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A Mobile Application for Early Diagnosis of Pneumonia in the Rural context

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ABSTRACT

Pneumonia is a lung infection that can range from mild to so severe that patient may have to be hospitalised. It happens when an infection causes the air sacs in lungs to be filled with fluid or pus. That makes it hard for breathing in enough oxygen to reach bloodstream. Children below the age of 2 and people over age 65 are at higher risk as their immune system may not be strong enough to fight it. Pneumonia may be cause because of bacteria, viruses, and fungi. The disease may have a long lasting effect on a patient, lungs may be damaged or weakened for life time and in some severe cases patient may die. Therefore early detection of this infection is necessary for best possible treatment. Advanced Technology can be useful in such a scenario. X-Ray is the simplest and common method used for detecting lung infection. Thus developing an automatic system for detecting pneumonia would be beneficial for treating the disease without any delay particularly in remote areas. Due to the success of deep learning algorithms analysing medical images have become easier. In addition, this algorithm's features pre-trained models on large-scale datasets which are very much useful in image classification tasks. In this work, we appraise the functionality of pre-trained models utilized as feature-extractors followed by different classifiers for the classification of abnormal and normal chest X-Rays. Statistical results obtained demonstrates that pretrained models employed along with supervised classifier algorithms can be very beneficial in analysing chest X-ray images, specifically to detect Pneumonia.

Keywords: detecting pneumonia, deep learning, CNN, chest X-ray image

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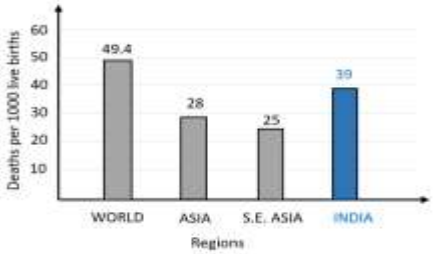
I. INTRODUCTION

Intrusion Pneumonia is a type of lung infection, caused by bacteria and bacteria-like organisms (Streptococcus pneumonia, Haemophilus influenza, Staphylococcus aureus, Mycoplasma pneumonia), virus (influenza type A and type B, respiratory syncytial virus (RSV)), fungi (coccidioides fungus) in surrounding environments Exposure and inhalation of the contaminated air in these environments ultimately leads to inflammation, and fluid filling in the lungs, in turn, reducing oxygen flow to the bloodstream. Aspiration pneumonia, pneumonia acquired by patients in hospitals (via contact with ventilators, instruments) are other categories of pneumonia. Viruses are the primary cause of pneumonia in children under five years. Children, infants, elderly, people with weakened immune systems, and people with severe alcohol misuse have an increased risk. It remains the leading infection-based cause of death among children below five years of age, approximately killing 100 children per hour. Out of 5.6 million under five deaths, pneumonia has accounted for 16 per cent, killing 880,000 children in 2016. In India, the Infant mortality rate is 39 deaths/1,000 live births (fig.1), i.e., 38 deaths/1,000 live births among males and 40 deaths/1,000 live births among females. Fig 1: The Infant Mortality of World, Asia, South East Asia(S.E. Asia) and India respectively. Additionally, MRI scans and imaging facilities are expensive and obtaining an accurate diagnosis is cumbersome. Patients in fast-growing metropolitan cities have better access to diagnostic imaging facilities, whereas those in rural areas and low growth economic regions do not have easy access to diagnostic imaging facilities. There are many researches continuing till today to the training time of CNN.



II. REVIEW OF LITERATURE

Pneumonia is a contagious disease that causes ulcers of the lungs, and is one of the main reasons for death among children and the elderly in the world. Several deep learning models for detecting pneumonia from chest X-ray images have been proposed. One of the extreme challenges has been to find an appropriate and efficient model that meets all performance metrics. Proposing efficient and powerful deep learning models for detecting and classifying pneumonia is the main purpose of this work. In this paper, four different models are developed by changing the used deep learning method; two pre-trained models, ResNet152V2 and MobileNetV2, a Convolutional Neural Network (CNN), and a Long Short-Term Memory (LSTM). The proposed models are implemented and evaluated using Python and compared with recent similar research. The results demonstrate that our proposed deep learning framework improves accuracy, precision, F1-score, recall, and Area Under the Curve (AUC) by 99.22%, 99.43%, 99.44%, 99.44%, and 99.77%, respectively. As clearly illustrated from the results, the ResNet152V2 model outperforms other recently proposed works. Moreover, the other proposed models—MobileNetV2, CNN, and LSTM-CNN—achieved results with more than 91% in accuracy, recall, F1-score, precision, and AUC, and exceed the recently introduced models in the literature.

Pre-Trained Convolutional Neural Networks

There are two well-known pre-trained deep learning methods based on CNNs: ResNet152v2 and MobileNetv2. These models have many applications, such as classification, feature extraction, and prediction.

- ResNet152v2 Architecture

Residual Network (ResNet) is a CNN architecture with hundreds or thousands of convolutional layers. Previous CNN structures decreased the efficacy of additional layers. ResNet contains a huge number of layers, with strong performance. The primary difference between ResNetV2 and the original (V1) is that V2 uses batch normalization before each weight layer. In the field of image recognition and localization tasks, ResNet has strong performance that demonstrates the importance of many visual recognition tasks.

- MobileNetV2 Architecture

The architecture of MobileNetV2 is based on an inverted residual structure where the shortcut connections of the residual block are between the thin bottleneck layers. The intermediate expansion layer of the MobileNetV2 uses lightweight depth-wise convolutions in order to filter the features. In traditional residual models, expanded representations in the input are used. MobileNetV2 consists of the primary full convolution layer through 32 filters, followed by 19 residual bottleneck layers.

THE DEEP-PNEUMONIA FRAMEWORK

As seen in the literature, there have been many deep learning models introduced to diagnosis pneumonia from chest X-ray images. These models introduce various values in performance metrics to verify the model validation. One of the extreme challenges has been to find an appropriate and efficient model that meets all performance metrics. The objectives of our study are (i) to propose a deep learning framework for pneumonia classification with four different models, and (ii) to evaluate the proposed models by comparing them with different recently introduced models. A deep learning framework for pneumonia diagnosis was developed, Our model has mainly two tiers. The first tier is responsible for image pre-processing, such as resizing, augmentation, data splitting, and data normalization. Data normalization is used for re-scaling the image's pixel value to the interval [0,1]. The second tier works on feature extraction and image classification using different types of deep learning models.

Our Research is based on following Literature

Literature survey on Automatic Detection of Pneumonia on Compressed Sensing Images using Deep Learning In 2019, the authors Sheikh Raul Islam;

Santi P. Maity; Ajoy Kumar Ray; Mrinal Mandal suggests a Compressed Sensing (CS) based deep learning framework for automatic detection of pneumonia on X-ray images to assist the medical practitioners. Extensive simulation results show that the proposed approach enables detection of pneumonia with 97.34 percentage prediction accuracy and an improvement on reconstruction quality of the X-ray images in terms of PSNR by 1±0.76 dB and SSIM by 0.2±0.05 using the proposed method compared to the other state-of-the-art methods. Pneumonia is one of the life threatening very common disease and needs proper diagnosis at an early stage for proper treatment of recovery. Chest X-ray is used as an imagining modality to identify the disease by a professional radiologist.

III. GAP ANALYSIS

The other paper presents a concise summary of the Pneumonia Detection techniques by using compressed sensing(CS), Deep learning frameworks and CNN based feature extraction. This study provides a preliminary, concise, but complete background of the pneumonia detection problem. Thus, based on this study, for a given problem environment and data availability, a proper framework can be chosen easily and quickly. Background codes/theories can be used from the works cited here relevant to the chosen framework and the focus of research can be dedicated to improving or optimizing the chosen framework for better accuracy in the given problem environment.

IV. SUMMARY OF LITERATURE REVIEW

This section gives the important findings obtained during reviews as seen in Section 2.1 and are depicted below Highlights.

- This paper mainly focuses on a Compressed Sensing (CS) based deep learning framework for automatic detection of pneumonia on X-ray images to assist the medical practitioners
- This paper presents an implementation of well known convolutional neural network models exception and vgg16 for diagnosing a pneumonia.
- Specific features from the characteristic vectors were obtained and classified with standard neural networks.

- A training and testing set of positive and negative vectors were compiled..
- This paper describes CNN based feature extraction.
- Feature learned by pre-trained CNN models on large datasets

Observations

- Extensive simulation results show that the proposed approach enables detection of pneumonia with 97.34 percentage prediction accuracy. • An improvement on reconstruction quality of the X-ray images in terms of PSNR by 1±0.76 dB and SSIM by 0.2±0.05 using the proposed method compared to the other state-of-the-art methods.
- Its take maximum times for detection of pneumonia.
- Accuracy of detection is very low.
- Every network has own special capabilities on the same dataset.
- Accuracy of this approach is 91.5
- Based on the analysis of patterns present in rectangular segments from the ultrasound digital images.
- Pre-trained CNN models employed along with supervised algorithms.
- Feature extractors followed by different classifiers for the classification of abnormal and normal chest X-ray images.

V. METHODS

Design Methodology In our project, Chest X-ray image dataset is used. This Dataset is taken from Kaggle library. In the Kaggle dataset, it consists of 3875 Chest X-ray images of Pneumonia patients as well as Normal patients. The filtered data is used to train the Artificial Neural Network (ANN) by using MobileNets: Open-source models for ondevice computer-vision based classification application for TensorFlow, an open-source machine learning (ML) platform for running ML models. The Trained ANN is used to predict the confidence level of the labels with the help of a known X-ray image of a pneumonia patient to verify the accuracy of the model. On verification, the level of confidence would predict the stage and the possible complications of pneumonia in the patient.

Development of a mobile application
A software development method is used in the development of a mobile application is agile development method. A mobile application is developed in Visual Studio using tensorflow at the backend and flutter for the frontend. A test app, obtained from TensorFlow library is modified by adding the label and model files. Furthermore, three functionalities, namely; patient profile, X-ray analyser, and E-Diagnosis, are added. The input to the application is an uploaded X-ray image which gives the confidence level of pneumonia revalent in the patients. Additionally, User gets doctor's list with their information like their specialities, working hours, contact details etc. and also can book an appointment of a doctor. In history user gets Patients Details like Name Age Prior Disease if any along with Patient's Predicted Results User can able to decide what should the further steps to take in this kind of rush hours. The design methodology used in the development of this application for the preliminary detection of pneumonia is based on Artificial Neural Networks (ANN). ANN algorithm like MobileNets is faster in detection, with higher accuracy than Google inception v3. Complex algorithms are otherwise necessary to compare a single image with a large number of reference images. This method of comparison would require a large amount of computing power and time. Selection of MobileNets as an on-device classifier based on ANN is most favourable, as it is an open-source software from TensorFlow that works with minimal hardware and software requirements, which is generally met with smartphones available in the market today.

Requirement Gathering and analysis:
All the functional and non-functional requirements of the project were identified. Interaction with the users and all other stakeholders of the project was conducted to identify all the requirements starting from important features to the very basic features like the look and the feel of user interface.

System Design:
The initial step was project design. The project was designed based on detection of pneumonia process.
Implementation: In this stage system is developed according to module wise.
Verification: This stage all developed software are installed and they are tested with different way against system requirements.
Maintenance: According to software's new version and there use them need to update

VI. OUTCOMES

The detection and prediction of confidence using chest X-ray images is more accurate.

VII.CONCLUSIONS

The report is having literature survey of 4 papers. Problem statement is designed along with its objectives in chapter 1. The detail plan of all the activities is mentioned in section 1.6 of chapter 1. The highlights and observation are reported in chapter 2. In chapter 3, the software and hardware requirements of the system is discussed. Finally, the system design of the system is given in chapter 4. The system will detect the pneumonia, gives confidence to patient and keep patient's predicted history digitally. Due to the use of this system, early detection of pneumonia will be very easy and useful in rural population where people faces lack of medical treatments.

VIII. FUTURE WORK

Future work includes creating holographic representations instead of physical representations of the terrain and other objects. Additionally, other entities should be added to the mode, namely people walking on the streets.

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