"Benchmarks" for Digital Microfluidic Biochip Design and Synthesis

Fei Su and Krishnendu Chakrabarty

Electrical and Computer Engineering

Duke University

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Example 1: *Polymerase chain reaction (PCR) (mixing stage)*

Protocol of assay:

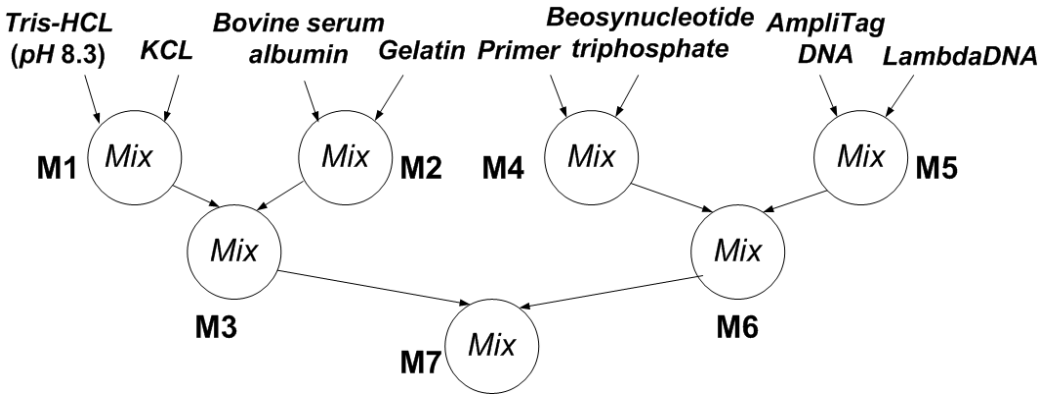

Figure 1-1: Sequencing graph for the mixing stage of PCR.

Module library:

Operation	Hardware*	Module	Mixing time
mixing	2x2 electrode array	4x4 cells	10s
	4-electrode linear array	3x6 cells	5s
	2x3 electrode array	4x5 cells	6s
	2x4 electrode array	4x6 cells	3s

*: Electrode pitch: 1.5 mm; Gap height: 600 μm

Results obtained using [ICCAD'04]

Table 1-1: Resource binding in PCR.

Operation	Hardware*	Module	Mixing time
M1	2x2 electrode array	4x4 cells	10s
M2	4-electrode linear array	3x6 cells	5s
M3	2x3 electrode array	4x5 cells	6s
M4	4-electrode linear array	3x6 cells	5s
M5	4-electrode linear array	3x6 cells	5s
M6	2x2 electrode array	4x4 cells	10s
M7	2x4 electrode array	4x6 cells	3s

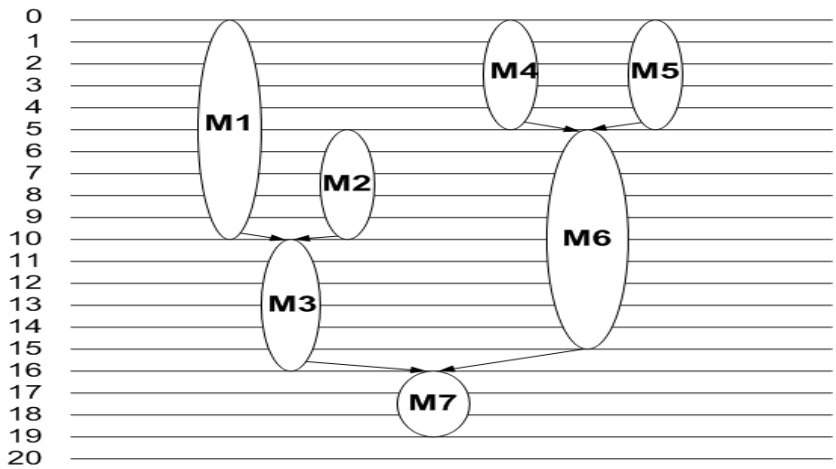

Figure 1-2: Schedule highlighting the usage of microfluidic modules.

Example 2: *Multiplexed in-vitro diagnostics*

Protocol of assay:

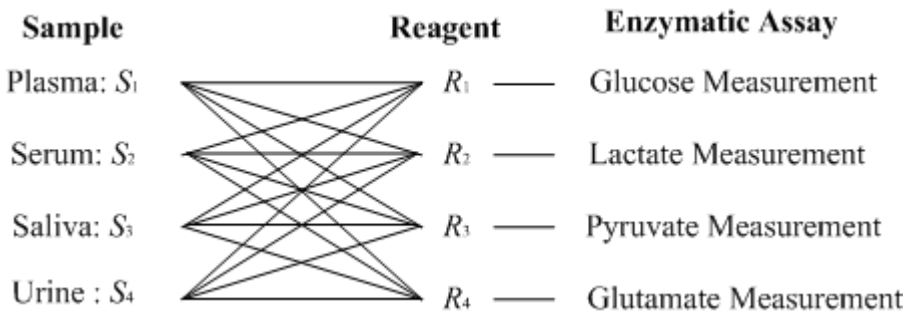

Figure 2-1: Behavioral modeling

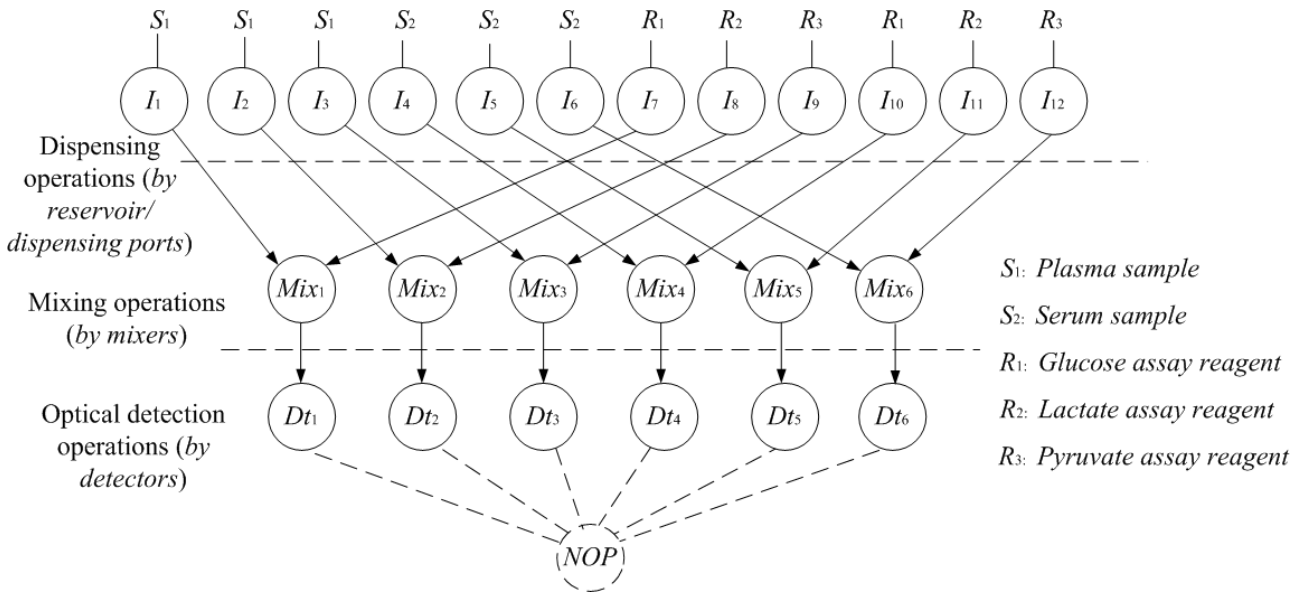

Figure 2-2: Sequencing graph model for multiplexed in-vitro diagnostics.

Module library:

Operation	Hardware*	Module	Mixing time
Mixing	2x4 electrode array mixer	4x6 cells	5s
Optical Detection	Optical detector for glucose detection	3x3 cells	10s
	Optical detector for lactate detection	3x3 cells	8s
	Optical detector for pyruvate detection	3x3 cells	13s
Storing	Storage unit	3x3 cells	N/A

*: Electrode pitch: 1.5 mm; Gap height: 600 μm

Results obtained using [ICCAD'04]

Table 2-1: Resource binding in multiplexed *in-vitro* diagnostics.

Operation	Hardware*	Module	Mixing time
M1	2x4 electrode array mixer	4x6 cells	5s
M2	2x4 electrode array mixer	4x6 cells	5s
M3	2x4 electrode array mixer	4x6 cells	5s
M4	2x4 electrode array mixer	4x6 cells	3s
M5	2x4 electrode array mixer	4x6 cells	3s
M6	2x4 electrode array mixer	4x6 cells	3s
M7	Optical detector	3x3 cells	10s
M8	Optical detector	3x3 cells	8s
M9	Optical detector	3x3 cells	13s
M10	Storage unit	3x3 cells	N/A
M11	Storage unit	3x3 cells	N/A

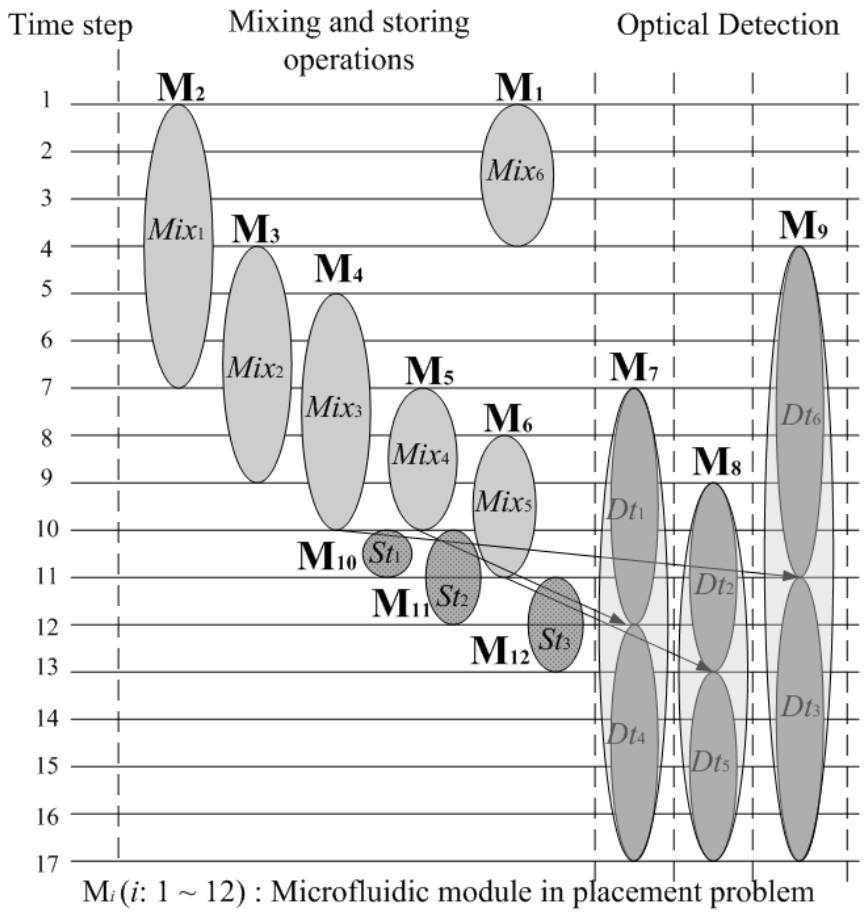

Figure 2-3: Schedule highlighting the usage of microfluidic modules.

Example 3: *Protein Assay*

Protocol of assay:

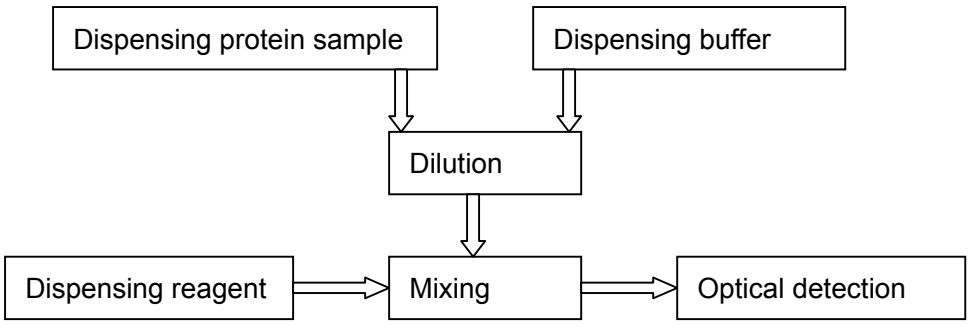

Figure 3-1: Behavioral modeling

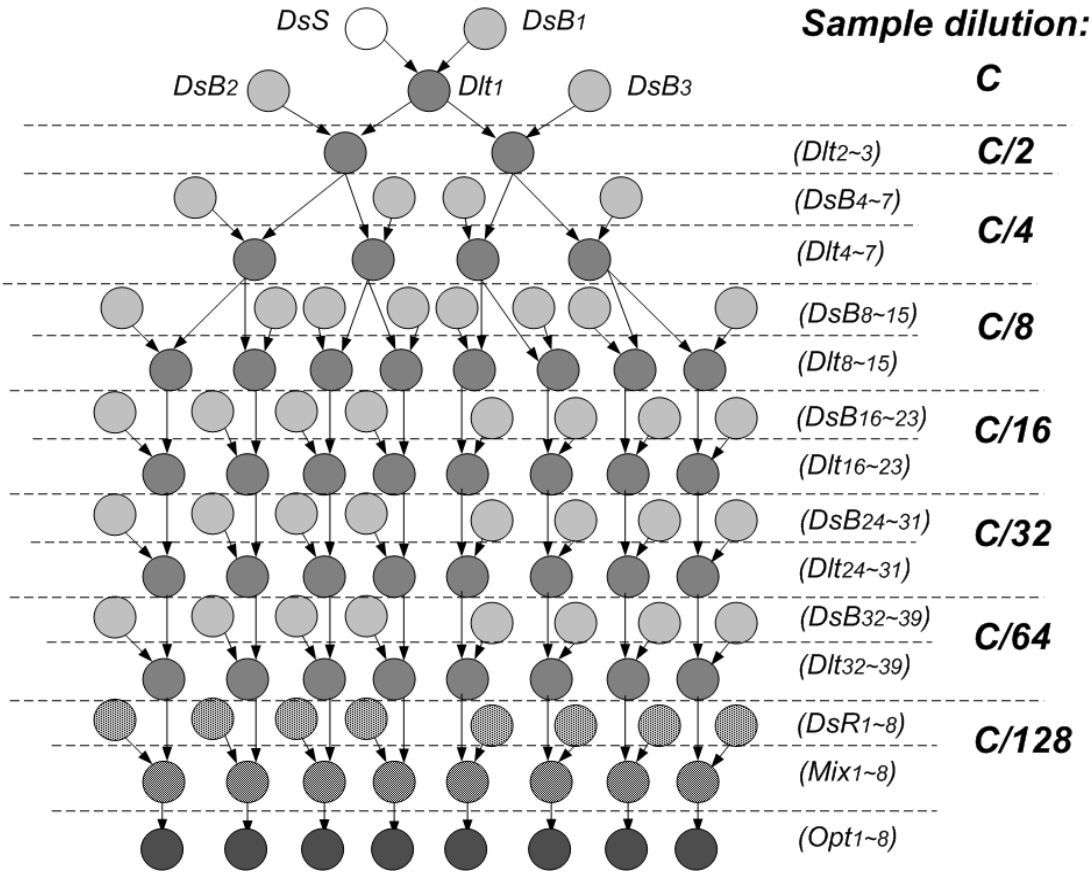

Figure 3-2. Sequencing graph for a protein assay.

Module library for synthesis.

Operation	**Resource**	**Time (s)**
DsS; *DsB*; *DsR*	On-chip reservoir/dispensing port	7
Dlt	2x2-array dilutor	12
	2x3-array dilutor	8
	2x4-array dilutor	5
	4-electrode linear array dilutor	7
Mix	2x2-array mixer	10
	2x3-array mixer	6
	2x4-array mixer	3
	4-electrode linear array mixer	5
Opt	LED+Photodiode	30
Storage	Single cell	N/A