Purpose

Introduce Bioscience students to the application of computer vision to better diagnose lung cancer nodules from CT scans.

Overview

The National Lung Screening Trial (NLST) studied the relative effectiveness of detecting lung cancer using traditional chest X-rays as compared to computed tomography (CT) scans. The study found that patients who received CT scans had a 15 to 20 percent lower risk of dying from lung cancer. This lesson will highlight the use of computer vision to analyze lung CT scans.

Educational Standards

Next Generation Sunshine State Standards

SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.CS-CS.1.5 Represent and understand natural phenomena using modeling and simulation.

Lesson Description

Day 1: Introduction

Students receive direct instruction on the following topics:
- Causes of lung cancer
- Types of lung cancer
- Characteristics of benign and malignant lung cancer nodules
- Staging lung cancer
- Process of computed tomography scans
- Using computer vision to analyze CT scans

Day 2: Introduction to 3D Slicer

- Students learn how to use 3D Slicer to segment a lung nodule.

Day 3: Patient Case Studies

Each student team receives a patient case study. For their patient, the group will need to:
- Use 3D slicer to segment a lung nodule
- Characterize the nodule as malignant or benign.
- Prepare the 3D Slicer data for 3D printing.

Day 4: Genetic Basis of NSCLC

- PowerPoint notes on the most common mutations associated with Non-Small Cell Lung Cancer.
- Introduce the Genetic Mutations in NSCLC lab. In this lab, students will test their patient’s DNA to determine the specific mutation that caused the lung cancer to develop.

Day 5: Part 1-DNA Digest

- Students will use restriction enzymes to digest their patient’s DNA and the DNA of patients with known genetic mutations.

Day 6: Part 2- Gel Electrophoresis

- Students will use gel electrophoresis to visualize the results of their DNA digests.

Day 7: Analysis of Results

- Students will analyze the gel electrophoresis.
- The team will then prepare a report for the patient which includes a diagnosis, prognosis, 3D model, and the genetic basis of the cancer.

Lab: Genetic Mutations in NSCLC

References


Figure 1: The Five Causes of Lung Cancer

Figure 2: The Strengths of Computer Vision and Human Vision in Image Analysis. The three pillars of computer vision are (1) automation of the nodule analysis process, (2) completeness in that all data is taken into consideration, and (3) the computer can detect image content that is not yet visible. The strength of human vision relies on the experience and training of the individual to quickly and accurately analyze an image.

Figure 3: Example of lung segmentation using 3D Slicer.

Figure 4: Example of lung segmentation using 3D Slicer.

Figure 5: Lung Cancer is the Biggest Killer in Both Men and Women

Figure 6: The DNA Electrophoresis Image