Spring 2025 Project Proposal for CPSC 290 - Directed Research:

Hyperspectral Imaging to Classify Counterfeit Risk in Pharmaceuticals

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Background

Neural networks are machine learning models inspired by the structure and function of the human brain. Every neural network consists of layers of artificial neurons connected to each other that send previous outputs above a specified threshold to the next layer [1]. Neural networks are at the heart of convolutional neural networks (CNN), which have proven to be the preferred learning model for visual recognition tasks due to ease of training, decreased memory requirements, and resistance to distortions [2].

One kind of visual recognition task in which CNNs can be used is the identification of medicine in clinical applications. As CNNs can classify inputs according to differing characteristics, they can be used to differentiate medicines. This means that CNNs can be trained for drug safety purposes. According to Tanz et al., a teenager dies every day from fake pills containing opioids [3]. Thus, an application that could quickly identify fake pills could save a significant amount oflives and healthcare resources.

One factor that makes counterfeit drug identification difficult is that counterfeit pharmaceuticals appear the same as real pharmaceuticals visually. Data preprocessing is needed to generate differentiable characteristics for a trained CNN to accurately classify inputs. Previous preprocessing techniques include X-ray fluorescence on Tenormin pills as described in Alsallal et al. [4]. While X-ray fluorescence preprocessing is faster than heavy chemical analyzing

methods, it requires specialized equipment which means its results are not easily accessible to end users.

The preprocessing method I propose to use in this project is hyperspectral imaging, which can be accomplished with a smartphone camera according to Stuart et al. and He et al. [5, 6]. Hyperspectral images capture detailed spectral information across a range of wavelengths, allowing for the generation of features that can be extracted through CNNs. Hyperspectral images have been previously used by Wilczynski et al. on original and counterfeit Viagra pills. As a result, hyperspectral image data is a viable data type for other kinds of counterfeit pharmaceutical detection.

Description of project

Working with hyperspectral image data of medicines Klonazepam and Tradolan provided by students in the School of Public Health, I will create and train a CNN model to differentiate original pills from fake pills. In the raw data, there are images of size 400x320 that contain a combination of real and counterfeit drugs of type Klonazepam and Tradolan. This model would be used in the *RapidSense* mobile app (currently under development). The model would serve as the key feature in the app that will allow users to quickly identify whether or not a drug they are using is a counterfeit. The app aims to reduce drug overdoses and connect users to help if need be.

Once the model is trained, I will verify its accuracy with a test dataset. If any input hyperspectral drug image is identified to have a chance higher than 25% of being counterfeit, the model will flag the drug as being hazardous. After verification, the model will be delivered to the School of Public Health students for their research work.

Deliverables

- Identify potential deep neural network architectures for the classification task
- Train model on a dataset of hyperspectral images
- Evaluate the accuracy of the model in identifying counterfeit pharmaceuticals
- Deliver the model in a format suitable for integration into a smartphone application

References

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