Robotics and Bioinformatics in the Healthcare Industry

Ahmed H Mahamad
University of Minnesota
Rochester MN

INTRODUCTION

As a student pursuing a career in medicine I thought it would be necessary to understand the fundamentals of computer science and technology. According to the New Jersey Institute of Technology, "Computer science is the study of information: its structure, its representation, and its utilization. This includes the theory, analysis, design, efficiency, implementation, and application of computer programs (software) and computer equipment (hardware) for developing computerized information processing systems in response to users' needs."(Information Processing Systems, para.3) In order to become fully successful, I must prepare myself for a future where technology is commonly used. Today, medical institutions are transitioning to technologies such as robotics and bioinformatics. My paper will present topics regarding robotics and bioinformatics, along with how they connect to Computer Science and modern medicine.

ROBOTICS

Robotics will be divided into three parts, the history of robotics, the application of robotics, and the potential of robotics. According to the *Merriam-Webster Online Dictionary* a robot is " 1 a : a machine that looks like a human being and performs various complex acts (as walking or talking) of a human being; *also* **:** a similar but fictional machine whose lack of capacity for human emotions is often emphasized b **:** an efficient insensitive person who functions automatically 2**:** a device that automatically performs complicated often repetitive tasks 3**:** a mechanism guided by automatic controls."(Robots, para.1)

History of Robotics

According to the University of Texas at Austin in the Robotics Research Group "The word 'robotics' was first used in "Runaround", a short story published in 1942, by Isaac Asimov (born Jan. 2, 1920, died Apr. 6, 1992). I, Robot, a collection of several of these stories, was published in 1950." (First use of the word 'robotics', para.1)

Asimov made the four laws of robotics, **"Law Zero**: A robot may not injure humanity, or, through inaction, allow humanity to come to harm. **Law One**: A robot may not injure a human being, or, through inaction, allow a human being to come to harm, unless this would violate a higher order law. **Law Two**: A robot must obey orders given it by human beings, except where such orders would conflict with a higher order law". **Law Three**: A robot must protect its own existence as long as such protection does not conflict with a higher order law"(Three Laws of Robotics, para.1).

Application of Robotics

Robots can be used in many ways such as industrial, astronomical and mechanical applications. One of the best applications of robotics is in the field of medicine. Today robotics can help physician's complete surgical tasks. The best robot widely used today to do surgical procedures is the Di Vinci robot which was approved by the FDA at the start of the millennium. According to the *Division of Biology and Medicine* at Brown University, "There are four main components to Da Vinci: the surgeon console, patient-side cart, EndoWrist Instruments, and Insite Vision System with high resolution 3D Endoscope and Image Processing Equipment"(System Overview, para.1).

Surgical console

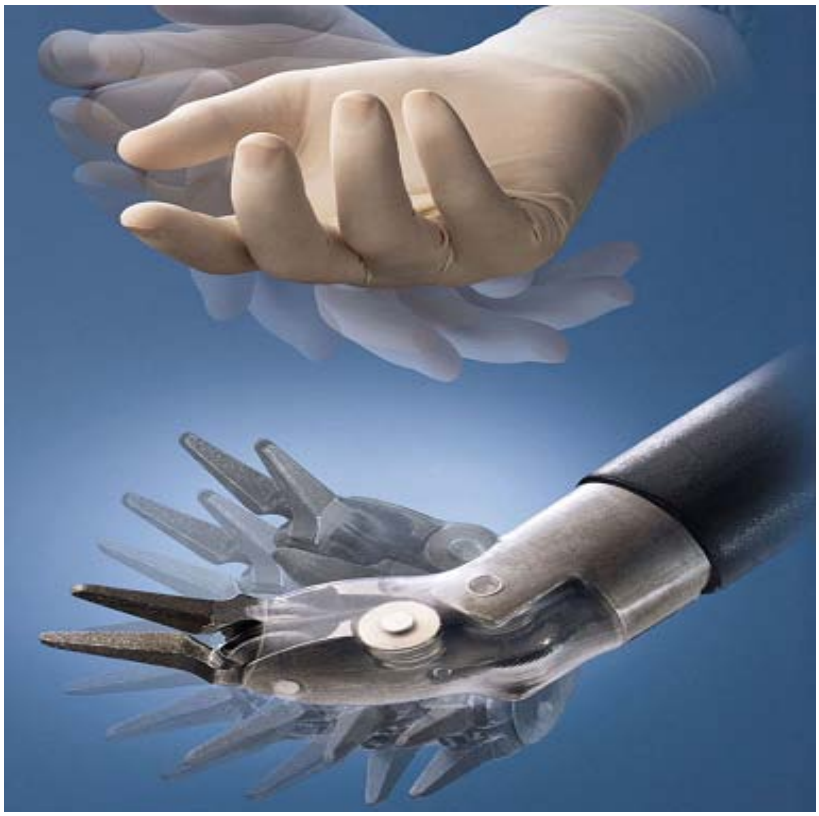
The surgical console allows the surgeon to use the instruments to move within a cubic foot area of work space. According to intuitive surgical the makers of the Divici Surgical Robot, "The system seamlessly translates the surgeon's hand, wrist and finger movements into precise, real-time movements of surgical instruments inside the patient."(Surgical console, para.3) It allows the surgeon to make safe operations due to the precision of this robotic machine. The best thing about the surgical machine is the ability to make real-time movements which can enhance the success of the surgery, and that is an important aspect when using a robot.

Patient side cart

This cart contains the robotic arms that directly contact the patient. Intuitive Surgery, the makers of the Da Vinci surgical robot, state that the patient side cart, “Provides either three or four robotic arms—two or three instrument arms and one endoscope arm—that execute the surgeon's commands. The laparoscopic arms pivot at the 1-2 cm operating ports, eliminating the use of the patient's body wall for leverage and minimizing tissue damage. Supporting surgical team members assist in installing the proper instruments, prepare the 1-2 cm port in the patient and supervise the laparoscopic arms and tools being utilized.” (Patient side cart, para.1-4). This sophisticated part contributes significantly to the process of the surgery. The medical staff can move these parts to their designated areas preventing errors.

Endo Wrist Instruments

These instruments are interchangeable and allow movements that are similar to that of the physician’s hands. These parts are used at different times throughout the surgery. This provides the surgeon with more options of movement rather than limitations. It allows the surgeon to operate on any part of the patient, thanks to the options of the Endo Wrist Internments



Insite Vision System

The Insite Vision System is the camera unit that shows the images of the patient. According to the Division of Biology and Medicine at Brown University “The system provides over a thousand frames of the instrument position per second and filters each image through a video processor that eliminates background noise. The endoscope is programmed to regulate the temperature of the endoscope tip automatically to prevent fogging during the operation” (Insite® Vision and Navigator Camera Control, para.1).

The Potential of Robots

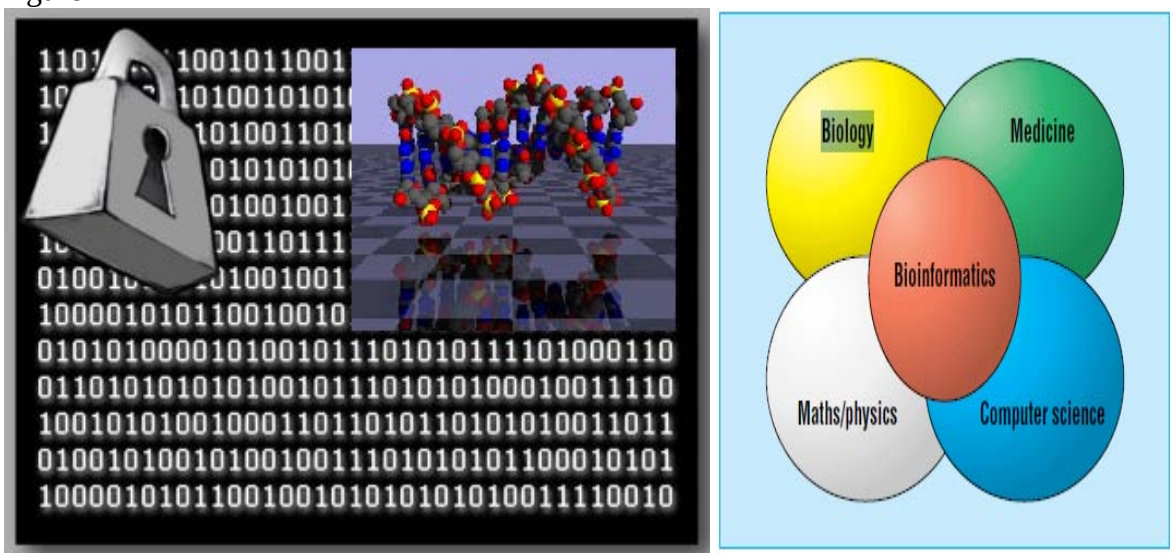
According to Dr. Yulun Wang the Founder and Chief Technical Officer of Computer Motion, Inc., and the leading expert in the field of medical robotics, the potential of robotics is “best measured by superior patient outcomes. Advancement in robotic technology and products should therefore be continually examined from this perspective” (Wang). Thanks to computer science the field of medicine in the future will excel because of robotics.

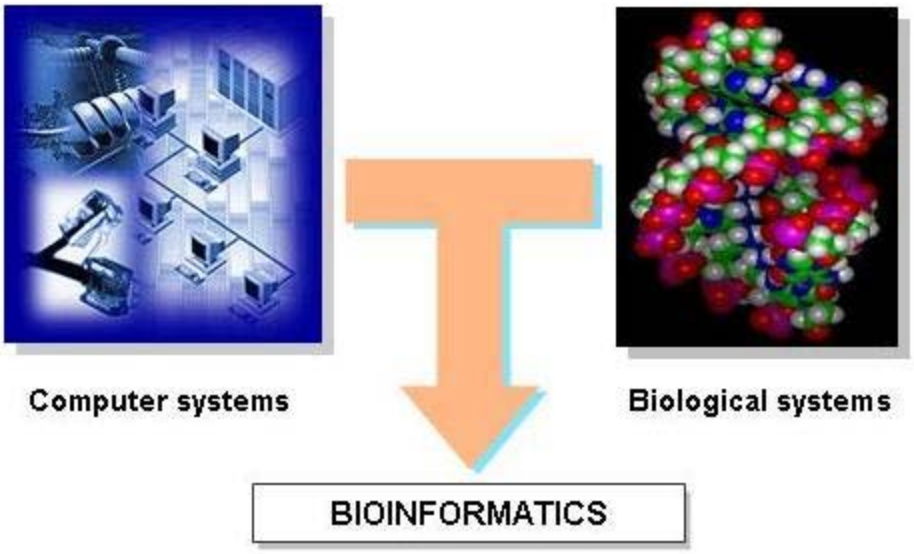
Bioinformatics

Bioinformatics involves disciplines from four core subjects, computer science, biology, Medicine, and Math/physics. Ardeshir Bayat, a Medical Research *Center fellow*, best provides the definition of bioinformatics “Bioinformatics is defined as the application of tools of computation and analysis to the capture and interpretation of biological data. It is an interdisciplinary field, which harnesses computer science, mathematics, physics, and biology fig 1. (Bayat, 1018)” it is very important to understand the human genome. One of the best ways to

understand the human genome is by compiling all of the genes. Once the data is complied the information will be proceed using massive databases. In order to use a database you must have people who are experts in data processing. The medicine and computer science departments will share ideas on how to map the human genome. According to an interview I had with Barbara A. Koenig, Ph.D. a professor of Biomedical Ethics & Medicine at Mayo Clinic College of Medicine, “The cost of genome sequencing (based on "hi throughput" genomic analyses) is going down. The real costs in the system in the future will be the bioinformatics related expenses, figuring out how exactly particular genes are associated with disease and eventually with outcomes of interventions.” The field of information technology would interconnect with the field of medicine to advance the potential of world. A picture is worth a thousand words, the image below shows how the intersection of computer science and biological systems brings about the field of bioinformatics.

Figure 1




Computer systems
Biological systems
BIOINFORMATICS

References

Bayat A. Bioinformatics: science, medicine, and the future *BMJ* 2002; 324: 1018–22

Information Processing Systems. (n.d.). *NJIT: New Jersey's Science & Technology University*. Retrieved March 19, 2010, from http://www.njit.edu/v2/archivecatalog/undergraduate/91/19-und.html

RRG/Learn More/History. (n.d.). *Robotics Research Group : The University of Texas At Austin*. Retrieved March 19, 2010, from http://www.robotics.utexas.edu/rrg/learn_more/history/

Robot-Assisted Surgery: da Vinci. (n.d.). *Division of Biology and Medicine*. Retrieved March 19, 2010, from http://biomed.brown.edu/Courses/BI108/BI108_2005_Groups/04/davinci.html

Robots - Definition and More from the Free Merriam-Webster Dictionary. (n.d.). *Dictionary and Thesaurus - Merriam-Webster Online*. Retrieved March 19, 2010, from http://www.merriam-webster.com/dictionary/robots

Wang, Y., & PhD. (n.d.). The Potential for Robotics Technology in Surgery. *Google*. Retrieved March 19, 2010, from http://74.125.155.132/scholar?q=cache:CebSwb0_UqoJ:scholar.google.com%20/+the+potential+of+robots+in+healthcare&hl=en&as_sdt=100000000

Images

http://www.davincisurgery.com/$assets$/7a9a5682-444e-4c22-b44e-88e33b1c1a15/davinci_si_console.jpg

http://www.mercymiami.org/centers_of_excellence/Minimally_Invasive_Surgical_Institute/da-Vinci-Si-2-large.jpg

http://commons.wikimedia.org/wiki/File:Isaac.Asimov02.jpg

http://www.carolinaroboticsurgery.com/davinci_hyst.html

http://www.intuitivesurgical.com/corporate/newsroom/mediakit/InSite-new.jpg

http://microarrays.ucsd.edu/~narimene/

http://api.ning.com/files/*328RBM57Unm-*BJFt4Luc0hBt6Y0PNLUgq9ffPUh4BNSu3jDe2sTlwCxDeXgo37gG7bWs1KbLRYzK9rqa3wEhlKacE4KrXV/dna47_3_2.jpg

http://www.bb.ustc.edu.cn/ocw/NR/rdonlyres/Electrical-Engineering-and-Computer-Science/6-875Spring-2005/0F52083E-BDFB-45A5-B804-3C186AFC80B3/0/chp_lock_binary.jpg