Development of a Hybrid Direct Ink Write 3D Printer: A Novel Approach to 3D Printing Multi-Material Functional Devices and Flexible Electronics

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Engineering Goals: The project is attempting to create a hybrid direct ink write 3D printer that utilizes a novel dual-gantry system which combines three extrusion methods; inkjet deposition, syringe pump die slot, and traditional fused filament deposition methods to innovate functional device and flexible electronics. 1. Develop and optimize extrusion methods through innovating new open-source extrusion devices. 2. Print multi-layer flexible electronic devices. 3. Develop novel program to run the multi-gantry device in a streamlined manner. 4. Optimize copper inks for printing electronics on flexible devices. Procedure: First, a dual-gantry 3D printer chassis was assembled. A novel 3D printer extruder carriage capable of holding three extruders was designed using Solidworks modeling, and 3D printed. A novel direct ink writing board was developed milled out, then soldered. A program was written from scratch to interface the printer motherboard. Graphene and copper Inks were then printed on deposited photopolymer films. Data: Engineering a hybrid 3D printer was successful. The novel copper prints tested conductive without further reduction. Multi-material conductive prints were successfully deposited in a streamlined manner. No post-processing of prints was necessary. Conclusion: The goals were all achieved. The structures produced by the hybrid inkjet 3D printer maintained conductivity with multiple materials when flexed. The printing methods were all successfully interfaced to print multiple materials simultaneously. The process of printing embedded flexible electronics could impact many fields, including the energy sector, biomedical field, and flexible electronics.

Awards Won:
Second Award of $2,000
Office of Naval Research on behalf of the United States Navy and Marine Corps: The Chief of Naval Research Scholarship Award of $10,000