Machine Learning Driven IoT Based Smart Health Care Kit

Lekhasree Narayanagari* and Baidya Nath Saha
Department of Mathematical and Physical Sciences, Concordia University of Edmonton, Alberta, T5B 4E4, Canada

* Corresponding author

doi:https://doi.org/10.21467/proceedings.115.24

ABSTRACT

This paper focuses on developing a machine learning driven IOT based smart healthcare kit. It plays an important role in emergency medical service like Intensive Care Units (ICU), by using an INTEL GALILEO 2ND generation development board. It facilitates to monitor and track different health indicators such as Blood Pressure, Pulses, and Temperature of the patient. This system allows to send the real time data of a patient to the physician and record it for future use. In this research we conducted two experiments: a)heart disease prediction from pathology data and b) lung disease prediction from X-ray images. For heart disease prediction we evaluate the performance of K-Nearest Neighbour and Random Forest Classifier and for lung disease prediction, we use VGG19 deep architecture. Experimental results demonstrate that machine learning can help to automate the IOT based smart healthcare kit and help doctors to diagnose the diseases.

Keywords: Internet of thing (IoT); Medical Services; Health care; Health Monitoring.

I. Introduction

Today Internet has become one of the important part of our daily life. It has changed how people live, work, play and learn [1]. Internet is widely used in different sectors, such as, education, finance, Business, Industries, Entertainment, Social Networking, Shopping, and E-Commerce. The next new mega trend of Internet is Internet of Things (IOT). Internet of Things (IOT) can be defined as the wireless network of devices which are connected to each other to share information and data. Visualizing a world where several objects can sense, communicate and share information over a Private Internet Protocol (IP) or Public Networks. The interconnected objects collect the data at regular intervals, analyse and use to initiate required action, and provide an intelligent network for analyzing, planning and decision making.

The IOT is generally considered as connecting objects to the Internet and using that connection for controlling of those objects or remote monitoring. However, this definition was referred only to part of IOT evolution considering only machine to machine connections. The actual definition of IOT is creating a brilliant, invisible network which can be sensed, controlled and programmed. The products developed based on IOT include embedded technology which allows them to exchange information with each other or through the Internet and it is assessed that about 8 to 50 billion devices will be connected through IOT by 2020. Since these devices come online, they provide better life style, create safer and more engaged communities and revolutionized healthcare.

The entire concept of IOT stands on sensors, gateway and wireless network which enable users to communicate and access the application/information. Considering all areas, IOT offers more prominent services in the field of health awareness. Consequently it is obliged to provide privacy and security to an IOT based health care network. Hence IoT based smart healthcare network outlines a savvy medicinal services framework where client information is received by the sensor, and is sent to the cloud through Wi-Fi [2].

Proceedings DOI: 10.21467/proceedings.115; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-947843-5-7

II. Literature Review

Due to IOT we can see many smart devices around us. Many people hold the view that cities and the world itself will be overlaid with sensing and actuation, many will be embedded in "things" what is referred to as a smart world. IOT is expected to spread rapidly in coming years as a new dimension of services that improve the quality of life of consumers and productivity of enterprises. Now a day, mobile networks deliver connectivity to a broad range of devices, which can enable the development of new services and applications. This new wave of connectivity is going beyond tablets and laptops, to connected cars and buildings, smart meters and traffic control, with the prospect of intelligently connecting almost anything and anyone.

This is what the GSMA refers to as the "Connected Life". The author describes the concept of sensor networks which has been made viable by the convergence of micro electro-mechanical systems technology, and wireless communications [3]. Firstly the sensor networks applications and sensing task are explored, and accordingly the review factors influencing the design of sensor network is provided. Then the algorithms and protocols developed for each layer and the communication architecture for sensor networks is outlined. The authors developed an Electronic Information Desk System. The system is designed to work independently without the need of any human operator and when a student or employee needs any information, they will need to send an SMS to this system which will respond with the information required by user. Many technical communities are vigorously pursuing research topics that contribute to the IOT.

Research efforts are being conducted in the field of IOT healthcare which gives a clinical evidence that the raw data received from wireless network has contributed in managing and preventing chronic diseases and monitoring patients. Therefore, various health monitoring systems include glucose monitors, ECG monitors, pulse audiometers, and blood pressure monitors. Similar research efforts are going on for the advancement of IOT and various products and services based on them such as Automation, Artificial Intelligence and Intelligent systems for energy conservation, Green Technology, and many more [4].

III. Advantages of IOT based Smart Healthcare Kit

In the traditional approach the healthcare professionals play the major role. They need to visit the patient's ward for necessary diagnosis and advising. There are two basic problems associated with this approach. Firstly, the healthcare professionals must be present on site of the patient all the time and secondly, the patient remains admitted in a hospital with having bedside biomedical instruments for a period of time. However, it demands for a reliable and readily available patient monitoring system (PMS) [5].

On the other hand, the IOT based health monitoring system uses ARDUINO microcontroller with Wireless Body Area Sensor Network (WBASN). In this work, the sensors used include temperature sensor, blood pressure sensor, and heart beat sensor. These sensors are placed on human body which monitor the health condition without disturbing the daily routine of the patients and these health related parameters are then communicated to physicians server using long range wireless technology. The expected outcome of this research is to offer proper and efficient medical services to patients by connecting and collecting data information through health status monitors and analyzing those data through machine learning techniques.

In this study, We have proposed a robust intelligent health monitoring system to monitor the patient automatically using IOT which collects the status information including patient's heart rate, blood pressure and ECG and sends an emergency alert to patient's doctor with his current status and full medical information. This would help the doctor to monitor his patient remotely and the patient is also capable of sending his health status directly. Our model can be deployed at various hospitals and medical institutes.

The system uses smart sensors that generates raw data information collected from each sensor and sends it to a database server where the data can be further analyzed and statistically maintained to be used by the medical

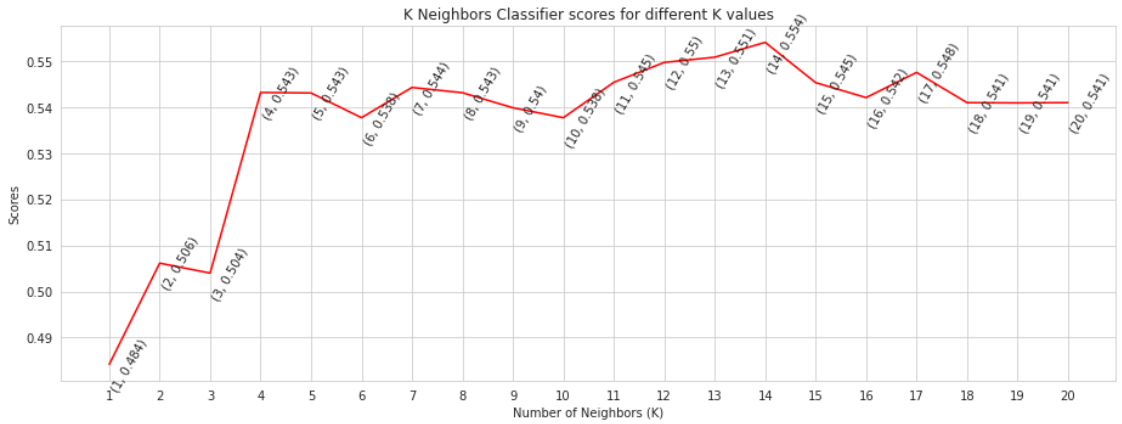

Fig. 1: KNN classifier for heart disase predicition

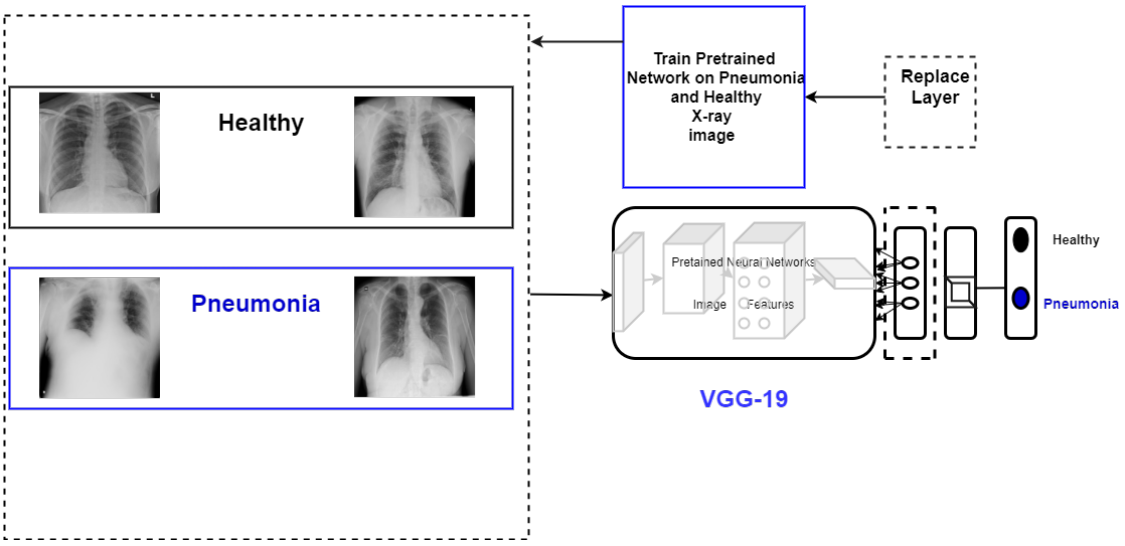

Fig. 2: Pneumonia detection from Lung X-ray.

experts. We have proposed a robust health monitoring system that is intelligent enough to monitor the patient automatically using IOT that collects the status information through these systems which would include patient's heart rate, blood pressure and ECG and sends an emergency alert to patient's doctor with his current status and full medical information [6].

IV. Experimental Results and Discussions

We conducted two experiments: a) Heart data analysis, and b) Lung disease detection. The data used for these two experiments could be collected from the patient remotely using IOT based smart healthcare kit. Performace of machine learning algorithms for these experiments are given below.

A. Analysis of Heart Disease Data Using Machine Learning

We implement k-Nearest Neighbour (kNN) for heart disease data [7] which includes a list of feature sets such as age, sex, type of chest pain, resting blood pressure, serum cholestoral, fasting blood sugar, resting electrocardiographic, maximum heart rate achieved, exercise induced angina, ST depression induced by exercise relative to rest, the slope of the peak exercise ST segment, number of major vessels (0-3) colored by flourosopy, and thalium

Proceedings DOI: 10.21467/proceedings.115
ISBN: 978-81-947843-5-7

Series: AIJR Proceedings
ISSN: 2582-3922

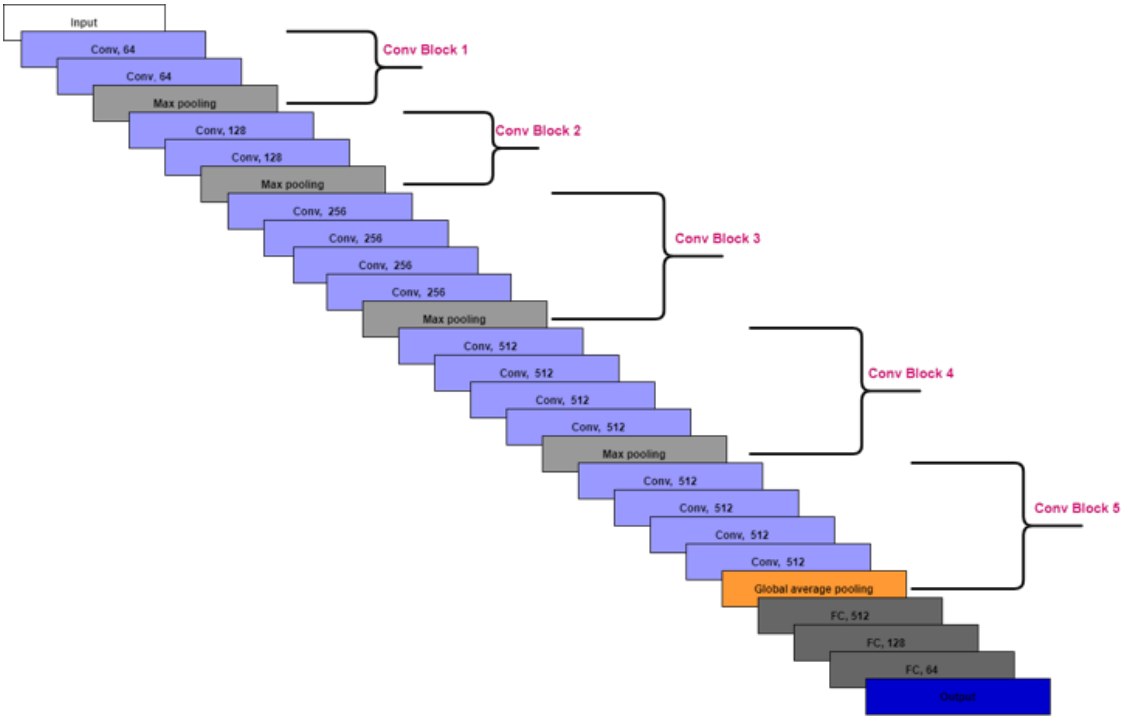

Fig. 3: VGG19

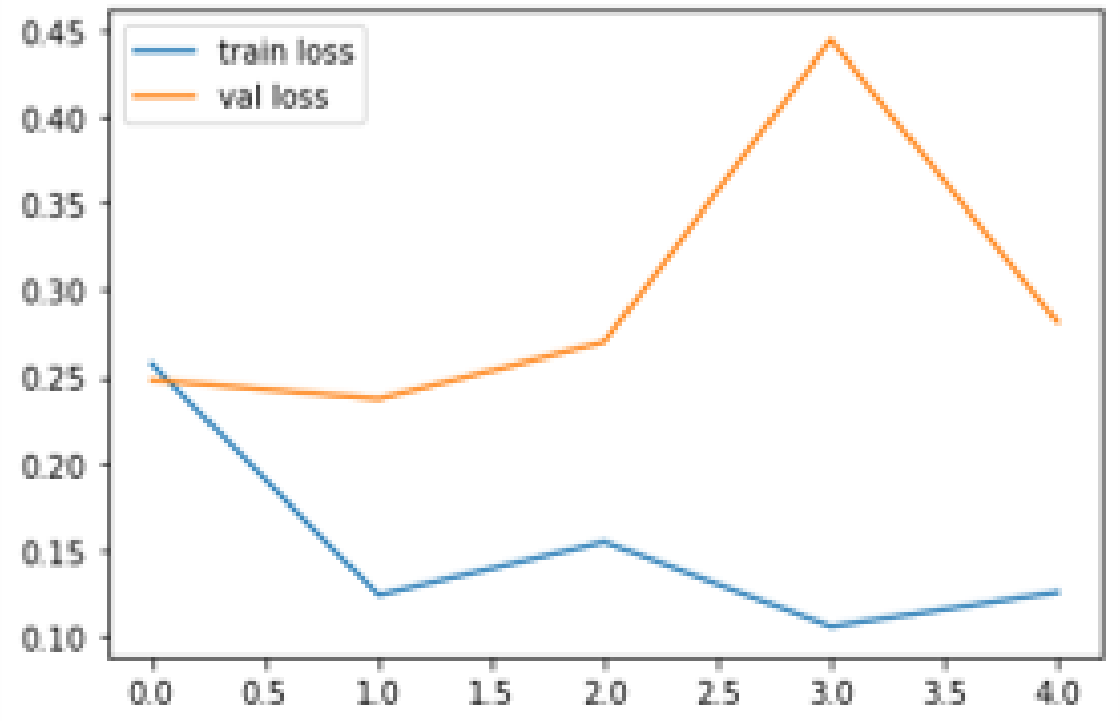

Fig. 4: train and validation loss for lung disease detection.

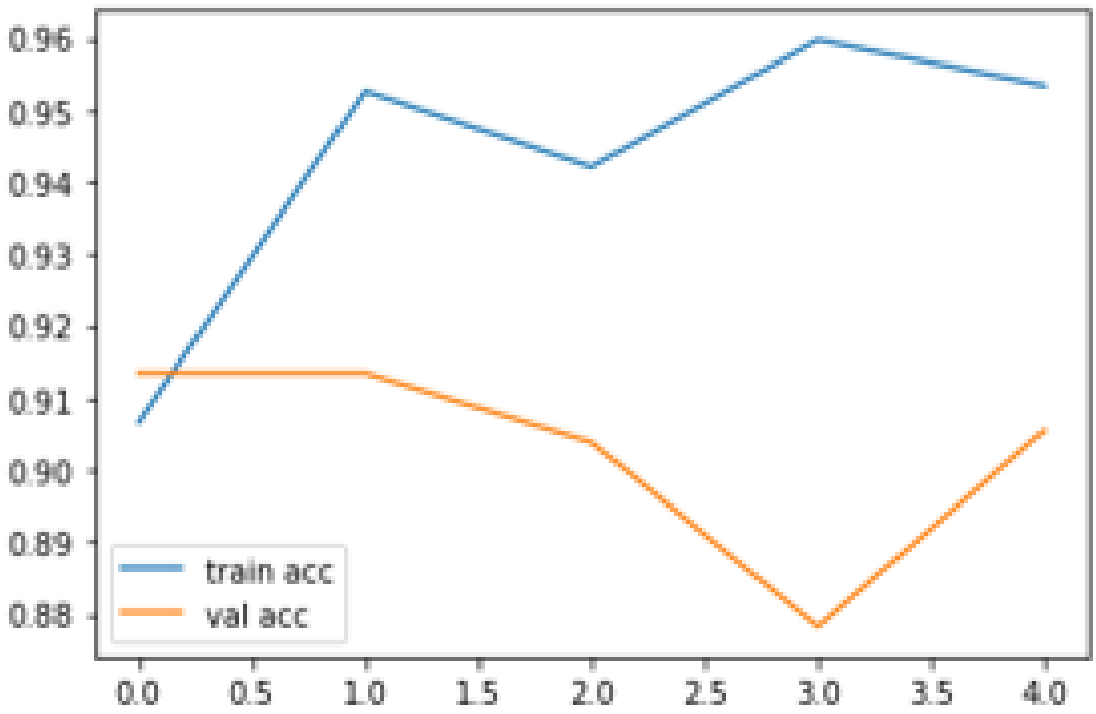

Fig. 5: train and validation accuracy for lung disease detection

stress test result to predict angiographic disease status. The performance of kNN classifer [8] is demonstrated in Figure 1.

B. Lung Disease Detection Using Deep Learning

In this experiment we implement VGG-19 [9] deep architecture for pneumonia detection from lung X-ray detection [11] as demonstrated in 2. The architecture of the fine-tuned VGG-19 model is shown in Figure 3.

We fine-tune VGG-19 by retraining only the model's last convolution block while freezing the model's first four blocks. To limit the number of learning parameters, this study uses global average pooling instead of a fattening layer after the feature extractor. The Adam optimizer is used with binary cross-entropy as the loss function [12]. The accuracy of the VGG-19 model [10] for pneumonia detection from X-ray images is found 89% after running 5 epochs. The train and validation loss and accuracy for pneumonia detection from X-ray images are demontrated in Figure 4 and 5 respectively.

V. Conclusion and Future Work

In this research we have presented a machine learning driven IOT based smart healthcare kit which can reduce the healthcare cost but allows patients accessing the healthcare system remotely [13]. In addition, machine learning helps doctors by diagnosing diseases. In future, we would like to investigate how online learning can be implemented to accomplish real time solution in IOT based healthcare kit.

References

[1] P. Gupta, D. Agrawal, J. Chhabra, and P. Dhir, "Iot based smart healthcare kit," 03 2016, pp. 237–242.

[2] P. Gupta, D. Agrawal, J. Chhabra, and P. K. Dhir, "Iot based smart healthcare kit," *2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT)*, pp. 237–242, 2016.

[3] M. Wu, T.-J. Lu, F.-Y. Ling, J. Sun, and H.-Y. Du, "Research on the architecture of internet of things," in *2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE)*, vol. 5. IEEE, 2010, pp. V5–484.

[4] M. N. Birje and S. S. Hanji, "Internet of things based distributed healthcare systems: a review."

[5] M. M. George, N. M. Cyriac, S. Mathew, and T. Antony, "Patient health monitoring system using iot and android," *Journal for research*, vol. 2, no. 01, 2016.

[6] Y. L. Kumbhare and P. H. Rangaree, "Patient health monitoring using wireless body area sensor network," *International Journal of Engineering and Advanced Technology*, vol. 4, no. 3, pp. 5–7, 2015.

[7] R. Detrano, A. Janosi, W. Steinbrunn, M. Pfisterer, J.-J. Schmid, S. Sandhu, K. H. Guppy, S. Lee, and V. Froelicher, "International application of a new probability algorithm for the diagnosis of coronary artery disease," *The American Journal of Cardiology*, vol. 64, no. 5, pp. 304–310, 1989.

[8] A. Smola and S. Vishwanathan, "Introduction to machine learning," *Cambridge University, UK*, vol. 32, no. 34, p. 2008, 2008.

[9] F. Q. Lauzon, "An introduction to deep learning," in *2012 11th International Conference on Information Science, Signal Processing and their Applications (ISSPA)*. IEEE, 2012, pp. 1438–1439.

[10] S. Bharati, P. Podder, and M. R. H. Mondal, "Hybrid deep learning for detecting lung diseases from x-ray images," *Informatics in Medicine Unlocked*, vol. 20, p. 100391, 2020.

[11] M. Elgendi, M. U. Nasir, Q. Tang, R. R. Fletcher, N. Howard, C. Menon, R. Ward, W. Parker, and S. Nicolaou, "The performance of deep neural networks in differentiating chest x-rays of covid-19 patients from other bacterial and viral pneumonias," *Frontiers in Medicine*, vol. 7, p. 550, 2020.

[12] N. Habib, M. M. Hasan, M. M. Reza, and M. M. Rahman, "Ensemble of chexnet and vgg-19 feature extractor with random forest classifier for pediatric pneumonia detection," *SN Computer Science*, vol. 1, no. 6, pp. 1–9, 2020.

[13] S. Banka, I. Madan, and S. Saranya, "Smart healthcare monitoring using iot," *International Journal of Applied Engineering Research*, vol. 13, no. 15, pp. 11 984–11 989, 2018.