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Conceptual design of nano-robotics for carrying the radioisotope material in nuclear industry

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ABSTRACT

Nano-robotics is introduced for the nuclear industry for radiation treatment as a complete cure of cancer because it leads to the removal of cancerous cells. In order to ensure the reliability of treatment, one needs to control the radiation behavior of the therapy. The omni-directional cancer treatment program (OCTP) is suggested for the therapy planning in which all cancerous cells are killed without damage to normal cells. This is one of the most important issues in the conventional radiation therapy planning. The clinical cancer therapy planning is performed by nanorobots. The tiny machine treats the cancer cells effectively. The collision event occurs approximately over 35 nm. Therefore, if the diameter of tumor is 1 cm, the curable length is about 5 nm. Thus, one movement of nanorobot radiates about 10 nm in two dimensional planning. The example organ in this study is the breast. Nanorobots enter from the upper side of breast and exit from the lower side of the breast in the clinical example.

1. Introduction

Following the highly advanced robot technology pursuit, the nanoscale robot is investigated for the nuclear engineering and radiological industry. Nano-robotics is introduced for the radiological treatment where the complete cure of cancer cell removing is accomplished. Although there are several difficulties to make the nanorobot in current technology, it is imaginable to challenge for the revolutionary technology in the radiation industry. The purpose of nanorobotics in radiation therapy is to remove the cancer cells without any damage to normal cells. It is not easy to make such treatment due to the very tiny size of the molecular level substances of biological cells. In addition, the important thing is to get to the targeted cancer cells containing the radioactive material. Hence, the solution of these matters is to use the intelligent robot carrying the radioactive material. The size of robot is smaller than the cells of molecular lumps and the radioactive material is a size of molecules. In order to make sure the reliability of treatment, one needs to give the radiation behavior of the therapy. The omni-directional cancer treatment program (OCTP) is suggested for the therapy planning in which all cancer cells are killed without the damage to normal cells. This is one of most important things in the conventional radiation therapy planning.

In the stage of nanorobot fabrications in the industrial applications, it is also thinkable to make the manufacturing of the nanorobot which can be done by three dimensional (3D) printing technologies for the mass productions, because it is impossible to make it by the individual manufacturing. So, the programmed fabrications are necessary. Fig. 1 shows the anticipated configuration of the movement for the nanorobots. The nanorobot has two tails which would supply the moving power with the actuator. It moves like the tadpoles with the similar size of bacteria and the two tails have a role for the direction changes without the circulations. The nanorobot has the sensing equipment where the small sized detecting system would be installed inside of the nanorobot body.

There were some applications for carrying radioisotopes in radiation therapy. It is not easy to use the molecular level or the single atomic level particle to make use of the radiation therapy in the patient. However, the rapidly developing nanoscale technology could make the dreaming therapy planning be possible in the clinical and commercial purposes. Eventually, the fully curable therapy method would be constructed. Usually, the cancer therapy by radiological purpose has two kinds of type as the radioactive material is used as external and internal of body. The nanorobot is used in the body, which is different from the radiation exposure therapy using some radioactive beams of X-ray, electron beam, or heavy ion beams.

There are some literatures for relevant topics. Zhang et al. (2006) worked that the radiation isotopes are delivered to the

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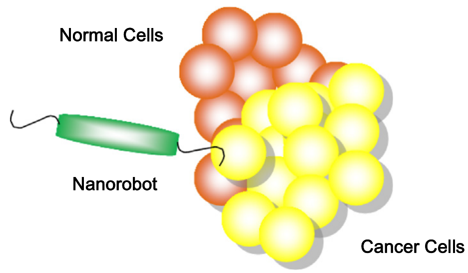

Fig. 1. Configuration of nanorobot and human cells of normal and cancer state as the molecular shapes. This shows the figure for the moving nanorobot in the cells where the human cells of normal and cancer state as the molecular shapes are described.

cancer target for therapy in which the monitoring and clinical applications have been done. Gruaz-Guyon et al. (2005) studied that antibodies incorporated with small radio-labeled molecules are effective together to treat the cancer cells in which the clinical purposes are immunoscintigraphy and radioimmunotherapy. Mairs and Boyd (2003) performed that the radioactive particles are used to seek the tumor in the patient by amalgamation of gene transfer in which the radiation therapy is used for the cancer target strategy.

There is a background of the study in Section 2. The Section 3 explains the method of the study. The Section 4 describes results of the study. There are some conclusions in Section 5.

2. Background

The history of robotics is back to the ancient era. There were many ancient mythologies in which artificial people were shown as the mechanical handmaidens that were made by the Greek god Hephaestus (Gera, 2003). After that, there have been many kinds of automatic machines. In the modernized systems, the remote controlled systems and the humanoids are frequently introduced. In the early 1870s, John Ericsson, John Louis Lay, and Victor von Scheliha made the remote controlled torpedoes (Gray, 2006). In 1921, the robot was used first by the Czech writer, Karel Čapek who used the Czech 'robota' as a meaning of servitude (R.U.R., 1920). In the scientific fiction movies, the humanoid robots are showing amazing adventures. Although the roles of the robots are substituting with the human works, the power and functions are overwhelming than those of the general human. Heavy weighing or flying fast is the exampled behavior of designed robots.

In this study, the nanoscale sized robot is a topic. The nanoscale stuffs are created by modern scientists. Following Feynman's theoretical talk (Feynman, 1959), the nanotechnology has been developed in many areas including the medical purposes. Nanoscale machine is the very tiny stuff as small as the molecular size. So, it can enter the biological organ effectively and easily without any obstacles like the antibody response, because the size of the nano-machine is smaller than the antibody's size. If there is any antibody response, the nanorobot can get out of the antigen–antibody reaction. For the medical considerations, there could be patient's symptoms which could be studied in clinical aspects. There are some more applications using nanorobots. In the medical treatment, the drug carrier (LaVan et al., 2003; Zyga, 2007), surgical task (Leary et al., 2006), diabetes monitoring (SPIEDigitalLibrary.org, 2007), and so on.

The automatic robot has been used in the industry in substitutions with the workers for preparing the dangerous or dirty tasks. There are some examples for industrial and medical applications for the patient treatments. Zhang et al. studied the dynamical simulations for the welding robot in which the new simulation code package was introduced and possible applications were introduced (Zhang and Zhang, 2014). In the medical application, Jonathan et al. worked that robot-assisted laparoscopic hysterectomy, right gonadal biopsy, and bilateral orchiopexies were performed without incident (Jonathan and Michael, 2014). The home care of robot was investigated by EU project ACCOMPANY for exploring the memory visualizations (Ho et al., 2013).

In addition, there are some industrial applications in the modern society. The simulations of the robot have been used for the physical operations substitutions. The RoboLogix is used to save the time and increase the safety level, because it can be done before the real operations of the system (Brumson, 2009). The real-time computing by RoboLogix for the simulations by robotics is performed for the geometrical and kinematical designs in which the 'what if' scenarios used (Robologix software package, 2009). From the International Federation of Robotics (IFR) study World Robotics 2012, the operations of industrial robots were about 1,153,000 and could be reached to 1,575,000 by the end of 2015 (Worldrobotics, 2014).

3. Method

3.1. Radioactive particle

The radiation isotope is Au-185 which has shout half-life of 4.25 min and 5.18 MeV in Fig. 2. Since this half-life is quite short, it is necessary to make the therapy planning meticulously. This produces the alpha particle and shows the Bragg-peak distributions.

3.2. Design of radioactive particle installation

Radiation isotopes are installed in the nanorobot and it is shielded by cover until it reaches to the cancer tumor. Then, the cover opens and the radiation exposes to the tumor cells. It is need-

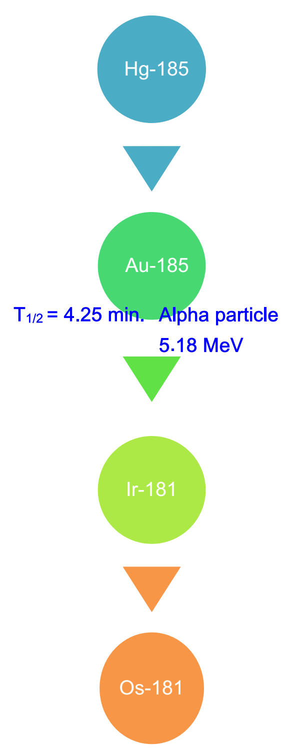

Fig. 2. Simplified process for the decay chain of Au-185. This is the scheme for the Au-185 decay as the simplified configuration for the easy understanding.

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