Disc-shaped Point-of-Care Platform for Infectious Disease Diagnosis (DiscoGnosis)

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Summary

The DiscoGnosis project aims at developing a Point-of-Care (PoC) platform (LabDisk [1] and Player) able to detect on a single disposable several tropical diseases caused by different pathogens (viruses, bacteria, parasites) in full automation.

Motivation

Current status in infectious (tropical) diseases:

- High mortality due to malaria (in 2012: 207 million cases; 627,000 deaths, 80% of which in Africa [2])
- Many diseases with same clinical symptom as malaria
- Resource- and expertise-limited endemic regions

Current status in diagnostics:

- Microscope blood smear tests: gold standard but only malaria specific
- Rapid Diagnostic Tests (RDTs): cheap but detect only one disease
- PCR: sensitive but requires trained personnel & bulky, energy-consuming, expensive equipment

How DiscoGnosis fills the gap:

- Four-disease test: malaria, dengue, pneumonia, typho
- Automated centrifugal liquid handling
- Patient-to-disc interface & *in situ* sample preparation

Figure 1: The LabDisk and Player

Design

The main concepts to achieve sample-to-answer analysis with minimum external intervention are outlined below:

- Assay transfer from tube to disc
- Development & interface of microfluidic modules
- Nucleic acid- (NA) and immunoassays on one disc

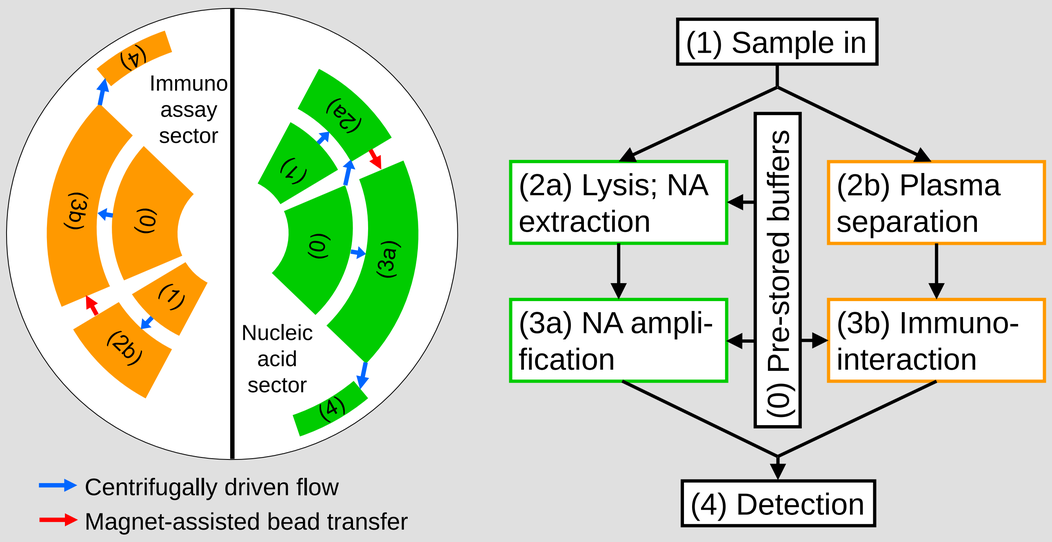
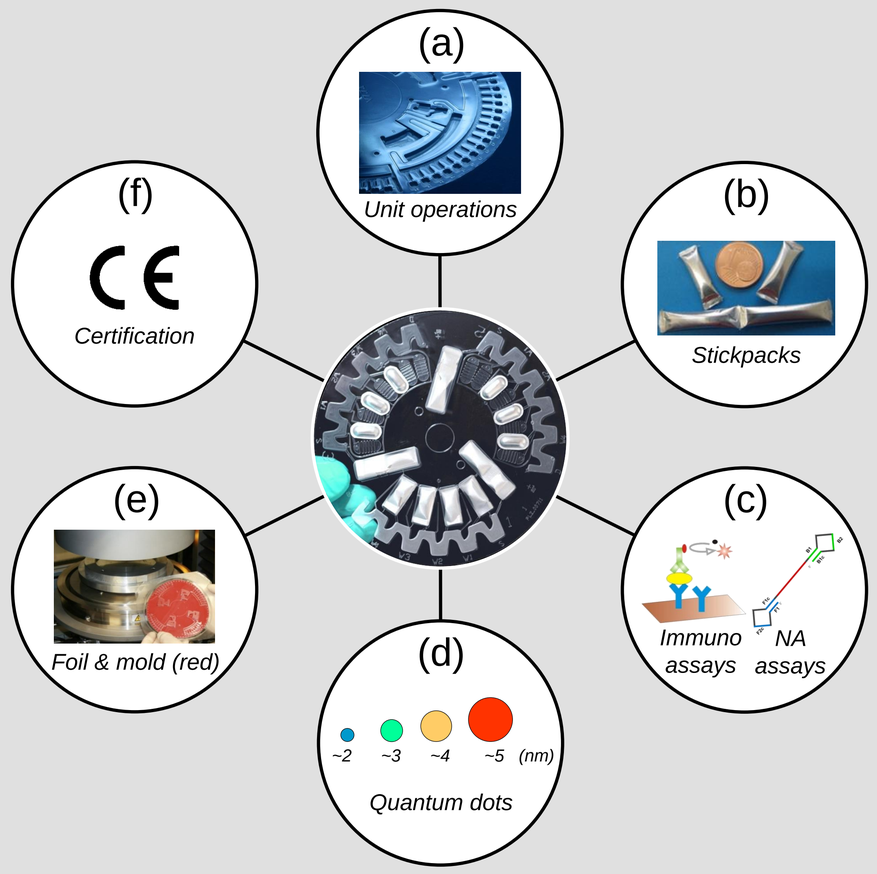


Figure 2: Disc-based process flow for nucleic acid- and immunoassays

Experimental

The DiscoGnosis key technological features:



a) Microfluidics: Unit operations serving a specific task (e.g., fluid transfer, mixing, valving, aliquoting).

b) Integrated components: (i) Blood transfer device for patient-to-disc interface; (ii) magnetic beads for sample purification; (iii) pre-stored reagents in dry/liquid form.

c) Bioassays: (i) DNA and RNA isothermal amplification (LAMP technology); (ii) antigen & antibody immunoassays.

d) Analytics: Quantum dot based fluorescence imaging with optical unit in the LabDisk Player.

e) Production: Microthermoforming of polymer foils adapted from macro- to microscale.

f) Quality control: (i) of tools and processes; (ii) of final platform: validation in Africa; comparison with gold standards.

Conclusions

The DiscoGnosis final prototype is expected to have the following operational features: (i) multiplexed detection; (ii) simple patient-to-system interface; (iii) sample in→result out automation. Its modular nature allows variable diagnostic panels and adaptation to needs imposed by specific endemic areas.

Acknowledgements

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References

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