Chapter 11
Industrial Robot–Integrated Fused Deposition Modelling for the 3D Printing Process

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ABSTRACT

In this chapter, six axis robots-integrated fused deposition modelling (FDM) processes have been used to fabricate the polymer three-dimensional (3D) printing objects. A unique method of printing 3D things uses an industrial robot with an FDM extruder as its end-effector. This robot is controlled by sophisticated controller technology and Robot Ware control software. The robot's end effector will travel along the designed toolpath as it is modelled by Robot Studio software. Printing a cube serves as a demonstration of the methods used to combine the FDM process with a six-axis industrial robot. This demonstrates how components can be produced using additive manufacturing and robotics. By applying different process parameters of the innovative system, the tensile and flexural strengths of printed specimens have been optimised using the Taguchi method.

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INTRODUCTION

A three-dimensional object is created using the additive manufacturing technique of fused deposition modelling (FDM), in which material is deposited in horizontal layers on top of one another. A huge spool of thermoplastic material is used to feed a moving, heated extruder head with filament. An industrial robot is a mechanical device that can be programmed to undertake repetitive or risky activities with high levels of accuracy in place of a human. The welding, painting, assembly, pick-and-place work, packaging, palletizing, product inspection, and testing are typical uses for these robots. Extruder orientation changes and printing on inclination planes are not possible with traditional FDM machines. An industrial robot with an extruder as its end effector can be used to get around this. The goal of the current effort is to investigate a novel industrial robot application to get over the constraints of traditional machines. The current work's goal is to create an FDM method that is coupled with an industrial robot to print 3D items. Additionally, this project seeks to print items on curved surfaces, numerous planes, and inclined planes. The six-axis industrial robot has a maximum payload capacity of 6 kg. The extruder in this work is moved using quick programming (meant for ABB robot) commands. The STL file created from the 3D model is utilised as the input file. Using a MATLAB tool, it is divided into layers based on layer thickness. The influence of various operating parameters such as raster angle, layer thickness, deposition speed and deposition angle on tensile strength and flexural strength is evaluated. By extruding the same build material from both nozzles of the extruder attached to an industrial robot, a new method has been created to reduce printing time. The findings showed that the tensile and flexural strength are considerably influenced by the deposition feed rate, scanline width, and raster angle parameters. Contrary to the traditional FDM technique, which slices items parallel to the horizontal plane, an industrial robot has been created that can slice objects in a variety of planes. The outcomes showed that with the aid of the robot, homogeneous material deposition was seen at the intersection of the planes. Using the methodology, a NACA0015 airfoil-shaped section of an aeroplane wing is printed. The wing is cut in a series of concentric curves, and each layer's curved surface is also printed along. By using the industrial robot to deposit material over nonplanar layers, the staircase effect is minimised.

OVERVIEW OF FDM PROCESS USING INDUSTRIAL ROBOT

The suggested system improves the CNC procedure. The proposed system only yielded a small number of prototypes, but the outcomes showed that the requisite dimensional accuracy was attained. In this study, a trajectory generating algorithm that creates trajectories for various paint thicknesses has been constructed. In this study, the deviation angle of the spray cone is adjusted via patch formation. The created trajectory generation algorithms have demonstrated a reliable level of performance, according to the paint thickness verification method (G. Q. Jin et al., 2013). A brand-new toolpath planning method for robotic manipulator applications like spray painting that is based on the CAD model of the work part. By segmenting the part's surface into smaller sections or patches, the system creates efficient toolpaths automatically. According to experimental findings, the technology that has been designed is useful for robotic applications. Aims to use a novel hybrid toolpath generating method to increase accuracy and decrease building time for additive manufacturing operations. To shorten the building time, algorithms were created to produce the toolpath for each slice based on its geometry. Applying the suggested tool route generating technique to five biomedical models produced successful results (Keating & Oxman,