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Modular robotic platform for autonomous machining

- Murshiduzzaman[1],
- Tanveer Saleh ORCID: orcid.org/0000-0002-9606-2323[1] &
- Md. Raisuddin Khan[1]

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Abstract

Product miniaturisation is one of the key aspects of modern manufacturing technology. One of the ways to fabricate miniaturised product is micromachining using sophisticated computer numerically controlled (CNC) machine tools. However, conventional CNC machines are bulky, stationary, and unable to carry out parallel operations. This research aims to develop a modular robotic platform which would be able to carry out machining operation in mesoscale. Hexapod robots are legged mobile robots which are used for verities of applications. Here, we have implemented a hexapod robotic platform to support and move the cutting tool (in this case, a drilling tool). The robot was controlled from the host computer through serial communication. A graphical user interface (GUI) was designed and implemented to operate the robot and the drilling spindle. Several machining operations were carried out with the system to assess its performance. An innovative compensation algorithm has been proposed to improve the positional accuracy of the robot movement. The proposed algorithm takes into account spindle speed and linear velocity to mitigate the positional error. The positional accuracy was improved by more than 60% after implementing the error compensation scheme. In this research we managed to achieve sub-10 µm repeatability (≤ 10 µm) at the lowest spindle and point to point linear speed of 2500 RPM and 200 mm/min, respectively. The performance (in terms of positional accuracy) of the robot was also compared with that of an existing commercial micromachining system where the robot was found to be almost ~ 2× time poorer to that of the commercial machine. Finally, the machined holes' quality was measured in terms of circularity and taperness. It was observed that at the best machining parameters circularity deviation was as low as 29.4 µm while taperness was 0.54 degree.