CS Capstone Problem Statement

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Reducing Patient Dose from Diagnostic Imaging Using Machine Learning

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Abstract

This report describes a problem that the patient who have a X-ray may get more dose of beam of radiation than average dose easily with diagnostic imaging techniques nowadays and presents a plan to apply an algorithm developed collaboratively at Oregon State University with researchers at Georgetown University to demonstrate a net reduction in dose based upon radiation counting data collected by an analogous detector set up at the Oregon State University TRIGA reactor. These diagnostic imaging techniques rely upon exposing a patient to a beam of radiation to create an image with sufficient contrast to detect the abnormality of interest. Our goal is to optimize the mechanisms with our developed machine-learning algorithm to stop the unnecessary irradiation when the desired outcome is reached to reduce the dose to patients.

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1 INTRODUCTION

systems used to detect radiation or determine the content of radioactive material are common in a multitude of nuclear science applications including, but not limited to, passive and active interrogation systems located at border crossings, common gamma spectroscopy systems used to analyze samples in a variety of environments in the nuclear industry, and detection of radiation from therapeutic treatments or diagnostic imaging applications in nuclear or imaging medicine. Most practical applications involve a radiation detector, process signal electronics, and some analytical approaches to determining the presence and/or amount of radiation or radioactive material being measured. The analytical approaches typically used involve collection of detector data over a finite or defined period of time followed by analysis of the integrated counts collected over that time. The start-and-stop process is repeated and necessarily involves time periods between collections cycles where the analysis is being performed instead of collecting more data. Herein, a novel approach is described that utilizes machine-learning techniques to eliminate this cyclic pattern and provides information in real-time.

2 PROPOSED SOLUTION

2.1 Description

Machine learning, which is also referred to herein as statistical analysis, data mining, or data analytic can be used to address complex data tasks through algorithmic methods. Researchers postulate the data creation from a particular model or they assume an unknown model and apply algorithmic methods to the data to reach conclusions. The latter ensures a data-driven process and supports an innovative way of solving complex data problems. Machine learning techniques are increasingly used in the radiation space data problems. For example, neural networks and support vector machines-based solutions such as interpreted gamma-ray spectroscopy data and a neutral network approach recognizing patterns for spectral analysis from High-purity Germanium detectors are well-known machine learning applications. However, these approaches are limited in their detection and post detection operations. we will apply the algorithm the optimize the radiation detection counting times using machine learning, the specific software we are going to use is WEKA, we are going to use the some models to analyze the data and train the system to recognize the image more intelligent. a method is provided to reduce the counting times in radiation detection systems using machine learning, wherein the method comprises: receiving an output data from a detector which is to detect a target material from a target body; analyzing the output data; identifying a material of interest from the analyzed output data; and controlling a source of the target material to prevent the source from harming the target body. An apparatus is also provided which comprises: a detector to detect radiation and to provide an output data in real-time; and a processor coupled to the detector, wherein the processor is to: receive the output data; analyze the output data; identify a material of interest from the analyzed output data; and control a source of the target material. The possible machine learning model we are going to use are artificial neutral networks, are computing systems that are inspired by, but not identical to, biological neural networks that constitute animal brains. Such systems ”learn” to perform tasks by considering examples, generally without being programmed with task-specific rules. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been manually labeled as ”cat” or ”no cat” and using the results to identify cats in other images. The other possible model could be ”Bayes rule”, Bayes’ theorem (alternatively Bayes’ law or Bayes’ rule) describes the probability of an event, based on prior knowledge of conditions that might be related to the event. For example, if cancer is related to age, then, using Bayes’ theorem, a person's age can be used to more accurately assess the probability that they have cancer than can be done without knowledge of the person's age.

2.2 Stretch Goals

The motivation is to reduce patient dose from both diagnostic imaging techniques such as X-rays and mammography systems through the implementation of an algorithm that utilizes machine learning techniques. our goal is to

- illustrate an apparatus and/or system with active emission and detection of radiation for optimizing nuclear or radio logical counting using machine learning, in accordance with some embodiment
- illustrate an apparatus and/or system with passive detection of radiation for optimizing nuclear or radio logical counting using machine learning, in accordance with some embodiment.
- illustrate a method for optimizing nuclear or radio logical counting using machine learning, in accordance with some embodiment.
- illustrate a matrix generated from collected detector data.

Overall, the stretch goal is that the users can use the developed system with diagnostic imaging to reduce the patient dose efficiently and accurately.

2.3 Cost

There are various costs of implementing this solution, including costs for the following:

- algorithm model
- Big data from detector
- machine learning software

3 Performance Metrics

The primary metric of completion is a functional optimized Diagnostic Imaging technique with machine learning algorithms. If the researchers can use the optimized system to detect the tumor or cancel more efficient. Additional metrics include performance speed and data acquisition accuracy and detail. The software performance speed determines how responsive the machine learning algorithm is, which affects the user It also determines the processing speed and detail, data collection, processing, and sending speeds, and accuracy as noted earlier.