Chapter 8
Deep Learning–Based Detection of Thyroid Nodules

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ABSTRACT

Thyroid nodule is a common disease on a global scale. It is characterized by an abnormal growth of the thyroid tissue. Thyroid nodules are divided into two types: benign and malignant. To ensure effective clinical care, an accurate identification of thyroid nodules is required. One of the most used imaging techniques for assessing and evaluating thyroid nodules is ultrasound. It performs well when it comes to distinguishing between benign and malignant thyroid nodules. But ultrasound diagnosis is not simple and is highly dependent on radiologist experience. Radiologists sometimes may not notice minor elements of an ultrasound image leading to an incorrect diagnosis. After performing a comparative study of several deep learning-based models implemented with different classification algorithms on an open-source data set, it has been found that ResNet101v2 gave the best accuracy (~96%), F1 score (0.957), sensitivity (0.917), etc. A simple and easy-to-use graphical user interface (GUI) has also been implemented.

INTRODUCTION

Conventional diagnostic and treatment procedures of diseases rely heavily on doctors'/clinicians' expert knowledge of the condition at hand. However, this diagnostic procedure has a significant flaw: its effectiveness relies highly on doctors' own experiences and intellect. As a result, diagnostic accuracy varies and is constrained. Image-based diagnosis procedures have become increasingly popular as digital technology has advanced, allowing clinicians to study abnormalities with organs beneath the skin and/

DOI: 10.4018/978-1-6684-5673-6.ch008

or deep within the human body. The diagnostic performance can be improvised with the use of imaging techniques. However, the ability and expertise of medical practitioners to exploit collected photos is still a factor. To address this issue, computer-assisted diagnostic systems were created to aid doctors in the prognosis and therapeutics process. The CAD systems, as their name implies, can be used for double verification, which is done to try to improve human diagnostic performance using a computer. This type of technology analyses and interprets medical images of various organs, such as Ultrasound scans. After the analysis is done, the classification output obtained helps doctors diagnose disorders.

The thyroid is an important organ in the human body that creates and produces vital hormones that regulate metabolism. It is located in the human neck. Thyroid disease has grown more crucial to diagnose and treat because of its vital role in the human body. The formation of nodules that cause thyroid cancer, as previously observed in prior studies, is a prevalent problem in the thyroid region. Thyroid nodules are anomalous lumps that grow on the human body's thyroid gland. Many reasons, including iodine deficiency, overgrowth of normal thyroid tissue, and thyroid cancer, can cause them. Thyroid nodules are usually segregated into two types based on their characteristics: benign (non-cancerous nodules) and malignant (cancerous nodules). Thyroid cancer is the most prevalent type of cancer, constituting 10% of all malignant tumours. Thyroid Cancer is a malignancy that occurs in the Endocrine System. Thyroid nodule detection has increased dramatically as several nodules are found by chance. The CAD classification of thyroid nodules can help the radiologist make an accurate diagnosis.

Clinically, evaluating thyroid nodules is difficult. Thyroid nodules are found out often by chance during neck diagnostic imaging and prevalence increases as a person ages. They are seen in 42–76% of adults. Many of thyroid nodules are considered non-cancerous, while 10% of them may be cancerous. Radioactive iodine therapy, thyroidectomy to prevent recurrence and death, immunotherapy or chemoradiotherapy may be recommended. Treatment for thyroid cancer varies based on the histological subtype, patient preference, and other factors as well as comorbidities. Ultrasound images are not particularly clear, which necessitates the use of a FNAB (invasive) procedure, which has unfavorable repercussions. For a cytological study of the nodule, a fine needle aspirate biopsy (abbreviated as FNAB) of the nodule might be obtained. Patients may have localized pain from FNABs, and while they are generally safe, there is a small risk of hematoma. The outcome of cytological analysis is uncertain in 20–30% of FNABs, which implies they do not always produce clinically meaningful data. The assessment of accidental Thyroid Nodules is usually performed by Sonography. Hypo-echogenicity, absence of a halo, micro-calcifications, firmness, intramodular flow, and a taller-than-wide form are some of the sonographic features of thyroid nodules that radiologists have recognized as suggestive indications of cancer (malignant).

Thyroid Imaging Reporting and Data System (TI-RADS)

TI-RADS is based on a five-point scale that assigns 0–3 points to each of the 5 Ultrasound features namely composition, echogenicity, shape, margin, and echogenic foci. A single score is generated due to the features composition, echogenicity, shape and margin due to mutually exclusive selections. The echogenic foci category might contain many features. The scores generated due to all features are added and the sum total obtained determines whether the nodule is harmless (TR1) or lethal (TR5). The TI-RADS score ranges from 1 to 5, nodules which have scores up to 3 can be classified as benign while nodules which have scores of more than 3 can be classified as malignant. The TR level, along with the nodule's maximal diameter, decides whether a Fine-Needle Aspiration Biopsy (FNAB) or no further action is recommended.