Skin Lesion Detection and Classification using Deep Learning Techniques

Functional Specifications and Methodology

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1. Introduction

1.1 System Introduction

To detect and classify skin lesion in images using machine learning techniques is a crucial task in assisting a physician in decision making related to patient health. Our work focuses on skin lesion classification and detection in images using deep learning techniques. In first stage Convolution Neural Network (CNN) is used to classify melanoma images of benign and malignant tumors. To improve accuracy, we will try use different deep learning models as well apply other accuracy improvement techniques. In second stage we will use the same technique to detect cancerous lesion in melanoma images. This Tumor detection model is basically an expert system built to detect skin cancer in patients. The model is trained on images using deep learning techniques. To build our expert system, we will be using a Convolution Neural Network for detecting lesion region and we will be using deep learning model for classification. The model takes an image as input and detects skin lesion in the person. Upon positive results, the model further classifies the tumor as 'Benign', or 'Malignant'. The dataset that is used for classification is taken from ISIC Archive [1].

1.2 Purpose of Document

The purpose of this document is to give the reader an overview of our system by focusing on the system functionalities, our assumptions and constraints.

1.3 Scope

In first phase we will train convolution neural network to classify skin melanoma images into 'Benign', 'Malignant' or 'Unknown. We will be improving accuracy using different improvement techniques. In second phase our model will detect skin cancerous lesion using the same approach, to train the convolution neural network. In the end we will try to make our own neural network using hyperparameters.

1.4 Intended audience

- Doctors/Physicians

1.5 Goals and Objectives

- Classify positive skin cancer results as 'Benign' or 'Malignant' using CNN.
- Skin Lesion Detection using CNN.
- Make our own neural network using hyperparameters.

1.6 Version

- Version 1

1.7 Related / Companion documents

The documents related to this document include deliverable 2 and Project Proposal document.

1.8 Prerequisite documents

Prerequisite documents include project proposal document and deliverable 2.

1.9 Background or context of this document

To elaborate in detail about the functionalities of our system to help the doctor reading our document get an idea as to what our system can and cannot do while also highlighting the design of our system to aid in an overall better understanding.

1.10 Terms or acronyms

- Lesion: Infected area of skin.
- Benign: Tumor composed of non-cancerous cells.
- Malignant: Tumor composed of cancerous cells.
- Thresholding: Method of image segmentation.
- Jaccard Index: It is a statistic used to compute similarity/diversity between sample sets.
- CNN: Convolutional neural Network.
- Unknown: These represent images that are not labelled and cannot tell us whether the tumor is benign and malignant as there is a possibility of another tumor class which has not been determined as of yet.

1.11 Summary

This document starts off by an introduction of our system, audience and the purpose of the document. The middle portion of this document goes through the assumptions and design of our system. Later parts of this document are focused on goals, development methods and architectural strategies.

2. GENERAL DESCRIPTION

2.1 Classification Problem

Three distinct classes are chosen namely ‘Benign’, ‘Malignant’ ‘Unknown’ with the intent of distinguishing non-cancerous from cancerous tumors. The images are fed to the deep learning model, which is then used to classify.

2.2 Detection Problem

A predefined set of masks is available to us highlighting the skin lesion region. Input Images are pre-processed to remove noise then resulted images with its respective masks are fed to CNN Our model will be trained on these masks, and then upon input

of an test image, it will predict its mask by drawing a boundary around the skin lesion. Jaccard Index will be used as the evaluation protocol. We aim to achieve as high the value of Jaccard Index as possible within the limited time and resources available to us.

2.3 Domain Overview

Recent years, a lot of work is being done in Machine Learning expanding every possible field. We are researching on Machine Learning in medical domain. To be more specific, we are working on automating the analysis of dermascopic images to increase reliability and accuracy of a diagnostic in the skin lesion domain. In human analysis we have to account for the human errors which are quite probable due to appearance similarities of malignant and benign tumors. This could result in a false diagnostic and may catastrophic impacts. We are building this model with the intent of assisting dermatologists in decision making by providing them with a second opinion to verify their results and increase the authenticity of a diagnostic.

3. Functionality

3.1 Functional Requirements

The functional requirements of our system include:

3.1.1 Data Preparation and Data Pre-Processing Requirements

- System shall provide features for labelling the dataset.
- System shall provide features for data formatting to make the dataset consistent.
- System shall provide features for noise removal and features for handling data inconsistencies.
- System shall provide features for data scaling so that the data can converted into a form appropriate for mining.

3.1.2 Data Set Splitting Requirements

System shall provide appropriate tools for splitting data into training, testing and validation sets.

3.1.3 Modelling Requirements:

Our System shall provide features for feeding the hyperparameters into our model. System shall have required libraries for training deep learning models.

3.1.4 Data Evaluation and Parameter Tuning Requirements:

System shall allow to test the data against data that has not been used for training. System shall provide features for fine tuning the parameters in the model to fit the accuracy requirements.

3.1.5 Data visualization

System shall provide features for visualizing the data and results.

3.1.6 Analysis and Validation Requirements

System shall provide features to test the efficiency of our model based on different evaluation criteria.

3.2 Non-Functional Requirements

3.2.1 Usability

- The systems interface shall be easily and understandable, consistent.
- The system shall be user friendly for admins.

3.2.2 Reliability

Dataset given to the system will be used to compare the results of our model and to measure the reliability of the results.

3.2.3 Extensibility

Modular approach will be used so that adding and removing components is easier.

3.2.4 Compatibility

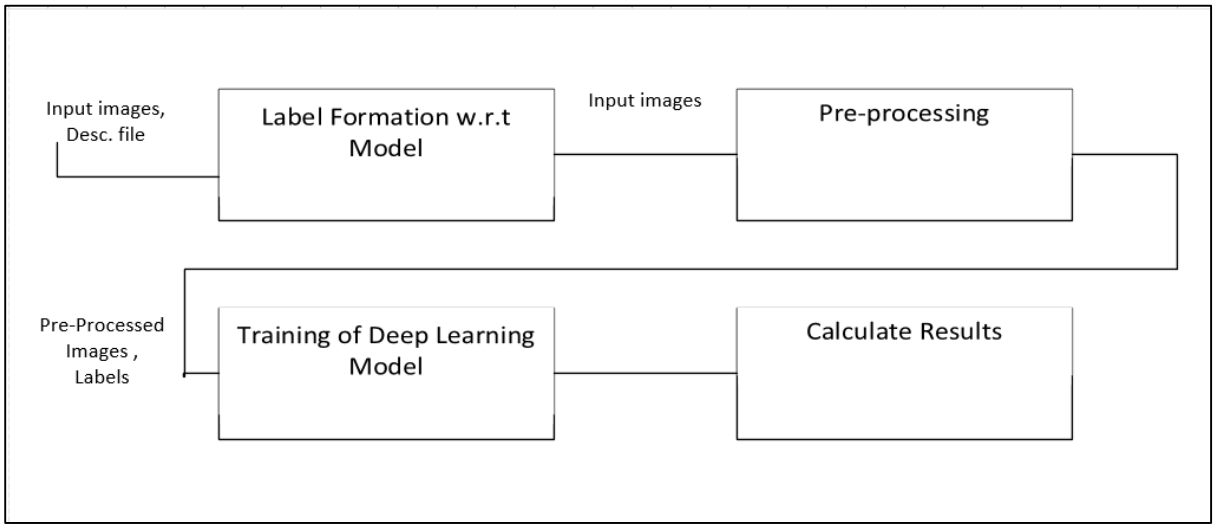
System will be compatible for Mac, Windows and Unix Platforms.

3.2.5 Asset Visualization and Scalability

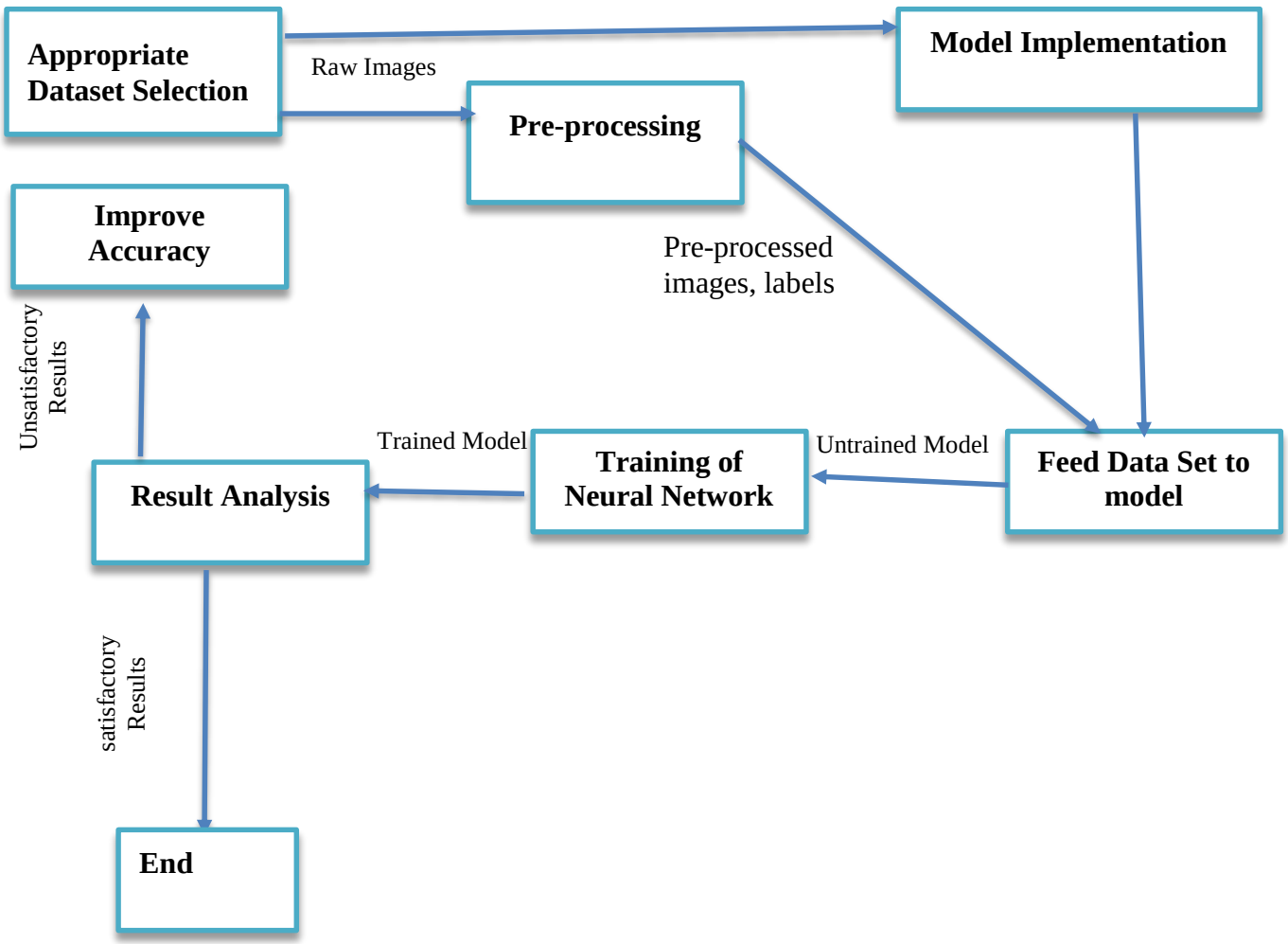
System should be able to depict the machine behaviour in visual form, so that the person with little to no knowledge about the system can interpret the health of the machinery. System shall be able to add assets without the need for investment in hardware.

4. SYSTEM ARCHITECTURE

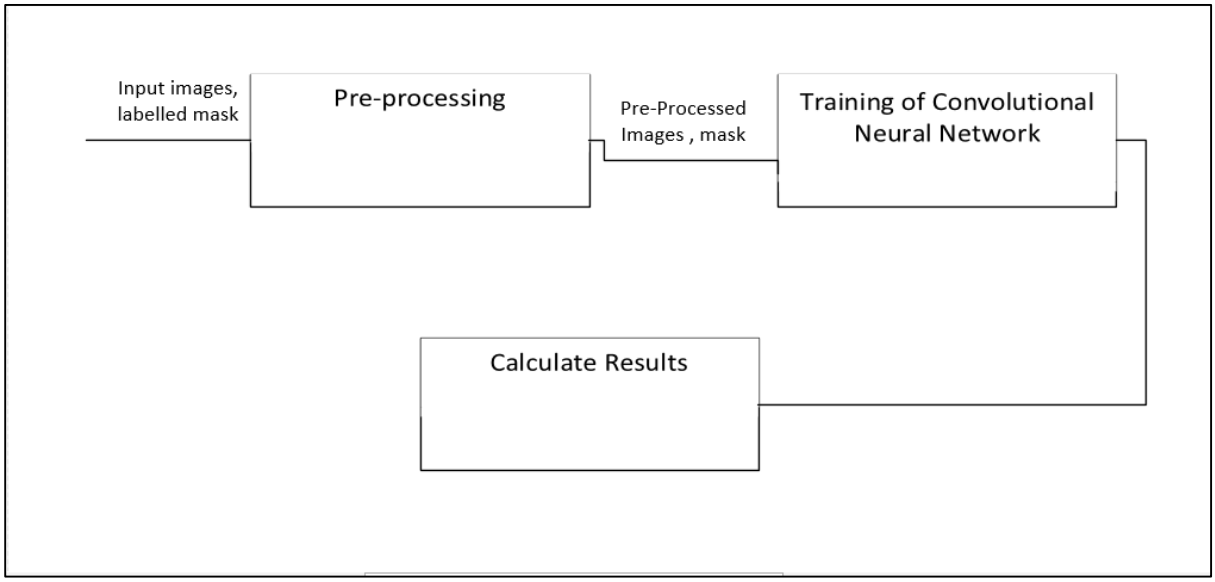
4.1 Classification Problem



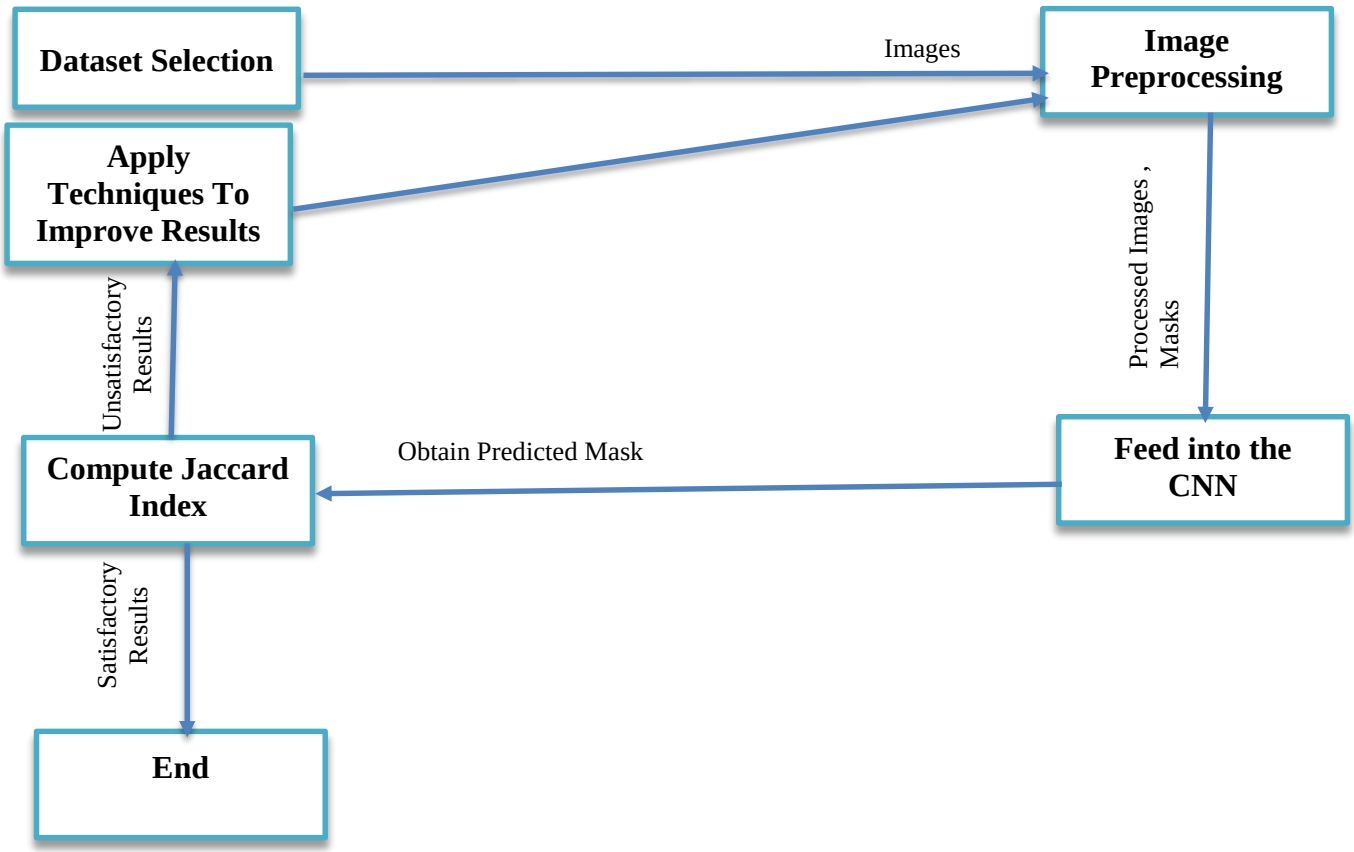
Detailed View



4.2 Detection Problem



Detailed View



5. System Requirements

- Need an input dataset to train the model on.
- Labelled dataset to verify test results.
- Need for a GPU to train on a greater batch size TitanX.

6. METHODOLOGY

Following is an outline of the methodology we will adopt for our research.

6.1 Classification Problem

After acquiring dataset, it is pre-processed, so the image size is a standard and the RGB images are converted to grey scale to reduce input feature vector size.
This processed dataset is then fed to the Deep Learning Model Convolution Neural Network. The test results will be analysed, and accuracy computed. If unsatisfactory results are obtained, we will apply different techniques for improvement of results we will try different deep learning models or hybrid models for results improvements.

6.2 Detection Problem

For this phase, we have a set of masks of skin lesion available to validate our results. Firstly, we will be pre-processing our images by applying different filters. Next, we will be feeding the pre-processed images and the masks in our convolutional neural network model. Next, we will be training our model on the input images, by the end of the training our model will act as a mask to detect the region of interest. For testing its accuracy, we will compare the mask we obtained with the actual mask that was available and compute the Jaccard Index. Our aim is to achieve a high Jaccard Index. If a lower Jaccard Index is obtained, we will retain our model until satisfactory results are obtained.

7. References

[1] "ISIC Archive," [Online]. Available: https://www.isic-archive.com. [Accessed 2018].
[2] "Jaccard Index," [Online]. Available: https://en.wikipedia.org/wiki/Jaccard_index.