PERFORMANCE ANALYSIS OF INTELLIGENT MEDICINE RECOGNITION SYSTEM ON A DEEP LEARNING-BASED FOR CHRONIC PATIENTS

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ABSTRACT

In this review the application of deep learning for medical diagnosis is addressed.A thorough analysis of various scientific articles in the domain of deep neural networks application inthe medical field has been conducted. This article proposes an intelligent medicine recognition system based on deep learning techniques, named ST-Med-Box. In this paper we build the new model for the diseases prediction. In that we use the deep learning concept artificial neural network (ANN) for predicting the diseases. In this paper we use the probabilistic modelling and deep learning concept for prediction. For that we collect the three diseases heart, kidney, and diabetic's dataset. For those diseases we build the one proper dataset. The proposed system can assist chronic patients in taking multiple medications correctly and avoiding in taking the wrong medications, which may cause drug interactions, and can provide other medication-related functionalities such as reminders to take medications on time, medication information, and chronic patient information management. The proposed system consists of an intelligent medicine recognition device, an app running on an Android-based mobile device, a deep learning training server, and a cloud-based management platform.

1. INTRODUCTION

Neural networks have advanced at a remarkable rate, and they have found practical applicationsin various industries [1]. Deep neural networks define inputs to outputs through a complexcomposition of layers which present building blocks including transformations and nonlinearfunctions [2]. Now, deep learning can solve problems which are hardly solvable with traditionalartificial intelligence [3]. Deep learning can utilize unlabelled information during training; it isthus well-suited to addressing heterogeneous information and data, in order to learn and acquireknowledge [4]. The applications of deep learning may lead to malicious actions, however the positiveuse of this technology is much broader. Back in 2015, it was noted that deep learning has a clearpath towards operating with large data sets, and thus, the applications of deep learning are likely tobe broader in the future [3]. A large number of newer studies have highlighted the capabilities ofadvanced deep learning technologies, including learning from complex data [5,6], image recognition [7],text categorization [8] and others.

1.1 Artificial intelligence

Artificial intelligence is a subpart of computer science, concerned with, how togive computers the sophistication to act intelligently, and to do so in increasingly widerrealms. It is the name of the academic field of study which studies how to createcomputers and computer software that are capable of exhibiting intelligent behaviour. Itis usually defined as "the study and design of intelligent agents", in which an intelligentagent is a system that perceives its environment and takes actions that maximize itschances of success (Calis et al., 2015). Artificial Intelligence deals with developingalgorithms and techniques that can solve the problems in a more human like fashion. Theterm "Artificial Intelligence" was coined by John McCarthy in 1955, who defined it asthe "Science and Engineering of making Intelligent Machines, especially intelligentcomputer programs" (Serenko et al., 2011). The field was established on the claim thatthe main property of humans, Intelligence—can be mimicked by a machine. ArtificialIntelligence is sometimes also referred to as "Synthetic Intelligence" and is concernedwith the computational understanding of what is commonly called - intelligent behaviourand with the creation of artifacts that exhibit such behaviour (Lindley CA, 2012)).

Programs which enable computers to function in the ways that make people seemintelligent are called artificial intelligent systems.The field of Artificial Intelligence research was founded at a conference on thecampus of Dartmouth College in 1956 (McCorduck et al., 2004). The attendees,including John McCarthy, Marvin Minsky, Allen Newell, Arthur Samuel, and HerbertSimron, became the leaders of AI research for many decades (Russell et. al., 2003). Theyand their understudies composed projects that were astonishing to the vast majority ofpeople: computers programs were winning at games, taking care of polynomial mathproblems, forming meaningful hypotheses and communicating in English.Since, long time, even before the advent of digital computers, many scientistswere convinced that machines could be made to exhibit intelligent

behaviour. It is naturalthat as soon as computers appeared, researchers began to program them to do things,which were thought to be possible for human mind only such as: solving numericalproblems, understanding text English and playing games.

1.2 Deep Learning

In healthcare organization deep learning is used for uncover the hidden opportunities and patterns in clinical data helps to doctors for treat the patients well. Deep learning collects the huge amount of data, including patient related records data, medical reports of patients and on that data applies neural network techniques to provide better outcomes. Deep learning solves the problems which are not solved by the machine learning. Deep learning uses the various neural network methods and provides the better results. In healthcare deep learning provides the analysis of any diseases accurately to doctors and helps to doctors to treats particular patient and give better medical decisions. Deep learning techniques analyze the patient's medical history or health data and provide the best treatment for that patient. Also deep learning methods are used for Alzheimer diseases at an early stage of that particular person.

1.3 Overview

However, a patient cannot know whether the medications heor she has taken are correct. Due to the wide variety of drugsused for patients with chronic diseases, their classification isobviously a complex task, and misidentification of medicationscaused by negligence may lead to the possibility of taking thewrong medicine.

Taking the wrong medicine may result in harmfulinteractions or offset the intended effects of the drugs, leadingto further serious consequences such as acute complications. Toaddress this problem, this paper proposes adeep-learning-based intelligent medicine recognition system,named ST-Med-Box, that can recognize medications andremind patients with chronic diseases when to take theirmedications.By using the proposed system, patients with chronic diseasescan know whether a drug is taken correctly the first time, thusreducing the probability of taking the wrong medicine and thecost of social medical care.

2. LITERATURE REVIEW

(Avci et al., 2009) have developed an expert diagnosis system for interpretation ofthe Doppler signals of the heart valve diseases based on the pattern recognition. Theirstudy deals with the feature extraction from measured Doppler signal waveforms at theheart valve using the Doppler Ultrasound technique. Wavelet transforms and short timeFourier transform methods are used to feature extract from the Doppler signals on thetime–frequency domain and Wavelet entropy method is applied to these extractedfeatures. For classification of extracted features they have used the back-propagationneural network. The performance of the expert system has been evaluated using 215samples for which the correct classification rate was about 94% for normal subjects and95.9% for abnormal subjects.

(Tantimongcolwat et al., 2008) have proposed an automatic method for theinterpretation of Ischaemic heart disease pattern of magnetocardiography (MCG)recordings using machine learning approaches. Early detection of IHD may effectivelyprevent severity and reduce mortality rate. Recently, magnetocardiography (MCG) hasbeen developed for the detection of heart malfunction. Although MCG is capable ofmonitoring the abnormal patterns of magnetic field as emitted by physiologicallydefective heart, data interpretation is time-consuming and requires highly trainedprofessional. They used two types of machine learning techniques, namely backpropagationneural network (BNN) and direct kernel self-organizing map (DK-SOM), toexplore the Ischaemic heart disease pattern recorded by MCG. For training the system theprepared a database of sequential measurement of magnetic field emitted by cardiacmuscle of 125 individuals.

(Avci, 2009) has presented an intelligent system based on genetic-support vectormachines (GSVM) approach for classification of the Doppler signals of the heart valvediseases. The system deals with combination of the feature extraction and classificationfrom measured Doppler signal waveforms at the heart valve using the Doppler ultrasound. Genetic-support vector machines is used for detection of the heart valvediseases, which selects the most appropriate wavelet filter type for problem, waveletentropy parameter, the optimal kernel function type, kernel function parameter, and softmargin constant C penalty parameter of support vector machines (SVM) classifier. Theperformance of the GSVM system is evaluated for 215 samples. The average rate ofcorrect classification rate was about 95% which shows that this GSVM system is effectiveto detect Doppler heart sounds. (Colak et al., 2008) used eight different learningalgorithms for creating artificial neural network models for the prediction of coronaryartery disease (CAD). The work was carried out as a retrospective case-control study. (Rao et al., 2007) have proposed an artificially intelligent system (LungCAD) thathelps in the detection of Lung cancer. They have applied a classification algorithm fordetecting solid pulmonary nodules from CT thorax studies. The LungCAD system wasclinically tested by a number of radiologists and was found to deliver significantly greateraccuracy both in detecting the affected nodules and in identifying the potentiallyactionable nodules. LungCAD was approved by FDA in 2006. (Zhou et al.,2002) haveproposed an automatic pathological diagnostic procedure based on the ensemble of neural

networks for identification of lung cancer cells in the images of the specimen ofneedle biopsies obtained from the bodies of the subjects to be diagnosed. They named thissystem as neural ensemble based detection (NED). They have built the ensemble on atwo level based architecture among which the first level ensemble is used to judgewhether the cell is normal or cancerous with high level of confidence.

3. THE PROPOSED SYSTEM

A. Design Concept of the Proposed System

To address the problems posed by patients with chronicdiseases taking multiple medications for those diseases, wepropose an intelligent medicine recognition system based ondeep learning technology. This system can automaticallyidentify pills and assist patients with chronic diseases inunderstanding the dosage of their medications and other relatedinformation, thus mitigating the problem of patients taking thewrong medications.

Currently, smart medicine pillboxes are often used toorganize drugs and help patients take medicine and combine avariety of drugs, but they ignore the potential adverse effects ofplacing different drugs together. To address this problem, weuse deep-learning-based image recognition technology toachieve immediate multiple drug placement and instantrecognition and to provide voice explanations of medicationinformation.

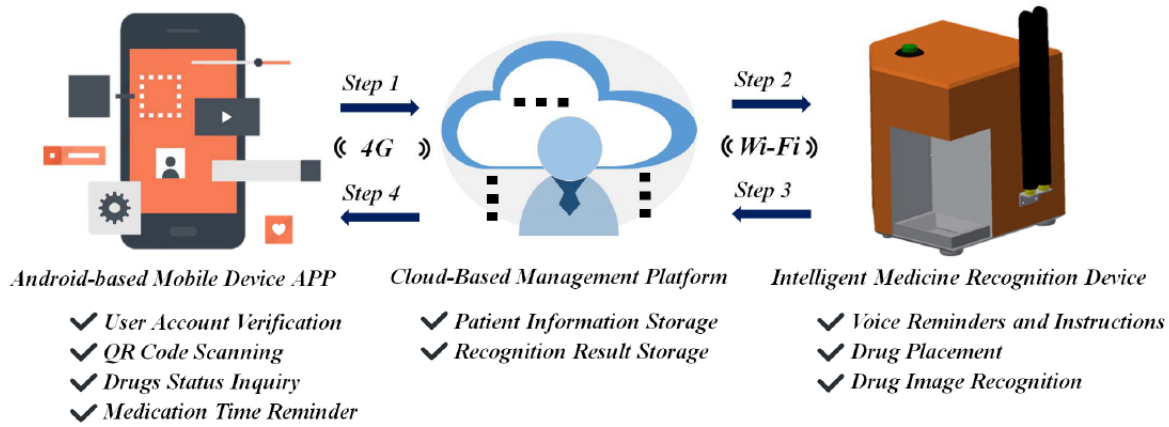


Fig. 1. Overview of the proposed system.

Fig. 1 shows an overview of the proposed system. Theproposed system consists of an intelligent medicine recognitiondevice, an app running on an Android-based mobile device, adeep learning training server, and a cloud-based managementplatform. As shown in Fig. 1, the proposed system is designedas a personalized service for patients with multiple chronic diseases taking multiple medications. The proposed system isintroduced as follows.

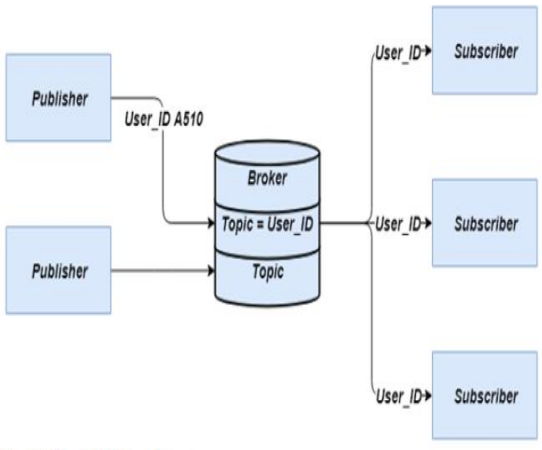


Fig. 2. The MQTT architecture.

Step 1: First, a user logs in to his or her account through theaccount verification mechanism of the Android-based mobiledevice app. After successfully logging in, the user can click onthe QR code option in the Android mobile device app to scanthe QR code on a medicine package to obtain the medicationinformation. Then, that medication information is transmittedover the 4G network to a cloud-based management platform forstorage. Drug information (such as the drug name, medicationtime, and dosage) can be checked via a website.

Step 2: The cloud-based management platform transmits themedication information obtained from the QR code on themedicine package to the proposed intelligent medicinerecognition device over a Wi-Fi network. The proposedintelligent medicine recognition device issues a voice prompt toremind the patient to take his or her medicine. Then, the patientplaces the medicine in the recognition region of the proposedintelligent medicine recognition device and presses the buttonto recognize the pills. After the recognition process is complete,the current medication status (the medication is correct, themedication is incorrect, more medicine needs to be taken, lessmedicine needs to be taken, or other related

medicationinformation) will be announced to the patient by voice.

Step 3: The proposed intelligent medicine recognitionsystem transmits the recognition results back to the cloud-basedmanagement platform over the Wi-Fi network. Thus, familymembers or the patient can check the patient's medication records (drug name, dosage, and actual medication time)through the website.

Step 4: The Android-based mobile device can receivemedication records from the cloud-based management platformover the 4G network. In this way, family members or the patientcan also instantly view the patient's medication records (drugname, dosage, and actual medication time) through the Androidmobile device app to ensure proper management of chronicdiseases.

For intercommunication among the intelligent medicinerecognition device, the cloud-based management platform, andthe Android-based mobile device, in addition to using theHTTP protocol, the message queuing telemetry transport(MQTT) protocol [35], [36] is also adopted. The MQTTprotocol is used to quickly transfer data between the Androidmobile device app and the cloud-based management platform.The MQTT protocol is a publish/subscribe-based messagetransmission protocol. The MQTT architecture is shown in Fig.2.

The MQTT architecture consists of publishers, subscribers,and a broker. As shown in Fig. 2, a publisher is the source of amessage. Messages are sent to particular topics. If a subscriberis subscribed to a topic, that means that he or she wants toreceive messages related to that topic.For example, if a publisher sends message "A510" to a

particular topic, then all subscribers subscribed to that topicwill receive this message.

4. METHODOLOGY

Step 1- Collection of data and datasets preparation

This will involves the collection various medical related information is gathered from various sources. Data will be collected from the various sources like from UCI Repository. In that patient previous history, patient reports such information is collected. Also various diseases datasets are collected from UCI Repository, Kaggle datasets, Pima datasets, and datasets-data.gov. Then the pre-processing is applied on the collected dataset and extracts the important features and removes the unnecessary information from that datasets. By using the extracted information generate the new dataset which is used for prediction of diseases.

For our project we can prepare a datasets which contains three diseases as Heart, Kidney, and Diabetes disease. In that first we take conman features of all those diseases and also some other important features. By combining the all common and other features we make a dataset. But prepared dataset are having some missing values. There is need to find the missing values. For finding the missing values we use the decision tree linear regression. We build the model with decision tree linear regression with the known x and y values and also new x values by using that values we predict the new y values.

We split the dataset into training and testing datasets as x_train, y_train for training and x_test for testing and predict the y_pred as new values. By repeating that process we find the all missing values. We also tried with the multi regression and random forest linear regression methods but by using that methods prediction accuracy is very less as compare to decision tree linear regression method. By using decision tree method we get the greater than75% accuracy. So finally we used decision tree linear regression method and we build the proper dataset.

Step 2- Developing the new probabilistic modeling and deep learning approach (ANN) for diseases prediction

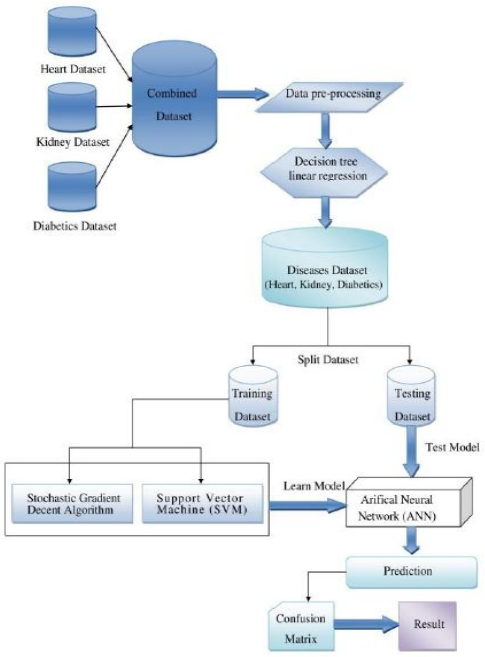
In this step develop the new probabilistic model with the help of deep learning approach that is artificial neural network for predicting the diseases. Artificial neural network is the deep learning techniques which is work as similar to human brain. With the ANN we build the new model for predicting the diseases. ANN runs effectively on prepared dataset. By applying the pre-processing we divide the dataset into the training set and the testing set. In that we divide dataset in 80-20% as for training and testing. On that divided training and testing datasets we apply the model and train by using the learning algorithm.

Step 3-training and experimentation on datasets

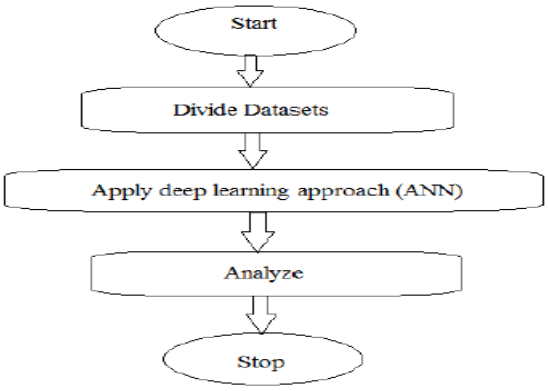
Developed diseases prediction model will be trained by using the stochastic gradient decent algorithm. By using stochastic gradient decent algorithm our diseases prediction model will be effectively trained on dataset. On that datasets ANN model do the accurate prediction for heart, kidney, and diabetes diseases. With the stochastic gradient decent algorithm we learn our model effectively and get the better result for the heart, kidney, and diabetes disease. After the learning we can produce the confusion matrix for our model that gives the prediction matrix. Based on the confusion matrix we check the accuracy of our model.

Step 4- Deployment and analysis on real-life scenario of peoples

By appalling the prediction model does the diseases prediction effectively. Trained datasets and tested data sets are deployed in real-life scenario made by human experts and will leverage for future improvement.Figure3 (a) and (b) show the overall flow of the project. Methodology follows the following architecture as,



(a)



(b)

Figure 3 (a) & (b) Workflow of diseases prediction system using deep learning based on treatment history and health data.

5. EXPECTED RESULTS

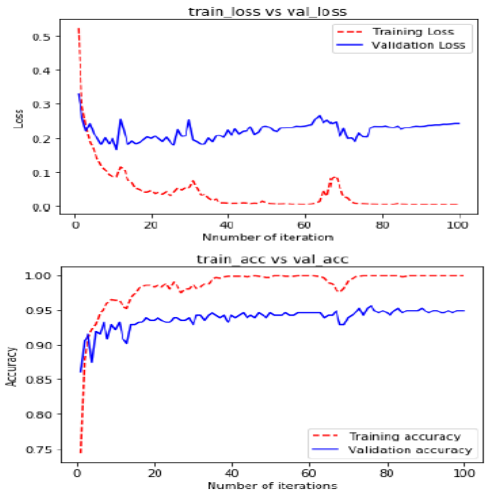


Figure4 Training loss vs. validation loss AND training accuracy vs. validation accuracy of heart diseases

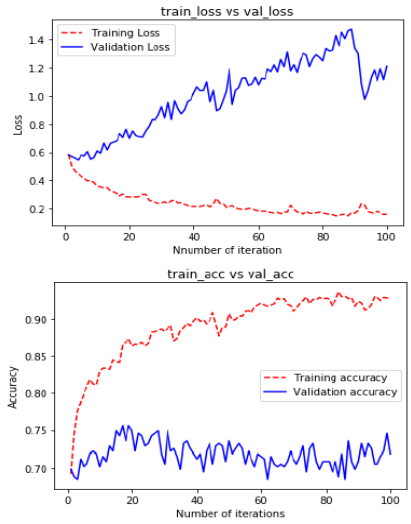


Figure5Training loss vs. validation loss AND training accuracy vs. validation accuracy of diabetes diseases

Fig. 6. Code names for 8 types of drugs.

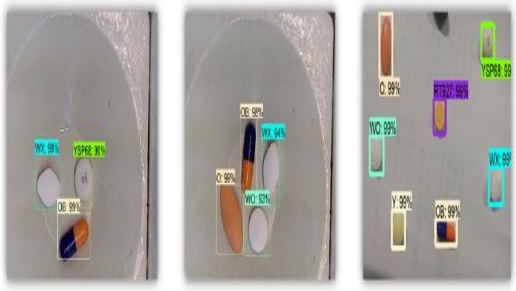


Fig. 7. Photographs captured during the actual drug recognition process andthe recognition results generated by the proposed intelligent medicine device.

CONCLUSION

The aim of the study was on disease prediction in humans based on historical data. In this paper, a new Probabilistic model and deep learning method is proposed. In that pre-processing is applied on dataset and remove all the unnecessary data and unwanted data. Then extract important features from that data, it runs effectively on healthcare databases. By using the ANN we build the model. Chronic patients, including 480 million elderly people in theworld today, suffer from a variety of diseases. In the treatmentof multiple chronic diseases, many drugs are needed, andphysiological functions decline. Cognitive ability is

reduced,possibly causing patients to take the wrong medicine.Therefore, elderly people have become a high-risk group foradverse drug events.To solve the problem of taking the wrong medicine, in thispaper, we have successfully developed an intelligent medicinerecognition system named ST-Med-Box based on deep learningtechnology. This system can recognize drugs and deliverrecognition results in a systematic and practical way.

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