Applying Principles of Electromagnetism and Resistive Heating to Develop a More Accessible Method of Metal Additive Manufacturing

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Current methods of metal additive manufacturing (AM) typically require high-power laser or arc technology to melt metal into desired forms (powder bed fusion and wire arc AM, respectively). These methods introduce dangers in toxic metal powders and intense UV radiation exposure. Following a sharp increase in demand for low-cost, accessible, and precise production of increasingly complex part geometries, there is a need for machines capable of meeting higher standards. This project aimed to evaluate a new method: combining chamber heating with electromagnetic modulation to control outward flow and material deposition. The heating techniques allowed for greater electrical efficiency while eliminating otherwise dangerous mechanisms. To test the novel arrangement, a toolhead and its internal components were constructed. A dual-drive extruder was designed, allowing for moving parts to be replaced in anticipation of many filament types and diameters, while simultaneously reducing slip and increasing extrusion speed range relative to other mechanisms. To protect delicate plastic components from heat, insulating and cooling regions were implemented between the hot-end and extruder. To demonstrate movement, x-axis and y-axis linear motion gantries were built. The stepper motors, extruder motor, heater, and electrical inverter modules, alongside numerous sensors and integral devices distributed within the machine, were controlled and powered continuously via an electronics system. The machine was capable of melting metal filament to create basic parts, demonstrating multisystem collaboration and validating the concept in its simplest form. More intensive part optimization, alongside multi-axis expansion, could make the design useful in standard working conditions.

Awards Won:

Fourth Award of $600

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