1/1/2016

Genetic Algorithm

Vision System for machined surfaces’ roughness prediction

Contents

[Acronyms and Abbreviation 2](#_Toc469115082)

[Background 3](#_Toc469115083)

[1.Introduction 3](#_Toc469115084)

[2.Project Proposal and Aim 3](#_Toc469115085)

[3.The Genetic Algorithm Theory 4](#_Toc469115086)

[Fitness Function 4](#_Toc469115087)

[Selection Technique – tournament selection 4](#_Toc469115088)

[Crossover Technique 4](#_Toc469115089)

[Mutation Technique 4](#_Toc469115090)

[4.Physical Aspects and Experiment 5](#_Toc469115091)

[Description 5](#_Toc469115092)

[Experiment 5](#_Toc469115093)

[5.Optimisation 5](#_Toc469115094)

[Population Size 5](#_Toc469115095)

[Tournament Size 5](#_Toc469115096)

[Fitness Function 5](#_Toc469115097)

[End Condition 5](#_Toc469115098)

[6. Results and discussion 6](#_Toc469115099)

[7. Conclusion 6](#_Toc469115100)

[8.Reference 6](#_Toc469115101)

[9. Appendix 6](#_Toc469115102)

[Code 6](#_Toc469115103)

# Acronyms and Abbreviation

V Spindle Speed

F Feed Rate

Ra Surface Roughness

Ga Surface digital image

NN Neural Networks

GA Genetic Algorithm

D Depth of cut

AI Artificial intelligence

# Background

Studies show that, the corresponding surface roughness, measured in micrometres, of a machined surface is dependent on the parameters selected during the machining operation (i.e. Spindle speed, tool cutting speed, feed rate, tool rate of approach and Depth of cut and tool cutting depth). Machining is loosely defined as material removal by use of a cutting tool. It has also emerged from research that the measured surface roughness can be discerned from the grey level content of the machined surface’s digital image, thus making it possible to determine associated surface roughness from image grey level. Making use of these properties a vision system for predicting surface roughness of a machined surface can be formulated.

# 1.Introduction

In the field of artificial intelligence, a genetic algorithm is an evolutionary computer programing representation of nature’s natural selection. The earth’s natural environment has been continually changing ever since its creation and will continue to change until its end. Biological organisms have had to adapt generation after generation to find an optimal biological physical structure and being to survive this change in environment. This process was first described by Charles Darwin as the survival of the fittest, in his book “On the *Origin of the Species*” (1859), and it obtained the term evolution. Evolution can be characterised as a continual optimization solution to the environmental problems faced by the species in context.

Just like Darwin’s model, a genetic algorithm (GA) creates the genetic composition of each individual solution within a population and breeds them repeatedly until the optimum solution is found to a given problem. These solutions, as with biological organisms in nature, share their genetic information with its offspring when “mating” with other solutions during the creation of a new generation. This sharing over genetic information over a vast number of generations allow the solution to search the solution search space and eventually finds the most fit solution to the problem.

The following report presents an optimization problem, to a genetic algorithm, that involves using Neural Networks to train a system to correlate surface roughness to a machined surface’s digital image. The genetic algorithm must consider certain parameters to predict the corresponding surface roughness of the machined surface.

# 2.Project Proposal and Aim

Using Neural Networks to train a system to correlate surface roughness to a machined surface’s digital image, and the machining (cutting) operation parameters(**V, F** & **D**), to predict the corresponding surface roughness of a machined surface (mild steel), given its image and machining parameters.

# 3.The Genetic Algorithm Theory

## Fitness Function

## Selection Technique – tournament selection

Selection is one of the main operators in EAs. Its main function is to select the fittest individuals for mating to create the next generation, therefore emphasizing better solutions. There are many selection models, but for this assignment, the Tournament Selection model was chosen and used to enable the selection of the two best individuals from the population.

Tournament selection involves creating a tournament of a desired size from the random selection of individuals within the population. Once the tournament is created, the fittest individual of that tournament is selected as a parent fit for mating.

Elitism was used to ensure that the best individuals make it through to the next generation without being mutated.

## Crossover Technique

The crossover is simply the process of deciding which parents to inherit a given gene from and produces an offspring made up of genes from its parents. Uniform cross over is a procedure that assigns a random cross over probability to each gene carrying element of the offspring

A uniform crossover was used to ensure that the chromosomes are mutated randomly and not at the same place with every generation. This created a higher diversity within the population. Before doing the crossover, a mask was created randomly. The mask then determined which chromosomes were to cross-over.

## Mutation Technique

The aim of mutation is to introduce new genetic material into an existing individual, this adds diversity to the genetic characteristics of the population. It supports crossovers by ensuring that the full range of allele is accessible for each gene.

The Gaussian mutation technique was used and the mutation rates were changed as time progresses. Thus, as the population starts tending towards the correct values, the amount by which the mutation varies the chromosome is varied.

.

# 4.Physical Aspects and Experiment

## Description

The objective of the vision system is to make use of certain parameters (**V**, **F**, **D** and **Ga**) to predict surface roughness, using Neural networks (even other cutting conditions, that is, for which different combinations of operation parameters (**V**, **F**, and **D**) are selected. This will be achieved through applying the following:

* corresponding surface roughness is measured using a reference contact method, and the corresponding image is taken accordingly.
* The measured contact surface roughness is used as a target during the training. This includes making use of **AI** techniques to predict the roughness of a machined surface through creation of a **NN** acting as a surface roughness predictor.
* After training, the **NN** will make use of four known attributes of a machined surface and then output the associated surface roughness.
* Training data to train the **NN** will be obtained experimentally. Grey level is extracted and used as an input to the **NN**. If necessary, the image pixels can further be used as inputs to improve the accuracy of the training process.
* A reverse **NN** will also be implemented to determine each of the four parameters associated with a certain surface roughness.
* Additional outputs as many as the image pixels themselves can also be employed to regenerate the image and get a feel of the roughness perceived by the vision system.

.

## Experiment

# 5.Optimisation

## Population Size

## Tournament Size

## Fitness Function

## End Condition

# 6. Results and discussion

# 7. Conclusion

# 8.Reference

# 9. Appendix

## Code