influencing variables on the target variables. The larger the grey relational grade the more significant impact the influencing variable (input) has on target variable (output). GRA is described as an alternative method of variable independence analysis. The main advantages of GRA are its comparative simplicity and its ability to deal with small sets of data that do not have typical probability distribution. [9]

For analyzing undeveloped and complicated systems, Grey System Theory provides understanding, techniques and ideas.

The main objectives of the Grey System theory are as follows:

The essential topic of Grey system theory includes the following areas:

- Grey relational space**
- Grey generating space**
- Grey decision making**

For the Grey Relational Generation the quality characteristics are first normalized, ranging from zero to one. Based on normalized experimental data, the Grey Relational coefficient is calculated for representing the correlation is calculated for representing the experimental data. Corresponding to selected response, overall Grey Relational Grade (GRG) is determined by averaging Grey Relational Coefficients.

The overall performance characteristic of the multiple response process depends on the calculated GRG. This is the conversion of a multiple response process optimization problem into a single response optimization problem. The combination of optimal parameters is then evaluated obtaining the highest Grey relational grade. The Taguchi method is used for the optimal factor setting to maximize the overall Grey relational grade.

Higher the better criterion can be expressed as:

$$x_i(k) = \frac{y_i(k) - \min y_i(k)}{\max y_i(k) - \min y_i(k)}$$

Lower the better criterion can be expressed as:

$$x_j(k) = \frac{\max y_i(k) - y_i(k)}{\max y_i(k) - \min y_i(k)}$$

Where $x_i(k)$ and $x_j(k)$ are the value after Grey Relational Generation for HB and LB criteria. $\max y_i(k)$ is the largest

1. In case of regression technique, a non functional model is established.
2. Using grey generating techniques, the disorderly raw data is turned into more regular series for the benefit of modeling instead of modeling with original data.
3. Building a grey model (GM)- by using the least 4 data to replace difference modeling in vast quantities of data.
4. The Grey process is defined and constituted replacing the stochastic process and to find the real time techniques.
5. To set up an approach to modeling with few data, avoiding searching for data in quantities.
6. For grey decision making, innovational techniques and concept are developed.
7. To develop novel control techniques eg. The grey forecasting control replacing classical control which is referred to as afterward control, also relational control, generating control and programming control.
8. To study feeling and emotion functions and fields with whitening functions.
9. To study the mechanism theory, along with grey sequence theory and grey structure theory.
10. Based on grey relations, grey elements and grey numbers to be used to study grey mathematics in place of classical mathematics study.

- Grey forecasting**
- Grey mathematics**
- Grey control**
- Grey theory**
- Grey programming [10]**

value of $y_i(k)$ for k^{th} response and $\min y_i(k)$ is the minimum value of $y_i(k)$ for the k^{th} response.

The Grey relational coefficient $\xi_i(k)$ can be calculated as:

$$\xi_i(k) = \frac{\Delta \min - \psi \Delta \max}{\Delta o_i(k) + \psi \Delta \max}$$

And $\Delta o_i = ||x_o(k) - x_i(k)||$

Where Δo_i is the difference between absolute value $x_o(k)$ and $x_i(k)$, ψ is the distinguishing coefficient $0 \leq \psi \leq 1$, $\Delta \min$ and $\Delta \max$ are the minimum and maximum value among the for corresponding k^{th} response. Now the Grey Relational Grade can be calculated as:

$$\gamma_i = \frac{1}{n} \sum_{k=1}^n \xi_i(k)$$

Where n is the number of process responses. The higher value of the GRG corresponds to a relational degree between the Reference sequence $x_o(k)$ and the given sequence $x_i(k)$. The Reference sequence $x_o(k)$ represents the best process sequence. Therefore, a higher GRG means that the corresponding parameter combination is closer to the optimal. The mean response for the GRG and the main effect plot of the GRG are very important. [11]

2. Conclusions

From the above study of tools and techniques used for Multi-objective optimization of processes and its parameters, it is come to know that,

1. With the consideration of multiple responses, the Design of experiments techniques has been applied using Taguchi Method.
2. Analysis of variance technique is used for determining the level of importance of welding parameters on the response variables.
3. The analysis of S/N ratio used for obtaining an optimum parameter combination for the required response variable characteristic.
4. For the optimization process parameters, Taguchi Method is efficient, close to target and economical.
5. The grey system theory is pioneered by Prof Deng Julong in 1982. Many scientific and technological theories require the continuous efforts of several generations of people and have gone through hundreds of years before reaching maturity and perfection.
6. Grey system Theory is 30 years old and still there is a wide scope to explore it for the applications in the science and Technology.
7. Engineers and Scientists engaged in the Advances of the Grey system Research should take serious in all criticisms.
8. Then the problems and flaws can be overcome, the new growing point be excavated, exploring and innovating with the modern computerized techniques for the analysis and Computations. Thus making the grey system theory, originated by Chinese Scholars goes forward significantly.
9. There is a wide scope for the development of Grey Relational System software for the applications in Engineering Field.

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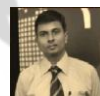
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