Notizen

1 Abstract

- overview over conventional biosensors
- possibilities, challenges of the new idea
- how the idea works

2 multiple biochemical coupling of signal processing with chemical actuators

- prospects
- fundamental and practical challenges
  - attention to composition, preparation and immobilization of the biocomputing surface layer
  - sucess depends in part on immobilization of the biocomputing reagent layer
  - system scalability
  - efficient transduction of the output signals
- high fidelity

3 common biosensing devices

- based on single input (analyte)

4 Layers

5 begriffe

unconventional computing = quelle

6 Chemical computing

- processing information by chemical means
- single logic gates (mimicking Boolean) to small logic networks

7 biocomputing

- biomolecular systems for processing chemical information
- more complex than nonbiological systems

8 overview of the evolution of biomolecular systems

- general concept
- multisignal digital biosensors processing complex pattern of different physiological markers
- practival considerations
- challenges

8.1 motivation

- common biosensing devices
  - single input
- multisignal logic gates /biochemical logic systems /biocomputing sensor systems

  Beschreibung

  - multiple target analytes(inputs) (enzymgates)/biochemical inputs
  - high-fidelity biosensing compared
  - rapid and reliable assessment of physiological condition (enzymes + automatically provessing)
  - optimal timely therapeutic intervention

- overviw of the novel research paradigm of digitally operating biosensors logically processing multiple biochemical signals through Boolean logic networks composed of biomolecular systems

- realization of closed-loop systems (sense/act/treat)

Chancen

- biomedical monitoring(example, closed-loop-¿ patient tailored timely therapy, personalized medicine= sensing devices + delivery devices)
  * closed-loop -¿ patient tailored timely therapy possible
  * sensing devices + delivery devices = personalized medicine
  * example feedback-loop: diabetes: electrochemical glucose sensing element + insulin-delivery feedback loop
  * fast delivery in emergencies
- environmental monitoring
- national defense
- food safety

8.2 enzyme logic gates

- coupling enzymatic reactions (logic gates) with electronic transducers and signal-responing materials

- examples
  1

  - glucose oxidase and catalyse operating as logic gates:
  - input : H2O2 and glucose
  - gluconic acid = biocalatyltic oxidation of glucose
  - only when both present opical output signal. = AND
  - define logic values: small changes = 0 and large absorbance changes as 1 =¿ AND
  - similar possible with XOR,AND, OR, NOR, INHIBIT

  - with logic gates with modular structur that enables therir assembly in networks NAND/ NOR possible

2

  - pH changes in solution as logic respones to input signals
  - AND invertase + glucose oxidase (from 5.8 to 3.5)
  - OR ersterase and glucose oxidase in glucose and ethyl butyrate - when one of both present -¿acidification
  - neutral ph = 3,5

Conclusion:

  - don't solve real computing problem nor operate as useful biosensors
  - represent first step toward the development of digital biosensors
  - funfact optimization of enzymatic reaction, up to 10 logic gates concatenated with low noise in the system

8.3 Enzyme logic circuits-scaling up the system complexity

- main challend: scaling up the complexity of the systems by networking the individual parts of a logic circuit
- addressed experimentallly when designing networks composed of concatenated enzyme logic gates
- assembled logic networks analyzed theoretically for opimization and noise reduction; coupling output signals with electronic transducers and bioelectronic devices

8.4 Biomolecular logic gates designed for biomedical analytical applications

- logic gates and their networks = biomolecular information processing systems
- =¿ biosensoric systems with logically processed signals represented by various biomarkers(characteristic of different abnormal physiological conditions)

- problems not addressed yet:
  - logic 0 values were defined as the absense of the enzymes
  - logic 1 not always correspond to the concentration expected in vivo /not normal physiological concentrations
  - input not justifies to their biomedical meaning

8.5 ENzyme logic system recognizing various injury-related physiological conditions

- types of injuries result in concentrations of chemical substances in the body
- example: lactate axidase, horeserasish peroxidase and glucose dehydrogenase = designed to process biochemical information related to pathophysiological conditions from brain injury
- markers: glucose(hemorrhagic shock),lactate(rhagic shock or traumic brain injury) and norepinephrine(traumatic injury)
- logic 0 = normal concentrations
- change results into different numbers 1,2,3 - convenient
- = biocomputing logic system
- challenge: difference between normal and unnormal minimal =¿ not linear, should be sigmoidal

8.6 hardware

9 Aufbau

- Abstract: Biosensoren, logic gates, possibilities, challenges and future work
- introduction Definition, possible fields(examples), special,... loops
- The idea Theory and practical
- Two examples

- Layers, challenges and future work
- conclusion