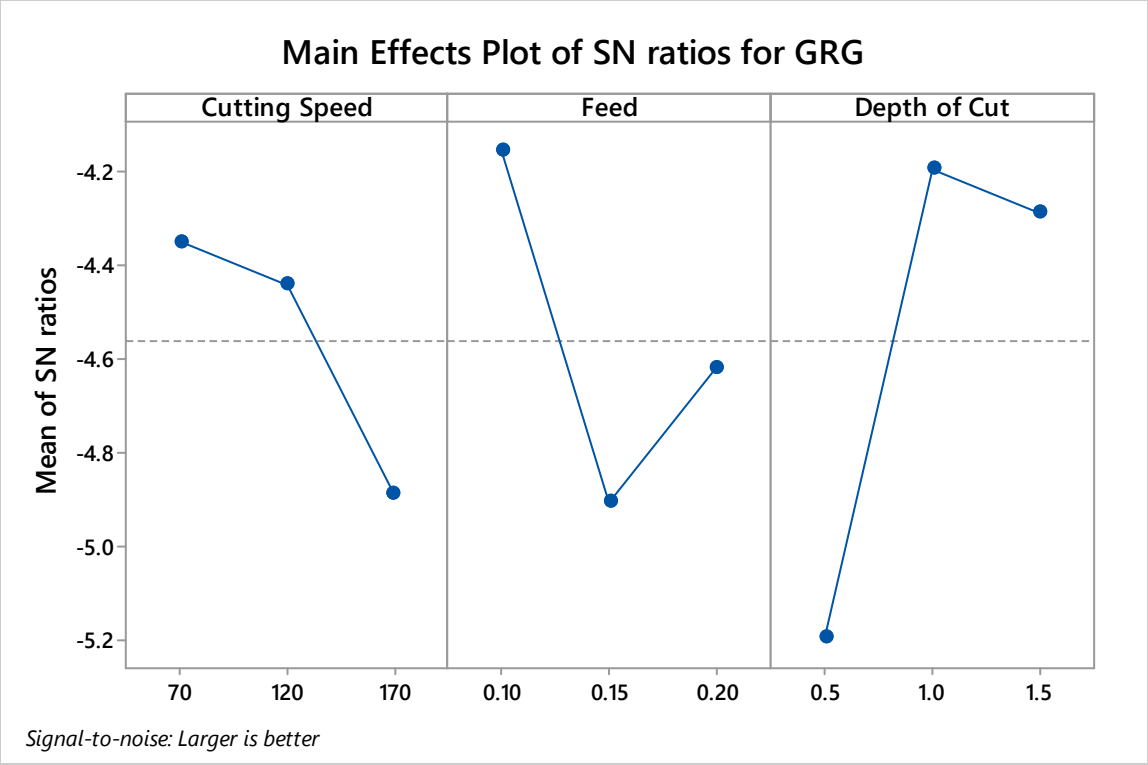

Fig. 2 Variation of S/N ratio with the process parameters for GRG

In the next step GRC was investigated as per Equation 4. It represents the relationship between actual normalized and best values.

$$\xi_i(k) = \frac{\Delta_{\min} + \zeta.\Delta_{\max}}{\Delta_{0i}(k) + \zeta.\Delta_{\max}} \tag{4}$$

Where, Δ_{0i} (k) - deviation sequence,
ζ - identification coefficient. Depending upon the importance of responses, it was decided. In the present work, it is 0.5 to give equal importance to both responses.

The grey relational grade (γ) is calculated after making a mean of all GRC as per Equation 5. The overall evaluation of the multi-responses was dependent upon the grade values.

$$\gamma_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k) \tag{5}$$

Where γ_i is the grey relational grade for the i^{th} experiment,
n - Number of responses.

Table 6 gives the grade values for all nine experiments. From Table 6 it is clear that trial five, gives the best grade value, therefore it gives compromised values of MRR and Ra. But at the same time, it was comparable to trial one and nine. In the present work, the analysis of grade value was done for simultaneous optimization, and it found first level of CS (70m/min), first level of f (0.1mm/rev) and second level of DoC (1mm) for the best values of MRR and Ra.

Table 7: Results of predicted and confirmation experiment for Multi response optimization

Response	Fifth trial of OA	First trial of OA	Ninth trial of OA	Optimal machining conditions	
				Predicted	Experimental
Setting level	$A_2B_2C_3$	$A_1B_1C_1$	$A_3B_3C_2$	$A_1B_1C_2$	$A_1B_1C_2$
MRR (mm^3/s)	450	58.33	566.66	149.99	116.67
Ra (µm)	2.82	1.975	**4.171**	2.210	1.993
GRG	0.672	0.667	0.667		

Table 7 shows predicted and experimental values of machining parameters and responses for different trials. It is seen that the grade values are very close to the experimental values.

5. Conclusions

In the present research work, dry machining of SS304 is done at different setting of input parameters. Taguchi integrated GRA technique has been used for multi-performance optimization of machining parameters with MRR and Ra as the major responses. The following conclusions can be drawn from this work-

1. The maximum MRR was obtained at CS: 170m/min; f: 0.2mm/rev; DoC: 1.5mm.
2. The minimum roughness was obtained at CS: 70m/min; f: 0.1mm/rev; DoC: 0.5mm.
3. ANOVA study confirms the statistical fitness of the data measured and obtained in the present work.
4. Depth of cut is the most influential factor for MRR and cutting speed for roughness.
5. The values of MRR and Ra after simultaneous optimization are 116.67 mm^3/s and 1.99 µm respectively.
6. For ready industrial use, the values of machining parameters for optimum productivity and surface quality under dry environment are- CS: 70m/min; f:0.1mm/rev; DoC: 0.5mm.

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