Developing a 3D Printer Capable of Producing Hybrid Hydrogel Based Artificial Cartilage

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More than 2 of every 100 Americans will require a joint replacement, as the population is surviving longer new strains on the human body are discovered. Knee replacements are required when the protective layer of cartilage is worn away from the joint's surface causing bone damage. Unfortunately total knee replacements do not provide lifelong support for an injured joint. For younger patients artificial cartilage can provide an alternative to the total joint replacements. This project explores the modification of a commercial 3D printer in order to 3D print hydrogel artificial cartridge, with material properties similar to natural knee cartilage. Hybrid artificial cartilage solutions were created using gelatin and hydrogel base, composed of sodium alginate and calcium chloride. Both of these materials, while incapable of behaving as an artificial cartilage solution independently, can be used in conjunction to form functioning artificial cartilage. In order to modify the 3D printer, a pump system was designed to dispense the cartilage solution on the printing base. Print speed and other aspects of printing quality were manipulated to create viable samples. Multiple aspects of the artificial cartilage samples were tested and compared against pre existing data on articular cartilage. While none of the tested samples matched all of the parameters of natural cartilage both 7g/4g and 7g/2g show potential for mirroring the function of natural cartilage. The least squares regression line for water composition and cartilage density suggest the optimal solution proportion for gelatin to sodium alginate levels is between 2.73 and 3.62.

Awards Won:

Second Award of $2,000