Novel smart concepts for designing swimming soft microrobots

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MOBILE MICrorOBOTICS

Potential applications

• navigation in very narrow spaces and micro-structured liquid environments
• in vivo tasks for diagnosis and therapy in inaccessible districts of the human body (e.g. central nervous system and cardiovascular system)

Core issues

• what kind of motion is more adequate to the target working environment (propulsion)
• how can this motion be implemented (actuation)
• what kind of power source can be exploited (power supply)

Cheaper, less painful and more flexible surgery

Nowadays most pursued approach

• direct propulsion by means of an external source of energy (e.g. magnetic field)
• dramatic simplification of microrobots design and fabrication
• complex and cumbersome external steering systems
• limited possibilities to implement additional features

NOVEL DESIGN APPROACH

Smart microrobots

• systems expressing a high degree of integration of the different functionalities they implement at several levels of task accomplishment
• smart behaviors provided by the intrinsic passive and/or active properties of the robot per se
• proper selection of materials and microdevice intrinsic architecture

Our vision: microrobots

• autonomously navigating in human body environments
• spontaneously reacting to specific environmental conditions in order to perform predetermined tasks
• exploiting environmental chemical energy to power-supply embedded actuation systems

Bioinspiration

Smart concepts for designing swimming soft microrobots

First objective

Movement in liquid and delicate micro-structured environments

• implementation of passive properties of interest in near-spherical microdevices representing a starting body structure for building our microrobots
• investigation on how different reactions to external fields (stimuli) can be implemented by properly selecting materials and controlling their confinement in the structure

Preliminary Results

Softness

• hydrogel structure
• safe navigation in confined areas and ducts

Neutral buoyancy

• low density component in the structure
• complex external gravity compensation strategies avoided

Fabrication process

• fast & simple
• inexpensive
• low cost materials
• no special facilities required
• scalable
• microdevices ranging from few millimetres to few tenths of microns in diameter

REFERENCES