Maastricht University

Biosensors, customisation, and prototyping

Citation for published version (APA):

Rogosic, R. (2023). *Biosensors, customisation, and prototyping: How to make point of care diagnostics more relevant*. [Doctoral Thesis, Maastricht University]. Maastricht University. https://doi.org/10.26481/dis.20230404rr

Document status and date:
Published: 01/01/2023

DOI:
10.26481/dis.20230404rr

Document Version:
Publisher's PDF, also known as Version of record

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy
If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

Download date: 25 Apr. 2024

Summary

The work presented in this thesis, is made of heterogeneous but complementary parts. While rapid prototyping has been the greatest common factor between chapters, metaphorically we can say that the least common multiple, is the user. Each study conducted, includes user-end specification, and one of the common goals, has been to develop or optimize technologies, in order to make them more relevant for a larger pool of people. The thesis begins with a study on 3D printing applied to flow cell development, which gives the tools to develop the following chapters: an experimental biosensor optimization, and a DIY laboratory instrument. Finally, the findings of all the chapters are combined in the last part of the thesis, which presents a scientific kit for educational purposes, its validation and the derived valorization efforts.

The Form2 from FormLabs, is one of the most used desktop SLA resin printers on the market. In **Chapter 2**, this printer is bench-marked, focusing on fabrication of milli- to micro-sized fluidic channels. Different types of resin are analysed, investigating accuracy and limits of the printer. The goal of this study is to offer an insight on how to efficiently use this printer in laboratory environments, lowering costs, production time, and allowing researchers to custom-build tools for their projects. The findings of this chapter show how commercial 3D printers can be used to create microfluidic channels, at lower resolutions with respect to the golden standard, but with alternative advantages. Examples of applications in which the performances of commercial 3D printers are satisfactory, are flow cells used in small to medium volume liquid handling.

Chapter 3 uses such 3D printed flow cell, in combination with a Molecularly Imprinted Polymer-based (MIP) sensing core and a Heat Transfer Method (HTM) readout. The goal of this chapter is to optimize, from an engineering point of view, the adhesion layer used to immobilize the MIPs to the readout part of the sensor. Three different adhesive layer are studied, showing their performance and behaviour. The results of the chapter are multiple: it is shown how the 3D printed flow cells performs well in comparison to older, more expensive models; the experiment also highlights that there is a significant effect due to the adhesive layer of choice, opening up possibilities for follow-up studies and in which similar technologies are used.

Chapter 4 describes a DIY syringe-pump, designed and fabricated with rapid prototyping techniques and optimized to be used by untrained personnel. Syringe pumps are amongst the most used types of pumps in biology, tissue-engineering and chemistry labs. The pump, described in this work, focuses on the maximization of the instrument usability, which would give it an edge over the currently available solution in literature, and on the market. The result is a compact, wireless, internally powered device, controlled by a custom-made app that can be downloaded on any type of smartphone. The technical performance of the pump is shown to be comparable with similar DIY instruments in literature. The user experience, has been evaluated during a class of bachelor-level students that have used and tested the pump. The qualitative investigation that followed showed that the majority of the users, despite having no laboratory experience, found the pump to be easy to use and had a good experimental experience, confirming that the initial goal of the study has been achieved.

Chapter 5 describes the design and fabrication, with 3D printing, of a modular science kit used for educational purposes. The kit is made of 3D printed, transparent, modular blocks, with embedded fluidic channels. The kit is equipped with two, 3D printed, syringe pumps (similar to the ones in Chapter 4). After building specific fluidic circuits with the modular blocks, liquids can be flushed through the system, creating and visualising scientific phenomena. The attention is caught by the visual effects created, and the curiosity of the pupils, stimulated. This chapter proposes an innovative educational tool for STEM classes, based on the principle of meaningful play: learning through the process of playing. The work in this chapter, focuses on the tools and the explanations on how to build and use the kit. However, to field-test its effectiveness, a study has been conducted in a primary school in Limburg. Because of the commercial valorization efforts, that the project lead to, and thus conflict of interest, data collection and evaluation was done by Nardie Fanchamps, a professor of educational sciences at the Open University of the Netherlands. Thanks to this collaboration, an article has been published, and the results are shown as external corroborating information. In summary, the results are promising, showing how the kit developed, improved the involvement of students, their fascination with the subjects studied, and with science in general.