One Pump
Develop a Single Blood Pump Device

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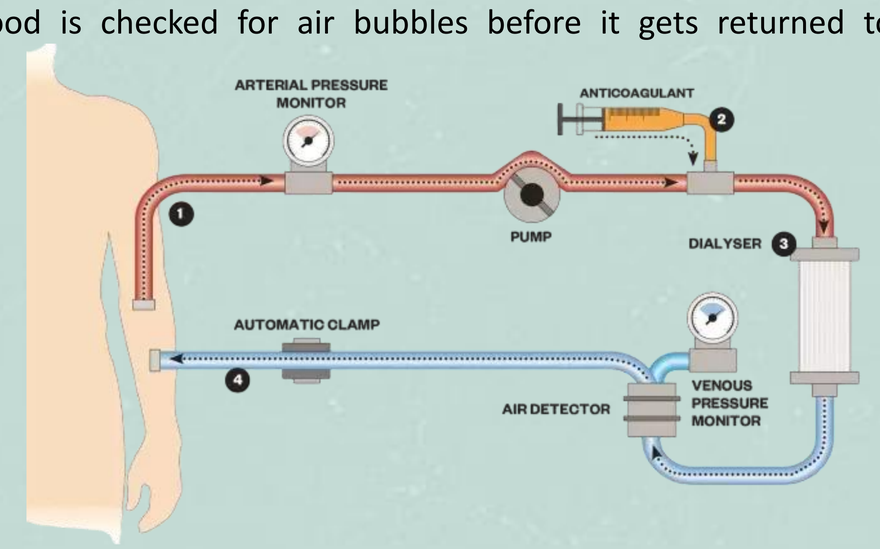
About the project

We aimed to design and build a safe, compact, cost-effective single-pump dialysis machine prototype. We used mechanical design, electronic control, and embedded programming to create the essential components and functions of an extracorporeal blood circulation system.
We were supported by **Kathrin Kehrle**, **Balten Lauströer**, and **Frank Biermann** at D.med Consulting GmbH , who are specialized in extracorporeal technologies and medical systems.

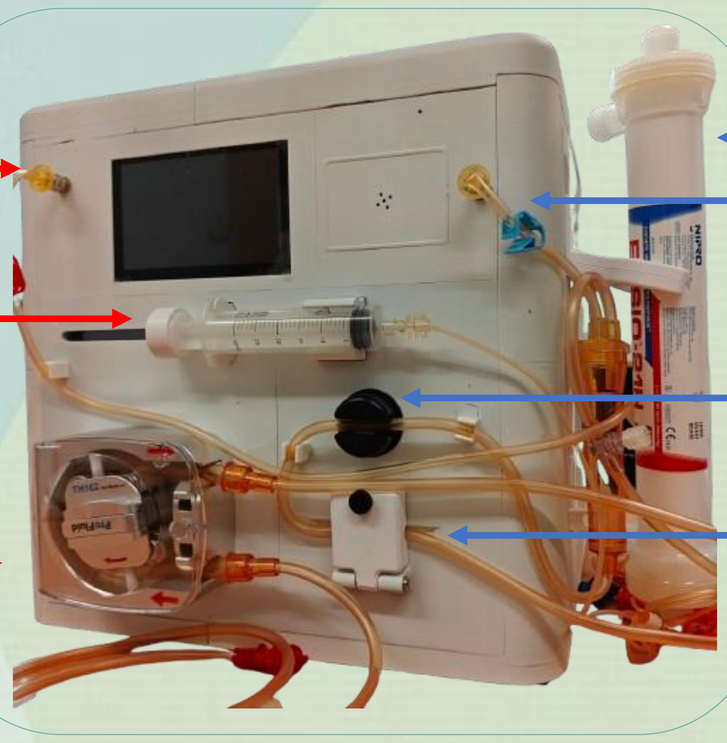
Extracorporeal Cycle

The roller pump extracts blood from the patient. The pressure sensors measure the arterial and venous blood pressure to monitor the flow. Heparin is administered as anticoagulant. The blood is filtered by the dialyser. To ensure safety the blood is checked for air bubbles before it gets returned to the patient's vein.



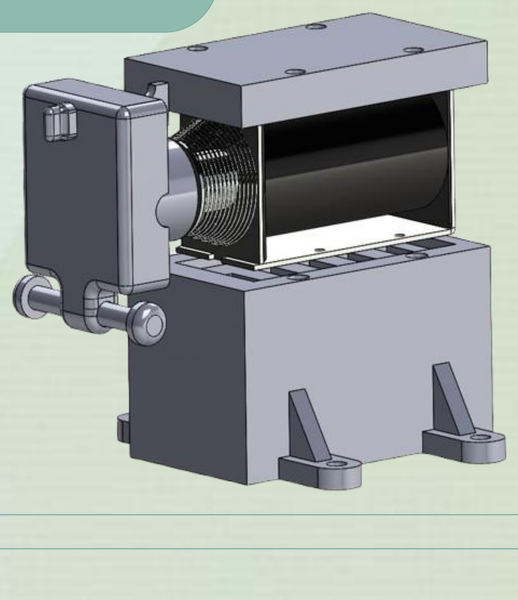
Housing

We designed a 30 cm x 30 cm x 30 cm housing to encase the components and provide easy access to them for maintenance. The housing is assembled from 3D printed parts made out of PETG. It has an opening for the touch display, from which the user can control the process and read the sensor output. The heparin syringe, the tubing for the blood circuit and the dialyzer can be inserted into mounts.



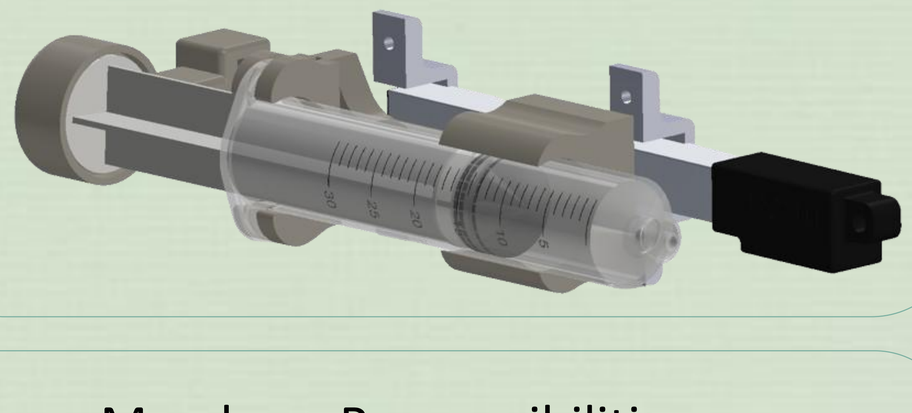
Safety Valve

We developed the safety feature of an air bubble detector and a venous clamp specifically for our prototype, since commonly used components are too heavy for our purposes. It is a fail-safe mechanism to prevent air embolism. The venous clamp, a solenoid, stops blood flow to the patient, by applying force onto the blood tubing. If the sensor detects an air bubble, it triggers the venous clamp.



Heparin Pump

Heparin is an anticoagulant substance. It is evenly injected into the extracorporeal blood circuit over the whole duration of the procedure with a linear actuator to prevent blood clots.



Conclusion & Outlook

We have created a 30x30x30 cm single-pump dialysis prototype with core functionalities, which is about 3 times smaller than common dialysis machines that are equipped with hydraulic circuit. For that we have assembled the housing out of 3D-printed parts, used and created lightweight mechanical parts, developed PCB circuits, developed a modular program for a ESP32-S3 microcontroller and a human-machine interface. With that we have laid the foundation for refinement and robustness of the housing assembly and program, stricter adherence to medical standards and more detailed and intuitive human-machine interaction.

Team Member	Responsibilities
Shubham Mehta	Scrum Master |Mechanical, Electronics
Vinit Trivedi	Product Owner | Programming
Stephin Santhosh	Engineer | Electronics
Beatrice Manga Franke	Programmer| Programming
Thi Mai Phuong Do	Engineer| Mechanical