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(57) Abstract :
and edge computing to facilitate real-time monitoring as well as adaptive control. The system leverages the use of sensors within CNC machines to collect machining parameters such as spindle speed, vibration, cutting forces, and tool temperature. These are passed to a high-speed data acquisition module and processed using an AI-tuned engine. A digital twin executes machining operations and forecasts tool behavior under given conditions. Machine learning algorithms, trained with historical and real-time data, offer suggestions for optimal cutting parameters to enhance efficiency while reducing tool wear. To confirm the system, several experiments were performed on a CNC milling machine and on metals such as aluminum and steel. The system was confirmed on the basis of tool wear rate, surface roughness, and machining time. Tests showed considerable minimization of tool wear, enhancement of surface finish, and enhancement of productivity in comparison to the traditional machining process. Overall, the study recognizes the ways in which AI-aided optimization will revolutionize subtractive manufacturing through less overhead, improved accuracy, and future trends in the direction of autonomous and adaptive machining for the manufacturing sector.

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