Towards the modular liquid-handling platform

Lars Yndal Sørensen
MSc. Stud., IT University of Copenhagen
Rued Langgaards Vej 7, 2300 Cph S
lynd@itu.dk

ABSTRACT
TBD

diskutere dem ud fra kriterier som performance, kompleksistet/pris, vedligehold, udvidbarhed, osv. Derefter vender du rundt og kigger på hvad for en type applikation du kigger på og ser derefter hvad for en type der så passer bedst.

Hvis der ikke i litteraturen findes eksempler på alle mulige typer er det ikke et problem snarere er det godt fordi der kunne være et hul der var værd at efterforske.

Questions:
[[1) Correct term: Dish dispenser, plate dispenser, similar...?]]
[[2) General term: Dishes or plates? (Must include both Petri dishes and wells.)]]
[[3) Write "I propose, or we propose...")]]
[[4) laboratory platform vs liguid-handling machine]]
[[5) Use term "experiment container" in instriduction to have as open approach as possible?]]
[[Mention: Not high performance design (?)]]

Author Keywords
Guides; instructions; author's kit; conference publications; keywords should be separated by a semi-colon.

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

See: `http://www.acm.org/about/class/1998/` for more information and the full list of ACM classifiers and descriptors.

INTRODUCTION
A lot of public and private institutions are working with laboratory platform to perform experiments in Petri dishes or wells. These experiments are often related to human health or other biological research, while each series of these experiments can be performed in a single type of dish. This has entailed that the available laboratory platforms mainly focus on to servo *one* type of dishes and that the platforms are designed for a single type of experiments.

In the design process, the knowledge of having to address just a certain type of experiments, makes it more rigid, what such a platform requires of equipment. Therefore each platform are very often designed in a non-modular way as each piece of equipment seeks to address as many functionalities as possible.

Public and private institutions that use laboratory platforms may, for several reasons, not be interested in platforms that aim at specific experiments. Reasons that are related to financial circumstances, or because they just need to perform a limited serie of experiments, before turning to a completely different type of experiments. This rules out the use of available laboratory platforms, in which case, some institutions are creating their own platforms to address their specific needs.

If the laboratory platforms where less rigid in their design, in terms of modularity, and they used more generic approach, they would be able to perform experiments in *a group* of types and address more needs per platform. Of course the specialized platforms would still be needed as some experiments simply can be generalized, but starting with, i.e. a module for adding and removing Petri dishes and wells, would benefit the majority, as this is the most common event on a laboratory platform.

This paper will from this point on, focus on the design of a module that can insert and remove experiment containers, describing the everything from the initial design goals, through the mechanical and software design, to the evaluation containing an integrated experiment into an laboratory platform[1].

DESIGN GOALS
In order to increase the design and clarify the important functionalities needed, a series of user scenarios will be described. The concrete design goals will be extracted from these and kept in mind through-out the design process, and be used to evaluate the proposed system at the end.

User scenarios

[1]The platform being integrated into during the evaluating experiments is currently still being designed, but is far enough the process that actual experiments are being conducted on this.

1. **Adding dispenser module to a platform**
   If a user has a laboratory platform and wants to increase the automation, she can easily integrate the dispenser with only a minor modifications.

2. **Different types of plates**
   To broaden the possible of the dispenser module, it must be able to handle different types of plates. The type of plates that are being handled, must be implicit chosen by the user or completely handled by the module.

3. **Adding/removing dish stacks**
   While a platform and the dispenser is running, it must be straight forward to add and remove stacks of dishes. The user shall not have to be concerned of the state of the dispenser, as the dispenser must adapt to the user's actions in runtime.

4. **Breakage**
   The module may of natural cause be worn and parts may break. When this happens, the parts must be easy and low-lost to replace.

Goals

- **Modularity** Able to attach/remove the dispenser module without any hassle
- **Versatility**
- **Usability** Easy to add/remove stacks of Petri dishes/wells Detects the platform layers automatically
- **Flexibility** Address different sizes of Petri dishes (including wells)
- **Repairability** Easy to create spare parts (low cost)

MECHANICAL DESIGN

As the proposed module shall be available to the largest amount of people, the design is based on open-source and non-specialized parts[2]. The choice of using open-source parts is too allow the user to either produce them by himself or acquire them elsewhere for a low cost.

To provide the reader with a better overview, the rest of this section will be divided into smaller sections, that each will describe one main part of the design, i.e. layer detection, the gripper and the dish containers. This description will include an iterative approach of improving each part. At the end, will be mentioned misc. small, but important design decisions.

TBD

Lægge vægt på at det er "normale" motorer Reference til GitHub

Overvejelser omkring fingre: 2 * 2: Udligne forskel ved greb Virker ikke da skæve brønde, kan bebeholde vinkel

Istedet fikserede greb: 3 stk

[2]The open-source parts are available around the world, but can be watched at **www.openbuildspartstore.com** and **www.pjrc.com/teensy**, which include the blueprints.

Gripping functionality

current product from industrial providers have gone for a squeezing approach Considered to add a small base to each dish as this would provide a distance between each dish, where a fork-shaped figure could go in an lift the base + dish. Rejected the idea because of the extra use of materials and the base would either had to be glued together (cut two pieces and glue these together to have a hole in the lower part which is a bit smaller than the dish) or when cutting the parts, the area could be engraved heavily to remove the upper half of the base

Detecting the distance to respectively the dishes, layers and platform (refer to other sections): Using US sensor No physical contact (good!!) IR sensor with filter Risk of getting to close (dishes/plates are often made of *transparent* glass/plastic) Lever switch Physical contact for sure

The detection of the different object should be done as close to the dispenser module, but with enough distance so the module itself won't be in risk of adding false measurements.

To create enough friction between the gripper and the dish, ideas of two semi-flexible U shaped figured was consider, but rejected as these might lift i.e. a plate of wells in an angled position - see figure xxx (provide a figure for this).

Another idea was to have a total of three "fingers", but where all of these were fixed, and therefore move the dish into a correct centered position before starting the lift. (See figure xxx)

As an initial test the gripper will be designed to carry several of the mentioned measuring equipments even though their functionality will address some of the same issues. In later iterations these least successful will be removed.

Layer detection

Endstop which can move up and down =¿ layer is at center/top of the "active" period

UltraSonic sensor at end of gripper (could be used for detecting dishes too)

Hall sensor =¿ same principal, but layer is where the value is the highest (Can be mounted at the inside of the plastic at the nearest horizontal layer)

Dish containers

Room for electronics in the bottom (and protected from liquids from above) Angled side + angled cuts to help align dishes that are removed from the platform Distance sensors on the top

Misc. design decisions

SOFTWARE DESIGN

TBD

Using a Teensy LC/Teensy 3.2 because of low cost and can performe at high frequencies Going for single threaded for starters..

Command	Description
d<stack number>	dispense a dish/plate from stack <stack number>
r<stack number>	remove dish/plate form platform and put it in stack <stack number>
c	calibrate
o	move to origo
l	get layer positions in mm
w	get width in mm
h	get travel height in mm
p	get current position in mm - format: (<width>,<height>)
s	get amount of dishes in stacks - format: Int array width dish amount for each stack. -1 if no stack in place

Table 1. Available commands and descriptions.

Aware of the limited space, which is why the system will take in a command and store this, but only in the last second transform a command into motions (figure?)

Created a queue for commands to be executed The commands can then be transferred from the host system to the dispenser to leave the dispenser less independent and the host doesn't have to store upcoming commands. This will make it easier to check upcoming motions and see if these can be executed simultaneously

An OK is returned upon every successfully executed command

Each command line is ended with a semicolon.

TESTING

Mechanical precision

TBD Uddybe hvad en reelt præcision er

Software testing

Different Teensies compared to amount of incoming data?

Integrated experiment

TBD

DISCUSSION

TBD Skal være en mere konceptuel diskussion (relatere til design goals)

CONCLUSION

It is important that you write for the SIGCHI audience. Please read previous years' Proceedings to understand the writing style and conventions that successful authors have used. It is particularly important that you state clearly what you have done, not merely what you plan to do, and explain how your work is different from previously published work, i.e., what is the unique contribution that your work makes to the field? Please consider what the reader will learn from your submission, and how they will find your work useful. If you write with these questions in mind, your work is more likely to be successful, both in being accepted into the Conference, and in influencing the work of our field.

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