Chapter 2
A Brief Insight into Nanorobotics

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ABSTRACT

The construction of a practical nanorobot is a definite futuristic reality. However development of a Nanorobot is associated with a multitude of challenges and limitations related mainly to its control and behavior aspects in different dynamic work environments. In this chapter a novel Nanorobot movement control algorithms in dynamic environment has being introduced. To avoid obstacles during movement trajectory, swarm intelligence based approach and for sensing, path planning, obstacle avoidance and target detection of nano-robot Quorum and RFID based approach has been utilized. Major proportion of work has been done on Microsoft Robotics Developer Studio 2008 (MSRD, 2008) along with two kinds of programming environment VPL and SPL. The chapter also includes a description of how nanorobotics technology has been applied in medical field. In this context, a non invasive method to treat a brain blood clot using nanorobots has being explained. Various other aspects of application of nanorobots has also been briefly mentioned.

INTRODUCTION

Richard P. Feynman once said "A friend of mine (Albert R. Hibbs) suggested a very interesting possibility for relatively small machines. He says that, although it is a very wild idea, it would be interesting in surgery if you could swallow the surgeon. You put the mechanical surgeon inside the blood vessel and it goes into the heart and looks around (of course the information has to be fed out.) It finds out which valve is the faulty one and takes a little knife and slices it out. Other small machines might be permanently incorporated in the body to assist some inadequately functioning organ.".However conventional techniques of robotics were found incapable to assist in the diagnosis and cure of cell or molecular scale diseases like cancer or cardiac diseases. This called for the development of nanoscale robots which can perform medical operations inside human body with nanoscale precision.

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Nanotechnology based robots namely nanorobots have enabled science to associate with engineering activities at the cellular level. Nano-sized nanorobots can investigate any biological environment (cell culture or human body) at the microscopic level. For example treatment of medical conditions such as cancer and thrombi can be done by following a temporal pattern and employing definite artificial intelligence based methods to find the affected region in the body. Future medical nanotechnologies have been imagined to employ nanorobots injected into the human body to perform treatment on a cellular level. Every nanorobot placed inside the human body will encounter immune system as an obstacle while circulating within a human body. Thus nanorobot must formulate a strategy to avoid and bypass such immune system. To avoid obstacles during movement trajectory, swarm intelligent based approach and Quorum and RFID based approach for sensing, path planning, obstacle avoidance and target identification of nano-robot has been also proposed in this chapter. Today, nanorobots have found a wide application in a spectrum of medical treatment technologies. Moreover since Nanorobot have to work in a human body based environment, numerous additional requirements in size, reliability, efficiency, security and bio-computability are essentially required. This will enable it to access capillary vessels and cells; deliver drugs quantitatively at desired positions, repair cells and gene. While these nanorobots have not being fabricated yet, a study of the theoretical and simulation aspects for defining design strategies, capabilities, applications and limitations alongwith an innovative algorithm for movement control have been discussed comprehensively in this chapter.

The most recent applications of nanorobots in medical treatment include treatment of brain blood clot (clot in brain blood vessel) and has been discussed briefly in this chapter (first nanorobot movement control algorithm was described by Cavalcanti, A., et.al (2004)).

In the present chapter:

- Section 2 describes how Nanotechnology and Bionanotechnology support a broad range of scientific disciplines and engineering.
- Section 3 presents nanorobot design, in which all the components have been described with their individual working in a nano environment.
- Section 4 describes nanorobot movement control algorithms in dynamic environment.
- Section 5 describes MRDS 2008 which is a 3D simulation tools for simulating Nanorobot control and movement.
- Section 6 presents a non invasive method to treat brain blood clot through nanorobot.
- Section 7 describes the summary of the work, state its major contributions, and hints on future directions.

NANOSCIENCE AND NANOTECHNOLOGY

Nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale.

Nanotechnologies are the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometre scale.The prefix of nanotechnology derives from ‘nanos’ – the Greek word for dwarf. A nanometer is a billionth of a meter, or to put it comparatively, about 1/80,000 of the diameter of a human hair. The size-related challenge is the ability to measure, manipulate, and assemble matter with features on the scale of 1-100nm. Nanotechnology, in its tradi-