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Commentary

Overview on Machining of Aerospace Aluminum Alloy Using Robotic Drilling System

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DESCRIPTION

This paper aims to identify the capabilities of a highly flexible industrial robot modified with a high-speed mechanical spindle for drilling aluminum 6061-T6. Focusing on drill feed rate, spindle speed and grooving cycle, the Taguchi design method was used to study the hole surface roughness and tail height. A state-of-the-art condition monitoring system was used to identify the vibrations that occurred during the drilling process and identify which robot poses increased stiffness and thus exhibited the optimal working range for drilling. Compared to CNC machines, the results show that CNC was able to produce the best surface finish and lowest height. However, the robotic system has reached and surpassed the CNC in some experiments, leaving plenty of room for further optimization of the process. Overall, the proposed drilling system is much more flexible than CNC milling machines, and considering the optimized drilling of aerospace aluminum, this robotic solution has the potential to significantly improve productivity.

The aerospace industry is constantly looking for ways to reduce costs, improve quality and shorten lead times. Drilling holes in the aerospace sector has always been of great importance to aircraft manufacturing and is the most frequently performed task in the machining of aerospace parts. A Boeing 747 contains about 3 million fasteners and each Boeing wing has about 40,000 rivets. Boeing drills approximately 1.1 million holes every day and to improve efficiency, then increased the adoption of automation in the automotive industry from 20% to 80%. Although there are similarities between the aerospace and automotive industries, the aerospace industry lacks the drive for automation and the consequent benefits.

Airbus and Boeing released their global market forecast for 2018-2037 in July 2018. Annual new aircraft deliveries are projected to grow by 3.5%, according to the report. Moreover, air traffic is expected to grow by 4.4% annually over the same period. Other forecast sources from airbus and show that demand for commercial aircraft will continue from 2015 to 2034, with the number of aircraft increasing from 19,000 to 38,500. The data demonstrates the expected growth to be seen in the future in the aerospace industry. Meeting the growing demand for automation in aircraft manufacturing has the potential to improve both productivity and part quality in the aerospace sector.

In the aerospace industry, assembly operations are often very physical and can be repetitive. An aircraft fuselage or wing assembly typically consists of skin panels that are attached to a support structure and then riveted together. The manual riveting process requires a pre-drilling process that can cause several potential health hazards related to fatigue, dust, noise and vibration. Additionally, due to the nature of the machining and assembly processes used, the sector has traditionally experienced high staff turnover, training costs and recruitment difficulties. It was found that at least 30% of workers found that the tools used in airplane assembly caused back pain after prolonged use. A study of 522 aircraft assembly workers also found pain, discomfort, and numbness in body parts such as the neck, shoulders, and knees, which correlated with workers being absent from work. Reported to be additionally, the quality of drilling within the sector is inconsistent. Quality at the start of a shift is usually higher than work at the end of the shift. This quality variability can be attributed to operator fatigue and human limitations, highlighting the urgent need to introduce more automation to labor-intensive activities. A challenge for automation is well quality. The accuracy of the connecting holes determines the quality of the rivets. As inaccuracies are introduced, bending stresses are introduced into the joint. This can adversely affect the fatigue life of the aircraft. 80% of structural failures are due to fatigue damage from holes in aircraft structural joints. Tight hole tolerances are also required and manual drilling with inherently poor hole quality therefore requires subsequent rework. These errors are concessions to the original specification and thus increase manufacturing costs.

Vibration during the drilling process often causes and poor hole quality, high noise levels and potential damage to components. We realized the importance of detecting vibration as early as possible to improve whole quality. Considering different Feed Rates (Fr) (0.9-7.8 mm/sec) and Spindle Speeds (Ss) (1800-3600 rpm), the investigation shows that increasing spindle speeds

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decreases stability due to a sharp increase in vibration and amplitude led and to vibration increases. Recent research suggests that identifying and using the correct machining parameters can avoid increased levels of vibration. Drilling parameters also affect surface Roughness (Ra) and showed that using different types of drill bits and adjusting different drilling parameters can greatly affect the resulting Ra of the hole. Pointed out that Fr is an important machining parameter that affects both borehole accuracy and surface quality, and adaptive material removal rate improves machining accuracy.