ABSTRACT

Drill wear is an important aspect commonly considered in evaluating the performance of a machining process. Machining industries essentially aim for unmanned production and better product quality. Major problems in achieving high productivity and quality are caused by the unexpected drill wear developed during machining. The actual cutting ability of the drill is reduced with increased wear, resulting in poor surface finish, over-size holes, built up edges along the lips, noise etc., also if the resharpening is delayed, more material has to be ground off. The rising demand for exacting performances from manufacturing systems has led to new challenges for the development of drill wear monitoring techniques. Today, the need for such a technique is greater than it once was, because of the shortage of skilled workers, higher machining speeds, increase in precision machining, and the need to lower downtime. Most of the proposed wear condition monitoring systems suffer from problems such as sensitivity to process noise, difficulty in on-line implementation, inability to accommodate variations in cutting conditions, unsuitability for shop floor implementation, and difficulty in the interpretation of results.

Although a wide range of monitoring methods have been investigated and developed, there has been very little migration of these innovations into industrial practice. The principal factor behind this phenomenon is the stochastic nature of the environment in which the system
must function. Online prediction of drill wear plays a very significant role to realize a fully automated manufacturing system. Untended automation of machining operations requires the development of reliable methods for on-line sensing wear. Many attempts were made to detect drill wear online, but a highly general and reliable drill wear monitoring system has yet to be developed.

In the present research work, an on-line drill wear model was developed for wear monitoring in the drilling process. The on-line drill wear model for variable cutting conditions was developed with a combination of spindle motor cutting current signals and computer based virtual instrumentation. The mathematical drill wear model was developed based on adaptive control theory and implemented using LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) in the application of virtual instrumentation. In this work, standard data acquisition software LabVIEW was applied to predict the drill wear states of HSS drill bit and two different machining approaches were studied. They were: i) Vertical Machining Centre and ii) Radial Drilling Machine. The drilling studies were conducted on six types of workpiece materials under wet cutting conditions with different feed, speed and drill diameter combinations. They were: i) AISI 1018 steel, ii) AISI 1040 steel, iii) Jute fiber reinforced composite laminates iv) AISI 304 stainless steel, v) Jute and Hay (Hybrid) fiber reinforced composite laminates, and vi) Jute and Coir (Hybrid) fiber reinforced composite laminates. For the present study, jute fiber reinforced bioepoxy resin laminates were manufactured, drilled and analyzed.
The study of the performance of the drilling involves two different approaches: i) Vertical Machining Centre (with feed values 0.10 mm/rev, 0.15 mm/rev, 0.20 mm/rev; speed values 800 rpm, 1000 rpm, 1200 rpm; Drill diameter 8 mm, 10 mm and 12 mm) for AISI 1018 steel, AISI 1040 steel, Jute fiber reinforced composite laminates and ii) Radial Drilling Machine (with feed values 0.10 mm/rev, 0.20 mm/rev, 0.30 mm/rev; speed values 400rpm, 600rpm, 800rpm; Drill diameter 8 mm, 10 mm and 12 mm) for AISI 304 stainless steel, Jute and Hay (Hybrid) fiber reinforced composite laminates and Jute and Coir (Hybrid) fiber reinforced composite laminates. Based on the experimental results, it was observed that, the cutting current consumption and the drill wear for selected work piece materials provide the linear incremental relationship for varying cutting conditions.

The developed on-line drill wear model displayed the wear states in the drilling of different workpiece combinations through the alarm system and the on-line graph. The established on-line drill wear model was used for the continuous monitoring of the cutting tool status, and to exhibit the drill wear states as a percentage of the maximum permissible wear. The performance analysis shows that the average efficiency of the developed on-line drill wear model was 95 - 97% for all workpiece materials under both vertical machining centre and radial drilling machine due to the combination of cutting current signals, varying cutting parameters and LabVIEW environment during drilling process. Meanwhile, it facilitated defective tool replacement at the proper time in an automated manufacturing environment, and was found to be in very good agreement with the experimentally determined drill wear values.