Alinteri J. of Agr. Sci. (2021) 36(1): 698-703
e-ISSN: 2587-2249
info@alinteridergisi.com

http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/
DOI:10.47059/alinteri/V36I1/AJAS21098

RESEARCH ARTICLE

Comparison and Prediction of Hyperthyroidism Accuracy Rate Using Novel Deep Learning Technology and Vivo Monitoring

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ARTICLE INFO

Article History:
Received: 13.04.2021
Accepted: 17.05.2021
Available Online: 28.06.2021

Keywords:
Hyperthyroidism
Machine Learning
Novel Deep Learning Algorithm
Vivo Monitoring
Python 3.7
Visual Studio

ABSTRACT

Aim: The aim of this research work is to determine the presence of hyperthyroidism using modern algorithms, and comparing the accuracy rate between deep learning algorithms and vivo monitoring. **Materials and methods:** Data collection containing ultrasound images from kaggle's website was used in this research. Samples were considered as (N=23) for Deep learning algorithm and (N=23) for vivo monitoring in accordance to total sample size calculated using clinical.com. The accuracy was calculated by using DPLA with a standard data set. **Results:** Comparison of accuracy rate is done by independent sample test using SPSS software. There is a statistically indifference between Deep learning algorithm and in vivo monitoring. Deep learning algorithm (87.89%) showed better results in comparison to vivo monitoring (83.32%). **Conclusion:** Deep learning algorithms appear to give better accuracy than in vivo monitoring to predict hyperthyroidism.

Please cite this paper as follows:

Reddy, K. and Rani, D.J. (2021). Comparison and Prediction of Hyperthyroidism Accuracy Rate Using Novel Deep Learning Technology and Vivo Monitoring. *Alinteri Journal of Agriculture Sciences, 36*(1): 698-703. doi: 10.47059/alinteri/V36I1/AJAS21098

Introduction

This study helps in determining the presence of hyperthyroidism at an early stage using modern algorithms like deep learning technology (Chaubey et al. 2020). The main importance of this work is to determine the presence of hyperthyroidism using python programming language by eliminating the human error rate and hence considered as the easiest and cheapest method to predict hyperthyroidism (Chaubey et al. 2020). This study can be implemented in hospitals and endocrinology test centers (Mandal, Sarmah, and Bhattacharyya 2019).

About 30 google scholar and 10 science direct articles were seen related to this work, carried out in recent years reporting the developed algorithms and models using machine learning algorithms namely logistic regression, decision trees and k nearest neighbor (kNN) algorithms to predict and evaluate their performance in terms of accuracy in prediction of thyroid diseases (Chaubey et al. 2020) whereas this research work deals with the prediction of hyperthyroidism using deep learning algorithm. A research work proposed online transfer learning for differential diagnosis of benign and malignant thyroid nodules from ultrasound images (Mandal, Sarmah, and Bhattacharyya 2019; "Review of Zhou et Al., 2020" 2020), This research work is encoded with python coding which is the easiest and simplest method to predict hyperthyroidism. One among the related work developed multitask cascade CNN for automatic thyroid nodule detection and recognition (Song et al. 2019). Online transfer learning for differential diagnosis of benign and malignant thyroid nodules from ultrasound images (Zhou, Wang, and Tian 2020a) is considered to be more

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accurate in thyroid diseases prediction compared to other research works.

Previously our team has a rich experience in working on various research projects across multiple disciplines (Sathish and Karthick 2020; Varghese, Ramesh, and Veeraiyan 2019; S. R. Samuel, Acharya, and Rao 2020; Venu, Raju, and Subramani 2019; M. S. Samuel et al. 2019; Venu, Subramani, and Raju 2019; Mehta et al. 2019; Sharma et al. 2019; Malli Sureshbabu et al. 2019; Krishnaswamy et al. 2020; Muthukrishnan et al. 2020; Gheena and Ezhilarasan 2019; Vignesh et al. 2019; Ke et al. 2019; Vijayakumar Jain et al. 2019; Jose, Ajitha, and Subbaiyan 2020). Now the growing trend in this area motivated us to pursue this project.

Inefficient early detection of hyperthyroidism that eliminates human error rates is the major key point that motivated to work on this project to determine the presence of hyperthyroidism at an early stage. The authors were expertised in the field of machine learning algorithm, deep learning technology and able to conduct studies in comparison in deep learning and vivo monitoring in the biomedical aspect. The main aim is to determine the presence of hyperthyroidism at an early stage with highest accuracy rate.

Materials and Method

This study was carried out at Microprocessor laboratory, Saveetha School of Engineering, Chennai. The sample size calculation was done using previous study results (Zhou, Wang, and Tian 2020b) using clinical.com by keeping alpha error-threshold by 0.05, enrollment ratio as 0:1, 95%confidence interval, power at 80%. Group 1 was a deep learning algorithm (N=23 study group) in vivo monitoring (N=23 control group). The total sample size was 46.

The thyroid images used in our research were from two datasets, one is from kegel website, called dataset 1, and another is from a real time image, called dataset 2. For applying DPL, we designed a simple manual initiation by defining region-of-interests (ROIs) for images. This methodology was implemented in accordance with the standard protocol (Zhou, Wang, and Tian 2020b) followed in the deep learning algorithm to obtain the predicted output. First we used python to train our source domain model on dataset 1, then we used multi-ROI input strategy to train our target domain model on part 1 of dataset 2. The trained dataset is given as input in the command interpreter. The training dataset first undergoes the process called dataset augmentation, where the dataset is multiplied into many datasets then it will undergo the process called preprocessing, which is to make all sizes into single size. We train those datasets by extracting the features using a novel algorithm. It undergoes a process called optimization which will optimize the model and loss minimization which will reduce the noises generated during training. In the last it will be undergoing a process called model serialization which will be evaluated after generating a model using the testing dataset and predict the presence of thyroid diseases. The input code is allowed to run and the datasets are implemented in Python3.7 and visual studio respectively. The predicted output is obtained and its accuracy is compared between both the methods.

Statistical Analysis

The accuracy comparison of deep learning algorithms with vivo monitoring was done in IBM SPSS 27.0.1. Since the variables were independent to each other, an independent sample T-Test was done to compare the accuracy rate.

Results

In this research work of predicting hyperthyroidism, both the techniques appear to produce the same variable results with accuracy ranging from 83.32% to 88.89%. It is observed in Fig. 1, the mean accuracy of novel deep learning algorithm is more compared to vivo monitoring. Fig. 2a represents the predicted output obtained after the process, model serialization and Fig. 2b, trained data loss that occurred after model optimization. The data loss can also be calculated which helps in evaluating the type of thyroid at an earlier stage.

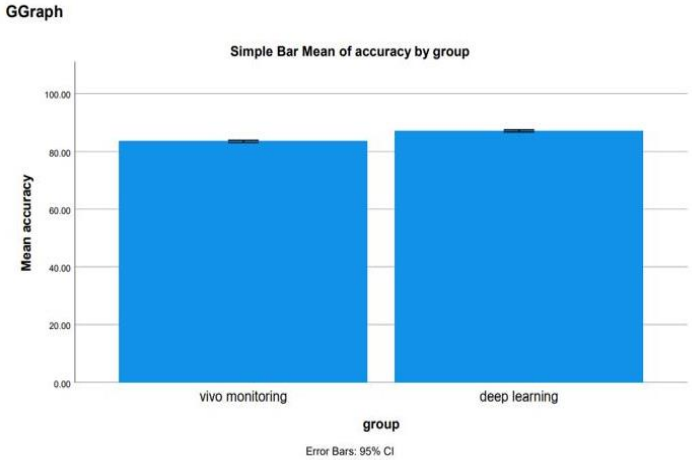
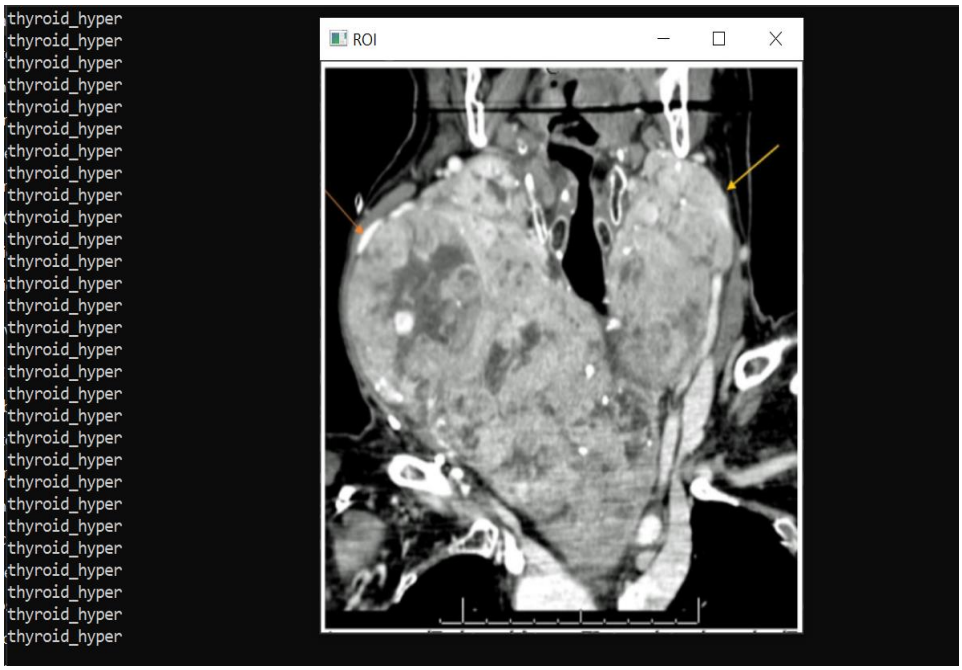
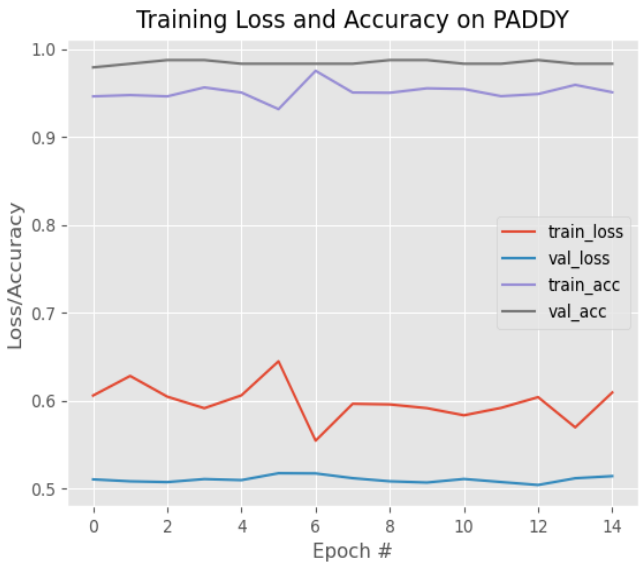


Fig. 1 Bar chart representing the comparison of mean accuracy of hyperthyroidism prediction with deep learning algorithm and vivo monitoring algorithms. Both techniques appear to produce the same variable results with accuracy ranging from 78.5% to 88.8%. X Axis: Deep learning algorithm vs vivo monitoring, Y Axis: Mean accuracy of detection ± 1 SD.



(a)



(b)

Fig. 2 a) Predicted output of hyperthyroidism and b) 88.9 % of accuracy in the prediction of hyperthyroidism

Novel deep learning algorithm had the highest accuracy, 87.89% in comparison to vivo monitoring, 83.32%. The descriptive statistics in Table-1 demonstrated that deep learning algorithms had less error rate than the vivo monitoring.

Table 1. Comparison of mean and accuracy using deep learning algorithms and vivo monitoring.

Parameter	Group	N	Mean	Std. Deviation	Std. Error Mean
Accuracy	Deep learning	23	83.5226	1.01382	0.21140
	Vivo monitoring	23	87.1391	0.89358	0.18632

Table 2. Independent sample T-test in predicting the accuracy of hyperthyroidism using deep learning algorithms and vivo monitoring. There appears to be a statistically insignificant difference($p>0.05$) in both the methods.

Parameter	Equal Variances	Levene's Test for Equality of variances		T-test for Equality of Means	
		F	Sig	t	df
Accuracy	Assumed	0.630	0.432	12.834	44
	Not assumed			-12.834	43.317

There appears to be a statistically insignificant difference ($P=0.432$, $p>0.05$) in both the methods using independent sample T test as shown in Table-2. This strategy suggested that a combination of different regions of

hyperthyroidism was critical for radiomics feature extraction procedure. These results showed that deep learning algorithms can be used to predict thyroid at a faster rate in comparison with vivo monitoring.

Discussion

In this research work of predicting hyperthyroidism deep learning algorithm had highest accuracy (87.89%) in comparison to vivo monitoring (83.32%). There appears to be slight increase in the significant difference but not statistically significant (Table-2). Deep learning algorithms are the easiest and cheapest way to determine the presence of hyperthyroidism. Related works carried out during recent years (2018-2020) (Sidiq, Aaqib, and Khan 2019), have less accuracy (59.7%) than proposed deep learning algorithms like thyroid diseases predicting using machine learning approaches that predicts only benign and malignant stages of thyroid gland (Wang et al. 2019) And few algorithms have better accuracy due to the data set they have chosen (Beaumont et al. 2019). Many researchers developed algorithms and models using machine learning to predict thyroid diseases (Zheng et al. 2018). Some of the studies designed and manufactured a 3D printer for age specific thyroid phantoms corresponding to child and adult age. This study can be implemented in clinical practices like hospitals and endocrinology test centers to predict hyperthyroidism.

The factors affecting this study might be due to image contrast where subjective image consistency is critical for human perception, pixel size, aspect ratio of the image which changes depending on the medium and image brightness. The aspect ratio of the image and its size are considered as the important parameter.

Although this study demonstrated several advantages over the other algorithms that attempted to predict and differentiate other thyroid diseases, it is limited to certain factors which includes the inefficient real time monitoring which could be more convenient to view thyroid gland and modification in algorithms to obtain real time applications.

In the near future, we will examine the application of thyroid disease detection technology in the healthcare field and how it can aid in the more accurate detection of different forms of cancer. As a result, this project has a bright future ahead of it, where manual forecasting can be easily converted to computerised output at a low cost. A better dataset of real time applications with various other machine learning and deep learning algorithms such as SVM, Naive Bayes, auto encoders may give better results .

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Vijayashree Priyadharsini 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019; Ramesh et al. 2018; Mathew et al. 2020; Sridharan et al. 2019; Pc, Marimuthu, and Devadoss 2018; Ramadurai et al. 2019). We hope this study adds to this rich legacy.

In the near future, we'll aim at how thyroid disease detection technology is being used in the healthcare sector and how it can help with more accurate cancer detection. As a result, this project has a bright potential, as manual forecasting can be easily converted to computerised production at a low cost. A larger dataset of real-time applications combined with other machine learning and deep learning algorithms like SVM, Naive Bayes, and auto encoders could yield better performance.

Conclusion

In this study of hyperthyroidism prediction, the novel deep learning algorithm (88.89%) that operates using python language appeared to give better results when compared to vivo monitoring (79.32%). The performance also continuously increased with increase in data which is not seen in other algorithms. This model is very efficient and holds a good potential to improve the diagnostic efficacy of thyroid ultrasound images, hence can be implemented in hospitals and endocrinology test centers.

Declarations

Conflict of Interests

No conflict of interests in this manuscript

Authors Contributions

Author YKR was involved in data collection, data analysis, manuscript writing. Author DJR was involved in conceptualization, data validation, and critical review of manuscript.

Acknowledgment

We would like to express our special thanks of gratitude to the management, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (Formerly known as Saveetha University) for providing me with the necessary infrastructure that was required in completing the project.

Funding

We thank the following organizations for providing financial support that enabled us to complete the study.

1. Axia clinics Pvt. Ltd, Hyderabad
2. Saveetha University.
3. Saveetha Institute of Medical and Technical Sciences.
4. Saveetha School of Engineering.

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