COMPUTATIONAL NANOROBOTICS: AGRICULTURAL AND ENVIRONMENTAL PERSPECTIVES

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In this paper we present an innovative approach to evaluate hydraulic conductivity, considering nanorobots as a paradigm capable to open new perspectives in the field of hydrology monitoring. The application of nanorobots for agricultural purposes and monitoring water and soil qualities may result in impressive impact towards environmental control and decreasing the damages caused by pollution to many different natural species. Over the past 15 years, we have gained insight into the hydraulic conductivity of fractured and karstic rocks by introducing particles of different size, charge, and chemical composition into a flow field and monitoring the breakthrough of these particles in space and time. From this information, we may infer the hydraulic aperture of the smallest throats in a flow path. Therefore we may be able to extend this concept to porous media using nanorobots [3]. We describe a computational approach for the investigation of nanorobots [2] to enable a better visualization of hydraulic conductivity of aquifer systems. The nanorobots are using chemical gradients over short distances along specific flow paths to solute integrated estimates of hydraulic conductivity. This information is quite useful to define geological characteristics, which are at most important when agricultural management or environmental disasters arises requiring efficient decisions in short time.

Geophysicists have held out hope of ways to describe hydraulic conductivity distribution with new analytical and detection methods and yet, we are little closer to the illumination of this Holy Grail than we were 40 years ago. The limitation of geophysical methods falls into two categories. First, there is a limitation of direct measurement on the size of the features we are looking for (pore throats). These small features require a short wavelength and thus high energy for resolution. Unfortunately, energy is rapidly dissipated in travel through earth material, generally resulting in degraded resolution at the desired scales. This wavelength/energy constraint is fundamental and cannot be overcome. Second, because geophysicists are unable to directly measure the feature of interest, they measure a surrogate of pore-throat sizes. That is, typical geophysical methods measure properties of waves, density, or electrical conductivity, which is used to generate lithologic information.

To achieve this aim, the nanorobot model is comprised by embedded electromagnetic sensing devices. Data from these sensors, when combined with a nano–positioning system for four-dimensional reference location, could either be stored in memory that could be downloaded after capture of the nanobots at some distance along the flowfield or be accessed by a signal from the surface, defining this way preferential flow paths. Such approach could be used even for tracking distinct materials - oil, uranium, or gold, just to quote a few. The nanorobots hardware feasibility may be observed as the result of most recent advances in a broad range of manufacturing techniques [2]. Inside the miniaturization trends, we may even quote some examples such as VLSI chips, including here CMOS based on currently technology, which could be observed as one possible way for manufacturing molecular machines with embedded control computation in near future [1]. Meanwhile these manufacturing methodologies may advance progressively, the use of computational nanomechatronics and virtual reality could help in the process of transducers investigation. Thus, this work aims to outline the ways to control and to prepare the use of nanorobots for upcoming applications which may concern agricultural and environmental issues.

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