Thyroid lesion classification in 242 patient population using Gabor transform features from high resolution ultrasound images

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A B S T R A C T

Thyroid cancer commences from an atypical growth of thyroid tissue at the edge of the thyroid gland. Initially, it forms a lump in the throat and an over-growth of this tissue leads to the formation of benign or malignant thyroid nodules. Blood test and biopsies are the standard techniques used to diagnose the presence of thyroid nodules. But imaging modalities can improve the diagnosis and are marked as cost-effective, non-invasive and risk-free to identify the stages of thyroid cancer. This study proposes a novel automated system for classification of benign and malignant thyroid nodules. Raw images of thyroid nodules recorded using high resolution ultrasound (HRUS) are subjected to Gabor transform. Various entropy features are extracted from these transformed images and these features are reduced by locality sensitive discriminant analysis (LSDA) and ranked by Relief-F method. Over-sampling strategies with Wilcoxon signed-rank, Friedmans and Iman-Davenport post hoc tests are used to balance the classification data and also to improve the classification performance. Classifiers such as support vector machine (SVM), k-nearest neighbour (kNN), multi-layered perceptron (MLP) and decision tree are used for the characterization of benign and malignant thyroid nodules. We have obtained a classification accuracy of 94.3% with C4.5 decision tree classifier using 242 thyroid HRUS images. Our developed system can be used to screen the thyroid automatically and assist the radiologists.

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1. Introduction

Thyroid cancer is the accumulation of malignant cells in the tissues of thyroid gland and constant exposure to radiation, age and gender affects the risk of thyroid cancer. Papillary, anaplastic, follicular and medullary thyroid cancer are four different types of thyroid cancers where anaplastic thyroid cancer is incurable compared to the rest [57].

In the United States, around 62,450 new cases of thyroid cancer are registered every year with papillary thyroid cancer being the most common type and on a yearly basis, around 1590 deaths from thyroid cancer are being reported [72]. In the United Kingdom, around 2700 new cases of thyroid cancer are registered every year, adding up to less than 1% of cancer cases [56]. Thyroid cancer has no age barrier but increases in aggression due to thyroid cancer being common in older population. About 2% of the teen and children population are affected; 2 out of 3 cases diagnosed with thyroid cancer are in the population aged below 55 years. Thyroid nodules are the first signs of thyroid cancer and females are three times more prone to thyroid cancer than males [51]. As much as 75% of the population develops nodules which are benign and less than 1% thyroid nodules become malignant [72]. Table 1 presents the percentage of population affected by thyroid cancer.

The rise in the incidence rate of thyroid cancer has increased the need for cost effective, quantitative and efficient diagnostic systems. In the very beginning, a blood test called thyroid function test is done to measure hormone levels in the blood and confirm the absence of other thyroid disorders. Fine needle aspiration (FNA) biopsy is commonly used in the detection of thyroid