SMART PROCESS MONITORING OF MACHINING OPERATIONS

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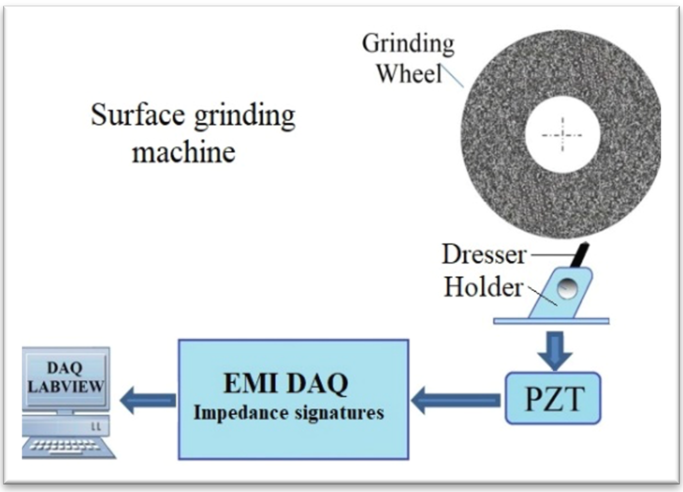
The world has experienced exponential growth in digitalisation and connectivity over the last twenty years. Many sectors have begun this process of change, including manufacturing. This evolution is often known as Industry 4.0. The fourth revolution is the process that uses network technologies to enable communication between machines. The world has moved from a mass-market to mass customisation, which is only possible thanks to increased automation. From this market demand, the solution found to increase product customisation speed is communication between machines and remote control of the system. Key Enabling Technologies (KETs) play a key role in Industry 4.0. Artificial Intelligence is a KET. Starting from the information contained within our data that can be collected, Artificial Intelligence allows this information to be fed into applications that support or complement humans to improve their processes, whether they are quality or production processes. The research work focused on the application of various Artificial Intelligence techniques in processes involving material removal, in particular the dressing and cutting operation.

Grinding operations are essential for the surface finish of workpieces. However, grinding wheels need to be regenerated to optimise their use. The name of this operation is dressing. It performs using a single-diamond or multi-diamond tool. The research work focused on both types of tools. Initially, the aim was to study the condition of the grinding wheel during single-point dressing operation. The tests involved the use of two different sensors to acquire signals useful for knowing the state of the grinding wheel.

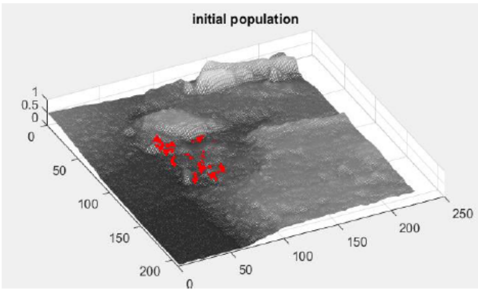
The first sensor is an acoustic emission sensor. Signals acquired in the frequency domain are converted into the time domain. The statistical parameters of the acoustic emission formed the input data for an artificial neural network. The supervised artificial neural network, once built and trained, was able to recognise the conditions of the abrasive wheel from the input data. The dressing operation was repeated with a piezoelectric sensor, which is much less expensive than the acoustic emission sensor. The input data were those of electromechanical impedance, and the artificial neural network system constructed was able to identify the best frequency for condition recognition of the grinding wheel. Given the effectiveness and potential of the piezoelectric sensor, the dressing operation is conducted with a multi-point tool. The piezoelectric sensor collected the impedance signals. A self-organising map was constructed to associate the grinding wheel condition signal with the correct tool tip.



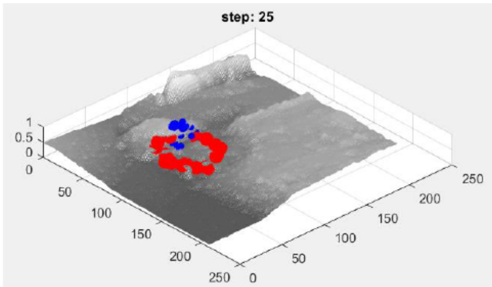
The second part of the thesis work focused on the recognition of the wear lip of a cutting tool. The cutting tool was working on a steel workpiece and its photos provided the size of the wear lip. A metaheuristic algorithm based on the movement of bees calculates the wear value from the images converted into numerical maps. There is no work in the literature using the bees algorithm to identify specific parts within an image. The results of the work compared with a direct measurement on the image showed that the method works excellently.

(a)

(b)



(c)



(d)

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Salvatore Conte, PhD, April 2021