Energy Consumption Predictor in Precision Machining

Degree programme: BSc in Mechatronics and Systems Engineering (Medical technology | Robotics)
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In the present context, the proper use of our energy resources is an increasingly important topic in the industry. The search for sustainability and eco-responsibility is done at all levels, whether in research and development, manufacturing, use or recycling once the equipment is no longer suitable or obsolete.

Introduction

In this context, the project partner wants to develop a tool capable of estimating the electricity and air consumption of his machines, and more particularly 3-axis and 5-axis numerical control (CNC). Estimates should be within a tolerance of +/-10% to physical measuring devices. This tool could have several uses in the context of energy consumption:

- Consumption Indicator visibility as a key performance indicator (KPI) to CNC operators and programmers to raise awareness
- Comparison between the consumption of the different CNCs
- dentification of machine components that consume more than usual, and therefore need to be replaced or overhauled
- KPI for future developments of the project partner

Methods

Each machine element (cooler, spindle, pump, etc.) has signals giving information such as whether it is active or not, temperatures or power indications. These signals can be saved in a CSV file via a signal analysis software "TNCScope". The tool developed in this Bachelor thesis is a C-encoded program able to read this CSV file and to calculate the air and power consumption. This same program also generates consumption result on the terminal, and a CSV file to be able to analyse power graphs in Excel for example. At the moment these calculations, tests and analysis has been performed on one specific CNC machine type.

Results

Compressed air, the cooler and the spindle are the machine's 3 biggest energy consumers. Even when stopped, the machine consumes a lot (air or electricity). On top of that, if we add options such as minimal quantity lubrication (MQL), which is a mixture of oil and air, we consume more than half the power just with compressed air. The calculation gives a result of 12.55 Nm3, and the measurement indicates a consumption of 12.87 Nm3. This equates to a process result of 97%. Variations are due to irregularities in consumption by component, differences in recording time and low-consumption elements ignored during calculation.

Outlook

The next step would be to verify the accuracy of the calculation program on another machine with different characteristics. It would also be necessary to test and measure the machine elements individually to check that each signal provides correct consumption. And finally, the calculation program would be integrated directly into the machine control system.

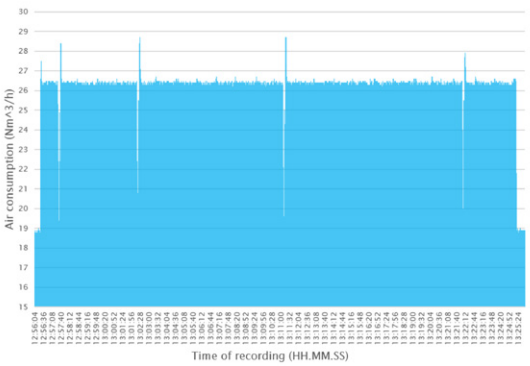

Figure 1: Air consumption measured during a 3-axis machining process

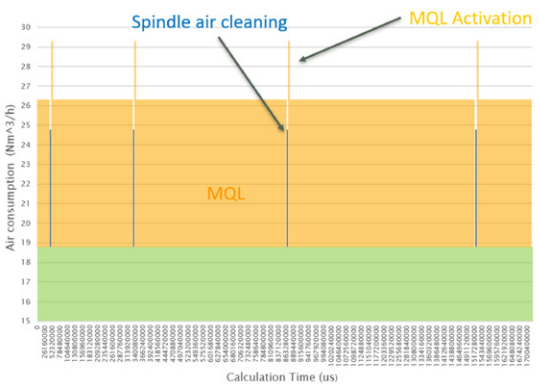

Figure 2: Air consumption calculated during a 3-axis machining process

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