Designing and Constructing an Affordable Computer Numerical Control (CNC) Machine Prototype with Five Degrees of Freedom (DOF) in Sri Lanka

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A low-cost Computer Numerical Control (CNC) machine with 5 Degrees of Freedom (DOF) is designed by combining 3 DOF translational motions along the x, y, and z axis with two rotational DOF around the x and y axis which are known as pitch and yaw respectively. In general, a three-axis CNC machine can perform movements about three different axes which are primary x, y, and z. However, a five axes CNC machine can perform rotation around two additional axes which are made possible by the table tilting mechanism, which gives its superiority in approaching along multi-directional directions. The design of 5 DOF CNC machines strives to provide freedom of operation for the end effector of the proposed CNC machine to work on a relatively complex tool path trajectory. The main objective of the proposed CNC machine is to construct a low-cost machine with the available resources in the environment or institution yet incorporating all the features that are required to provide precise finishing, a faster milling process, and higher power efficiency compared to the conventional 5 DOF engraving machine. G-codes are normally read by PC-based controllers but in the case of large industrial CNC machinery overheads caused by the complexity of trajectory and G-code increases the equipment cost resulting in economically hurting the smaller and medium enterprises. The machine is built using available materials in the environment thereby minimizing the capital cost. The Proposed CNC machine is also incorporated with the automated tool-changing mechanism in an attempt to reduce the processing time of the machine as well. The proposed model is built by combining G-code and M-code along with an automated tool-changing mechanism so that the machining process and automated tool-changing mechanism can work sequentially. This research aims at retaining the low-end functionality of the CNC machinery but at an affordable cost per machine.

Keywords: Automated Tool Changing Mechanism, Faster Milling, Power Efficient, Precise Finishing, 5 Degrees of Freedom