Sensors on the move. Inoculated Sensing Automata for the Early Detection of Endogenous Diseases

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Effective therapy takes a major advantage from early detection of pathological conditions. Standard screening policies may however be insufficient in this respect, especially when the delay between marker appearance and life-threatening conditions is short (e.g.: vascular diseases, neoplasias). We will discuss how inoculated swarms of automata with a sectional area of order $10 - 100\ \mu m^2$ (i.e. comparable to that of erythrocytes) can be devised, acting as an early warning system toward endogenous diseases. That such a view is neither unphysical or simply speculative may become clearer considering that nanoprobes with a size in the 10-nm range can be currently built, enabling detection of metabolites. At the same time, technology exists to manufacture information processing devices with a component density in the range $10^2 - 10^3\ \mu m^{-2}$, making $10-\mu m^2$ automata powerful enough to collect and process the information provided by their nanoprobes. Thus, times appear to be mature for automata to be built integrating sensing, computing and communicating systems with nanomechanics, taking advantage of the fact that all such devices share the same base material (silicon) and are manufactured with compatible (if not the same) technology.

In this talk the key issues connected with the making of nanometric smart and mobile sensing automata (*nanobots*) will be reviewed, showing how they can be envisaged to side up the immune system in the detection of endogenous diseases spanning from cancer to neurodegenerative syndromes, enabling therapy to attack diseases at their early stages.

Of the many issues connected to the prospective − yet realistic − manufacture of such devices, we will focus on the issue of nanobiosensing. Techniques based upon 1D systems will be shown to meet the required characteristics of size, sensitivity and selectivity, acting as an almost ideal platform for the detection of the more diverse metabolites. Use of semiconductor nanowires (including but not limited to silicon) and of carbon nanotubes will be discussed. A special emphasis will be given to their preparation, that is currently stepping up from the laboratory scale to manufacturing. Examples of recent applications both suitable for nanosensing or actually deployed to intracellular sensing will be reported and commented − along with possible scenarios that could sensibly contribute to bring forth nanobots.

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