CHAPTER 10

CONCLUSIONS and SCOPE OF FUTURE WORK

10.1 Conclusions

1. The holes drilled by the EDM process for the first set of experiment was unsuccessful as the composite breaks down on contact with the electrode. In the second set of experiment with reduced pulse current on EDM although drilling was done, there was black thread like formation between the electrode and the workpiece, this lead to frequent short circuits and closure of the EDM machine. Moreover, delaminaiton was observed at the entry surface of holes with a large heat affected zone. Hence EDM machining operation for drilling holes on carbon-silicon carbide composite material was not explored further.

2. The conventional machining using vertical machining center was used to drill holes on C-SiC. The first order models are developed for material removal rate and hole circularity are adequate and that of overcut is inadequate. The order of significance of parameters of the circularity model is drill size, feed and spindle speed and the order of significance for the material removal rate is spindle speed, feed rate and drill size. The response surface generated using MATLAB software, show curvature for the experiments which have been conducted. Hence the first order regression models are not adequately representing the process, hence a non-linear model would be able to represent this process better, for which further experiments would have to be planned. This experiment establishes that C-SiC can be drilled using HSS drills and a relatively clean cut is observed and further
investigation is required to analyse the effect of machining on the matrix and reinforcement used.

3. The BPN neural network model is developed using MATLAB neural network toolbox. Experimental data is used to train the neural network. The BPN model developed is found to be capable of predicting MRR with maximum error of 55% for C/SiC material. The BPN demonstrated a slightly better performance compared to the RBFN model. However the RBFN prediction is very fast. It is important to note that for BPN’s the required number of nodes in the hidden layer is to be found by trial and error whereas the RBFN’s have only one hidden layer with growing number of neurons. Hence, the MRR can be predicted with the above models with reasonable accuracy. The accuracy of prediction by the ANN models can be increased by increasing the number of experiments used to train and test the data. ANN model could also be developed for surface finish and tool wear by performing further experiments on C/SiC material.

4. BPN has shown the capability of generalization and prediction of material removal rate in drilling within the range of experimental data. The maximum deviation observed and estimated by BPN is minimal as compared to fuzzy. The present work can be extended with different process parameters, material thickness and type to test the ability of the expert systems in prediction of the output and these findings can then be applied to indirect tool condition monitoring in unmanned manufacturing system.

5. The result obtained confirmed that histogram analysis can be successfully applied to decide whether the surface analyzed is coarse or smooth. Hence acceptance or
rejection of components can be based on this analysis. As the surface becomes smoother, reflectivity increases resulting in an increase in the frequency of large value of histogram.

6. In the present work experiments have been conducted on carbon silicon carbide using HSS drills with different machining parameters. Factorial design method is used to conduct the experiments. The images have been analyzed with image metrology software TRUEMAP. Various amplitude parameters have been obtained. In this work, it has been shown that with the application of machine vision technique it is possible to effectively measures the tool condition by analyzing the machined surfaces. In this work, image of the machined surface was used in experimental investigation for measuring the condition of the tool instead of capturing directly the image of the cutting tool and hence this feature saves a lot of time. This methodology ensures that the machining process is not interrupted for measurements. Experiments prove that the machine vision system is independent of the machining process and can be adapted to any kind of surface roughness investigation. Hence the condition of the HSS tool while machining carbon silicon carbide can be assessed using surface texture as a basis with amplitude parameters.

Thus it can be concluded that non-conventional electro discharge machining is not preferred for drilling holes in carbon silicon carbide composite. Using vertical machining center with HSS drills, holes can be successfully drilled. However, the response surfaces generated using MATLAB for material removal rate, whole circularity and diametric overcut were found inadequate. Hence two expert systems, neural network and fuzzy
logic have been used to model the machining process. The backward propagation neural network algorithm performs with minimal deviation as compared to fuzzy logic algorithm. Histogram analysis is used to assess the surface finish under various machining conditions. Moreover the machine vision system developed works independently of the machining process and is able to assess the condition of the cutting tool using surface texture as a basis with amplitude parameters using ‘TRUemap’ software.

10.2 Scope of Future Work

Future studies may be carried out using different machining techniques on carbon silicon carbide composite. Experiments could be designed for second order regression analysis, particle swarm optimization, ant colony algorithm, artificial bee colony algorithm could be used to further optimize the process parameters. A new set of experiments could be designed with different input parameters and response parameters for the benefit of process planners. The second order statistics, co-occurrence matrix, autocorrelation approaches, etc may be used to quantify the surface finish. Artificial neural network approach may be included with statistical parameters used as input to predict the surface roughness. Future attempt may be made to evaluate the surface roughness of uniformly moving machined surface (the images are likely to blur due to the relative motion between CCD camera and the object to be captured). A major challenge will be to define a feature which will be invariant of the illumination, as in the case of human perception, to distinguish the same texture under different light conditions.