Department of
MECHANICAL ENGINEERING
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Autonomous Micro-Fluidic Sperm Separation Device

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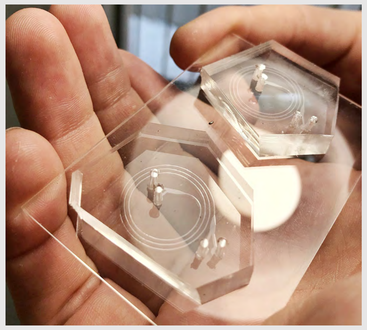
for Biomedical Microfluidics

Background and Objectives

Background

- 1/6 couples of reproductive age worldwide struggle with some form of infertility. Two common corrective procedures are Intrauterine Insemination (IUI) and In Vitro Fertilization (IVF). Both of these procedures require a process where sperm is separated from semen.
- Current techniques require a multi-step process involving trained lab technicians, lab machines/hardware, and can take up to 1.5 hours to process.
- The Utah Microfluidics Lab has created a novel Microfluidic chip that can separate sperm from semen utilizing special microfluidic properties.



Objectives

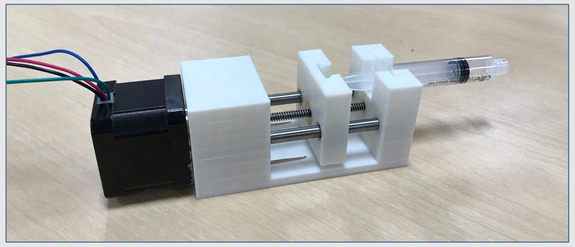
- Our goal is to create an autonomous, all-in-one inclusive device that utilizes the microfluidic chip to perform all the functions done in the lab, and in a fraction of the time.
- With the success of this device, IUI and IVF would be cheaper, faster, and more available to doctors worldwide.

Design Specifications

Specification	Requirement
Processing Time	< 20 minutes
Heating Sstem for Incubation	37 ℃
No Cross Contamination	Non invasive, and disposable parts
Compact Housing	"Printer Sized" ~ 12x12x6 inches
Autonomous	Plug in sample -> retrieve finished sample
Process Control	Adjustable flow, additives, and # of iterations

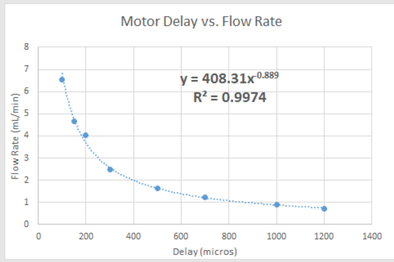
Pump Design

- Over Several pump designs, we provided much smoother flow, which is necessary for the microfluidic chip to be effective.
- For size and cost requirements, we built our own syringe pumps.



Pump Features

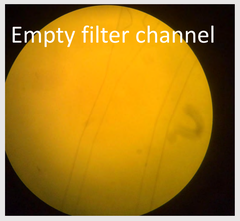
- Custom 3D printed base and slider
- 12V Stepper motor
- Accommodates 3ml syringe



Stepper-motor delay calibration curve

Pump Results

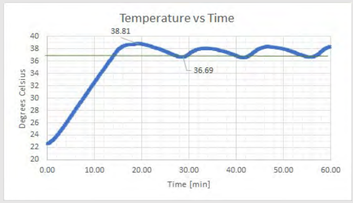
- Pumps can achieve smooth flow between .4ml/min and 7+ ml/min



The two pictures above show exit flow in the microfluidic chip. This proved that our custom built syringe pumps could achieve a flow steady enough to separate sperm in the spiral filter, accomplishing a major project milestone.

Heating Design

- The heating needed for incubation is achieved through heating coils of wire around the perimeter of the housing.
- A simple control system regulates power to the coils, and sustains a 37 ℃ climate.

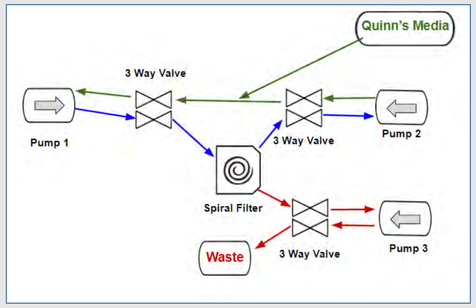


Results

- 14 min. to preheat from 23° C to 37° C
- Initial overshoot ~2° then ~1° lasting 8-10 min.
- Undershoot <1° lasting 3 min.

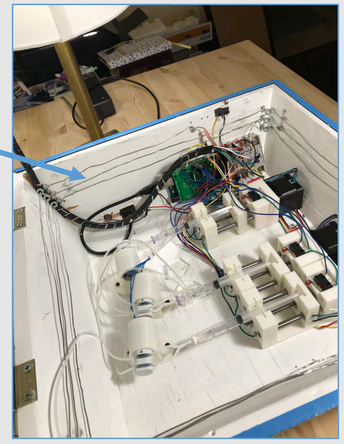
Flow Program

- At the core of this device lies the design of how to sequence the pumping to resolve the many flow directions of the semen throughout the filtering process.



A road map showing our devised network of valves and pumps flaunting the microfluidic "Spiral Filter" in the center of flow traffic.

Final Device Outcome



Results

- Process time – <15 minutes
- Incubation temp – 37℃
- Disposable parts/no cross contamination – Complete
- Process Control – Complete
- Compact all inclusive Housing - Complete

Future Work

- Live sample testing
- Process control tuning
- Quick releases cartridge for disposables

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