Chapter 1

INTRODUCTION

1.1 Introduction

Here the proposed project for improving the quality of a material production by three different point of perspective which represents two main aspect of material quality

- Material Removal Rate and Surface roughness Removal
- Minimization of thermal distortion

In view of the fact, that traditional extended method cannot solve a multi-objective prediction and optimization problem; we have implemented extended method to overcome this limitation. Furthermore to follow the basic assumption of extended method i.e. quality attributes should be uncorrelated or independent. It may not be so but is practical case. The study applied Principal Component analysis (PCA) to overcome this shortcoming to eliminate response correlation that exists between the responses and to evaluate independent or uncorrelated quality indices called Principal Components [3].

The project also includes the infrared thermal imaging camera for the experimental setup of .In the image field-of-view the thermal imaging camera offers a continuous picture of the temperature distribution. The distribution of heat during heating and cooling cycles across the whole machine structure provided is also important. This allows the machine’s structural elements to be measured online during the test. In an experiment the Aluminium 6061 material is used as a standalone work piece [2].

1.2 Objective

Objective of the project is to improve the quality of any material component by using the important material characteristics’ such as roughness of surface (Ra), material removal rate (MRR) and thermal distortion. Aim of the project can be extended not only in small scale but also to the large scale such as automobile manufacturing industry, construction industries; thermal power plants etc. objective is to achieve effective correlation between material and quality [1].

1.3 Scope of work

- ✓ Provides effective co-relation between material and quality
- ✓ Taguchi method helps in improving the quality at minimum cost and time
- ✓ Project propose simplest, systematic and effective methodology for optimizing the process parameters
- ✓ A device called infrared thermal camera helps in predicting thermal distortion
- ✓ A software called thermal application used in smart phones is added feature of this project which helps to predict the thermal distortion
- ✓ Problem statement is also extended to other domain areas like automobile industry, construction industry and thermal power point plants etc.

1.4 Surface roughness

Surface roughness, often referred to as roughness, is a component of surface texture. It is quantify by the deviations in the direction of the normal vector of a real surface from its best form. If deviations are large, the surface is rough; if the deviations are small, the surface is smooth. Roughness is typically considered to be the high-occurrence, short-wavelength component of a measured surface (see surface metrology). However, in practice it is necessary to know both the amplitude and frequency to ensure that a surface is fit for a purpose.

Roughness plays an important role in determining how a real object will interact with the environment. Rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces Roughness is often a good predictor of the performance of a mechanical component, surface irregularities may form nucleation sites for cracks or corrosion. On the other hand, roughness may advance adhesion. Although a high roughness value is often unwanted, it can be difficult and expensive to control in manufacturing. Decrease in the surface roughness will usually increase its manufacturing cost. This results in a exchange between the manufacturing cost of a component and its performance in application [2].

A sample of known surface roughness can be measured by manual comparison against a comparator called "surface roughness ", but in common a Surface profile measurement is made with a profilometer that can be contact type(typically a diamond stylus) or optical type(e.g. a white light interferometer). However, often a controlled roughness can be desirable. For example, a controlled roughness is required when a glass surface is too shiny to the eye and too slippy to the finger (a touchpad is a good example) a controlled roughness is required. In this case both amplitude and frequency are important [1].

Fig 1: A sample material after surface roughness removal

1.5 Material Removal Rate

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The processes that contain controlled material removal rate are collectively known as subtractive manufacturing, from processes of controlled material addition in feature, which are known as additive manufacturing. Exactly what the definition implies can vary "controlled" part, but it almost always implies the utilize of machine tools (in addition to just power tools and machining hand tools).

A room, building, or company where machining is done is called a machine shop. Machining of many products can be a business, a hobby, or both.[2] Much of the machining is carried out by computer numerical control (CNC), in which computers are used to control the movement and operation of the mills, lathes, and other cutting machines. MRR in turning operation is the volume of material that is removed per unit time in (mm3)/ min). A ring shaped layer of material is removed for each revolution of the work piece [2].

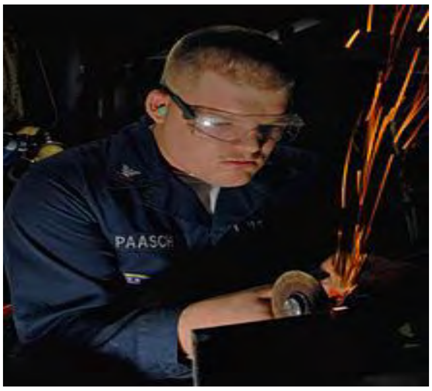

Fig2: Material removal manual process   Fig3: Operating a self driven machine

1.6 Predicting Thermal Distortion

A thermal imaging camera provides a visible image of otherwise invisible infrared light that is emitted by all bodies due to their thermal state. For researchers the thermal imaging camera has become a powerful tool and has applications in various fields such as building maintenance, bi- medicine, biometrics, computer vision, and so on. In this case study, a high-specification thermal imaging camera, namely a FLIR ThermaCAMS65, was used to record a sequence of thermal images of temperature distributions across the spindle carrier structure. The camera will be providing a sensitivity of 0.08 , and an absolute accuracy of ± 2% .

Fig4: Infrared Thermal Camera

The thermal imaging camera offers a continuous picture of the temperature distribution in the image field-of-view. The distribution of heat is provided during heating and cooling cycles across the whole machine structure is very important. During the test, this allows the machine's structural elements to be measured online. For the further analysis the camera can also providing live continuous thermal images that can be recorded [4].

The thermal images are saved as a matrix of temperatures with a specific resolution of one pixel (equivalent to 2.25 mm2), which equates to over 73,000 temperature measurement points for this 320 240 resolution camera. For the further analysis these thermal images can be transferred to a personal computer.

Thermal imaging camera specification	
Field of view/min focus distance	2418/ 0.3 m
Thermal imaging camera Spatial resolution (IFOV)	1.5 m rad
Thermal sensitivity @ C	50/60 Hz 0.08 C at 30
Electronic zoom function	2, 4, 8, interpolating
Focus	Automatic or manual
Digital image enhancement	Normal and enhanced
Detector type Focal plane array (FPA) 320 240 pixels	uncooled microbolometer;
Spectral range	3.5–13

In this work, the data has been analysed using MATLAB. The thermal imaging can have low absolute accuracy is one of the disadvantage, generally in the order of ± 3 C. In order to enhance this accuracy a number of MATLAB functions have been developed, including images alignment, averaging the images to reduce pixel noise, and extraction from the temperature data by averaging groups of pixels at a specific point. The radiation depends on the temperature of the machine tool structure which is measured by the thermal camera; due to the emissivity of the machine surfaces also it is affected. In addition, radiation reflects from shiny surfaces (ball screw, test mandrel, etc.).

The thermal images can be directly captured by the thermal camera and appearing as very hot areas. It is necessary to know the emissivity accurately, in order to measure the temperature of the machine structure precisely for which the application of masking tape with a known emissivity (0.94) is a common and effective solution.

Then the camera parameters are set according to the measurement conditions considering the distance between the machine and the camera and emissivity of the machine tool material [4].

Fig 5: An Image Showing Thermal property

1.7 Android application for thermal imaging

Thermal camera application is the first unique solution for merging the exploding Android smart phone world with the Thermal Imaging world. The modern, innovative, exclusive pending technology can be used by professionals in security purpose, safety vision, healthcare centre, veterinary, construction field, maintenance, wildlife observation and many other applications. The Thermal camera application for Android mobile devices features high-resolution thermography and long range enhances a night vision capabilities.

The lightweight and compact Thermal camera application device fits multiple phone models. By making use of its standard connector it can also be mounted on any tripod or camera handle. With its interchangeable lenses system, the Thermal camera application device provides effective detection of far away targets through its long range (20mm) lens, and a wider view through its 6.9mm lens. Its 8.6Hz FPS version is export license free.

Through an easy to use, plug & play device, Thermal camera application enables smart phone users to record, save, and share thermal images and videos with their contacts through using email, mobile messaging applications, or social networks [7].

Fig 6: Thermal image captured in smart phone

1.8 Reducing Thermal Distortion

Distortion usually occurs more during a Machining process. There are several methods for controlling distortion, some method can be applied during Machining process and some methods are applied after Machining process. Some method may reduce one distortion mode and increase another, so it is important to identify the distortion mode [3-4].

There are some methods which help in distortion control

- ✓ Minimisation of buckling distortion
  - ➢ Increasing the critical buckling stress of the plate
  - ➢ Reducing Material residual stress
  - ➢ Reducing the Material heat input
  - ➢ Material under mechanical tensioning
  - ➢ Material under thermal tensioning
  - ➢ During Machining of “flame straitening” application
  - ➢ Modifying the residual stress after machining
- ✓ Minimisation of angular distortion
  - ➢ Presetting
  - ➢ Restraint
  - ➢ Line heating
- ✓ Minimisation of bowing distortion
  - ➢ Reducing Material heat input
  - ➢ Balancing the Material residual stress