Realization of a Point of Care Hematology Analyzer

Degree programme: Master of Science in Engineering | Specialisation: Mechanical Engineering
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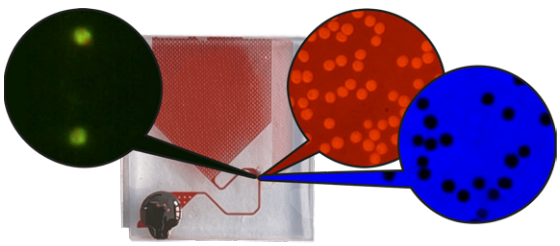
The Complete Blood Count CBC is the most performed blood test worldwide. Still, a diagnostic device that can process such a CBC directly on-site at a low cost is inexistent. This work demonstrates the feasibility of a prototype for a compact, low-cost blood cell analysis device and analyses the possibilities for mass production.

Objective

The master's thesis is about developing a new point of care (PoC) device consisting of optical components and a microfluidic chip for processing and counting blood cells. This diagnostic device aims to make patients' lives easier and enables an analysis of the blood wherever it is needed.
Currently, inexpensive off-shelf components are becoming more powerful. Components such as graphical process units (GPU), and low-cost, high-performance camera chips and LED sources enable high-quality image processing through microscopy. The overall goal is to develop a competitive diagnostic device with full functionality. The point-of-care device consists of a digital fluorescence and absorption microscope. This thesis focuses on the prototypical implementation and execution of a manufacturing analysis, taking into account cost and scalability.

Implementation

The basis of this work laid my previous specialization project, which resulted in an experimental setup. By analyzing the technologies and manufacturing processes established on the market, a solution suitable for the project was developed. The mechanisms and specifications required for functionality were worked out step by step and validated experimentally. All the experience gained was used in the production of the prototype. The manufacturing processes suitable for mass production do not apply to prototyping due to high initial costs. Therefore, a conducted feasibility study analyzed the future possibilities.



Microfluidic chip with micrographs performed through reflected and incident light microscopy, illustrating white and

The challenge is to find a compromise between optical performance and the device's compactness. The price requirements severely limited the choice of available optical elements. In this conception, the focus lies on optimizing the device's compactness to achieve high portability. Compared to the experimental setup, a reduction of the optical path by more than 50% took place.

Result

The prototype proves that manufacturing a functional blood counter with a sales price below 1'000 CHF is possible (figure 2). The microscopical setup magnifies the blood samples around 20 times. By consequent compaction of the setup, outer dimensions of 16 x 13 x 20 cm3, corresponding to approximately 4 liters at 2.5 kg, were achieved (figure 1). The elastic deformation-based frictionless Z-axis features a resolving power in the nanometer range.

Figure 2: Design of the PoC-device «Microcyte»

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