Automation of the Removal Process for a FDM 3D Printed Object

The additive manufacturing industry has grown rapidly since the invention of 3-D-printing in the 1980s and is receiving more and more recognition today. The production process is however, still very time consuming and requires a great deal of knowledge. Additionally during the heating of the 3D printing material volatile organic compounds (VOC) and nanoparticles, which are harmful to the supervising employee, are released into the environment. In order to reduce the complexity and supervision requirement, as well as the employee contact with said harmful environment, this paper presents a concept to automate the entire 3D printing process chain. The concept describes possibilities of automation beginning at the CAD file, all the way to the finished, ready to use 3D printed object. The focus of this thesis however, is on the automation of the removal process for a FDM 3D printed object. To design functioning universal gripper fingers an analysis is implemented, analyzing thirty thousand STL files from the online portal Thingiverse to calculate an appropriate range of dimensions that will need to be removed from the build platform of the 3D Printer. Furthermore, an analysis is conducted to determine a mathematical description of the force required to remove a 3D printed object. With said information five gripper finger designs are implemented and attached to a gripper on a lightweight robot. By means of the Robot Operating System (ROS) the robot and gripper are fully automated to remove the 3D printed object from the build platform without using a vision system. This is implemented using an algorithm which analyzes the GCode file of the printed object and determines its position, orientation, and dimensions. Upon receiving this information the robot executes the removal process, for which multiple strategies are examined. Once this task is completed another algorithm tests whether the removal succeeded. The presented automated removal process is tested with the five designs, proving that it is possible and economical to automate said process, reducing the non-value adding time of 3D printing. The developed concept is not bound to the FDM process but can be applied universally to any 3D printing process by means of minor adjustments to the presented designs.

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