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THYROID NODULE SEGMENTATION USING U-NET ARCHITECTURE

RAVIKANTI SHREYA[1], MOHAMMAD SAMEER[2], D HIMAVARSHA[3] & MR.T.VEDA REDDY[4]

1, 2, 3.Student of Department Of Computer applications & Anurag University

4. Assistant Professor of Department of Computer applications & Anurag University

ABSTRACT

Thyroid nodules are considered as most common disease found in adults and thyroid cancer has increased over the years rapidly. Further automatic segmentation for ultrasound image is quite difficult due to the image poor quality, hence several researcher have focused and observed that U-Net achieves significant performance in medical image segmentation. However U-net faces the problem of low resolution which causes smoothness in image, hence in this research work we have proposed improvised U-Net which helps in achieving the better performance. The main aim of this research work is to achieve the probable Region of Interest through segmentation with better efficiency. In order to achieve that Improvised U-Net develops two distinctive feature map i.e. High level feature Map and low level feature map to avoid the problem of low resolution. Further proposed model is evaluated considering the standard dataset based on performance metrics such as Dice Coefficient and True positive Rate. Moreover our model achieves better performance than the existing model.

1.1 INTRODUCTION

Segmentation detects the region of interest of an image so as to accurately divide the boundary between the thyroid parenchyma(tissue) and nodules. The precise segmentation of thyroid nodules has become an indispensable step for research because it can effectively determine the size and location of nodules, which doctors may use to issue diagnostic reports and develop treatment plans. Developing automated segmentation methods can effectively lessen the reliance on physicians' diagnostic expertise because manual segmentation is tedious and time-consuming.

Implementing an efficient segmentation methodology which will support in Thyroid nodule segmentation is used to find size location of gland which will used to find thyroid disorder.

Thyroid nodules segmentation is used to detect boundaries, size, and volume of nodules. The method proposed in project is about Thyroid nodule segmentation using U-Net Architecture.

Thyroid nodules are among the most common endocrine complaints in the adult population and they are clinically important primarily due to their malignant potential. Thyroid nodule segmentation refers to the process of identifying and delineating the boundaries of thyroid nodules within medical images, such as ultrasound, CT scans, or MRI scans. For finding thyroid disease, segmentation is considered a best for identification of thyroid nodules because of its inexpensive and trouble-free nature. For diagnosis of thyroid disorder, it is very important to separate thyroid nodules from thyroid gland.

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For the same in biomedical image processing, image segmentation and classification followed by image preprocessing is very imperative steps. Segmentation is an essential step to detect and produce region of interest (ROI) of nodules, which is beneficial for analysis in nodule characteristics and forthcoming diagnosis. Manual segmentation by physicians is a time-consuming task, and as a result,

there is a need for automated segmentation methods. This not only reduces the reliance on expert diagnostic skills but also saves time. The proposed solution in the project revolves around using an efficient segmentation methodology, specifically U-Net architecture, to achieve accurate and automated thyroid nodule segmentation. Inherent characteristics of ultrasound images, such as attenuation, speckles, shadows, low contrast, and signal loss, makes the segmentation task more challenging to segment thyroid nodules from these images.

OBJECTIVES:

The main objective is:

1. The goal of thyroid nodule segmentation is to identify the boundaries, size, and volume of nodules within medical images.
2. The aim of this work is to categorize and review the thyroid nodule segmentation methods in medical ultrasound.
3. To improve the chance of survival by creating awareness among the people on types of nodules.
4. To lower thyroid cancer mortality by early identification of thyroid nodules and prevention of calcification.

1.2 PROBLEM STATEMENT

How it started?

- According to the statistics of 2018 global cancer worldwide, thyroid cancer ranked ninth in incidence and sixth in mortality (Bray et al., 2018). Although the majority of nodules are benign (noncancerous), there is a small percentage of them contains thyroid cancer, which is still curable if early diagnosed.
- So, it is necessary to know about the concept of thyroid nodules and its segmentation process.

2. LITERATURE SURVEY

2.1 Literature Survey

In the literature survey section, the paper provides an overview of the existing methods and techniques for Thyroid Nodule Segmentation . The early diagnosis of thyroid diseases is crucial for effective treatment, and the segmentation of thyroid nodules from ultrasound images plays a vital role in this process. In recent years, deep learning techniques have demonstrated remarkable success in medical image segmentation tasks.

1. Early Approaches to Thyroid Nodule Segmentation

Historically, thyroid nodule segmentation relied on traditional image processing techniques and manual interventions. These methods often struggled with noisy images and complex nodule shapes. Researchers started adopting machine learning techniques, such as thresholding and edge detection, to automate the process.

2. The Emergence of Convolutional Neural Networks (CNNs)

The advent of deep learning, particularly Convolutional Neural Networks (CNNs), revolutionized medical image segmentation. CNNs showed promise in handling complex and variable image characteristics, making them suitable for thyroid nodule segmentation.

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SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

1. Spiral Premise Work (RBF) Neural System: Utilizes a radial basis function (RBF) neural system to characterize thyroid nodules. The main area of interest is obtained using a specific region growing technique, and from this region, the thyroid volume is estimated.

2. Classification using CNN, KNN, and Bayesian: Proposes classification of thyroid nodules using k-nearest neighbors (CNN), support vector machines (KNN), and Bayesian classifiers. Provides information on segmentation and classification techniques for thyroid images.
3. Thyroid Projection Determination using KNN: Presents a based method to determine thyroid projections in thyroid ultrasound images. It includes contrast enhancement to suppress speckle noise.

Limitations of existing Methods:

Accuracy Limitations:

The methods may have limitations in accurately segmenting or classifying thyroid nodules, particularly in the presence of noise or variations in nodule characteristics.

Generalization Challenges:

These methods might not generalize well to different datasets or diverse clinical scenarios, limiting their broader applicability.

Task Specificity:

Some methods are designed for specific tasks, such as projection detection or classification, and may not address more comprehensive challenges like nodule segmentation.

Dependence on Specific Techniques:

The choice of specific classifiers or techniques in these methods can significantly impact their performance, making them sensitive to algorithm selection.

3.2 PROPOSED SYSTEM

Segmentation is one of the primary steps in identification of thyroid cancer, further U-Net has gained popularity due to its capability of analysing the biomedical image and promises better efficiency. However conventional U-Net architecture has several drawbacks. Main drawback is low resolution image information in designed feature maps, this directly effects the efficiency of the model. Other drawback is it is very difficult to optimize the pooling operations, hence to avoid such issue we developed Improvised U-net where apart from the conventional U-net two feature map are designed namely high level and low level which helps in avoiding the low resolution issue. In here at first we design the U Net which is biomedical architecture of convolution neural network; later two feature maps are designed

Advantages of Proposed System:

Robustness to Visual Variability:

SGU-Net's semantic guidance mechanism helps it maintain robustness in the presence of noisy pixels and variations in ultrasound image appearance.

Enhanced Feature Abstraction:

By abstracting features from a semantic perspective, U-Net can capture important nodule characteristics that might be challenging for traditional methods to extract.

Improved Accuracy:

The use of semantic guidance contributes to more accurate nodule representations,

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potentially leading to higher segmentation accuracy.

Evaluation on Challenging Dataset :

U-Net's performance is assessed on the Thyroid **ultrasound**, known for its challenging images with high noise and unclear nodule boundaries.

The fact that U-Net achieves promising results on this dataset demonstrates its effectiveness in handling real-world clinical scenarios.

SYSTEM REQUIREMENTS SPECIFICATION

REQUIREMENT ANALYSIS

The project involved analyzing the design of few applications so as to make the application more users friendly. To do so, it was really important to keep the navigations from one screen to the other

well ordered and at the same time reducing the amount of typing the user needs to do. In order to make the application more accessible, the browser version had to be chosen so that it is compatible with most of the Browsers.

4.1 FUNCTIONAL REQUIREMENTS

Functional requirement should include function performed by a specific screen outline work-flows performed by the system and other business or compliance requirement the system must meet. Functional requirements specify which output file should be produced from the given file they describe the relationship between the input and output of the system, for each functional requirement a detailed description of all data inputs and their source and the range of valid inputs must be specified. The functional specification describes what the system must do, how the system does it is described in the design specification. If a user requirement specification was written, all requirements outlined in the user requirements specifications should be addressed in the functional requirements.

4.4 SYSTEMS REQUIREMENT AND SPECIFICATION

Hardware Requirements:

- Processor : Intel i3 and above
- RAM : 4GB and Higher
- Hard Disk : 500GB: Minimum

Software Requirements:

- Programming Language/Platform : Python
- IDE : Visual Studio

SYSTEM DESIGN

5.1. INTRODUCTION

Software design sits at the technical kernel of the software engineering process and is applied regardless of the development paradigm and area of application. Design is the first step in the development phase for any engineered product or system. The designer’s goal is to produce a model or representation of an entity that will later be built. Beginning, once system requirement have been specified and analyzed, system design is the first of the three technical activities -design, code and test that is required to build and verify software.

The importance can be stated with a single word “Quality”. Design is the place where quality is fostered in software development. Design provides us with representations of software that can assess for quality. Design is the only way that we can accurately translate a customer’s view

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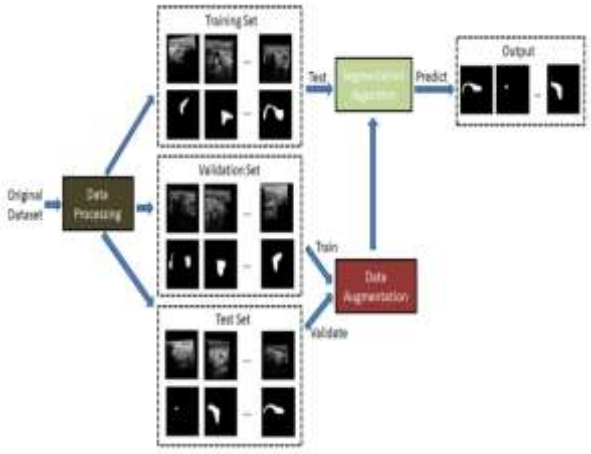
into a finished software product or system. Software design serves as a foundation for all the software engineering steps that follow. Without a strong design we risk building an unstable system – one that will be difficult to test, one whose quality cannot be assessed until the last stage. The purpose of the design phase is to plan a solution of the problem specified by the requirement document.

This phase is the first step in moving from the problem domain to the solution domain. In other words, starting with what is needed, design takes us toward how to satisfy the needs. The design of a system is perhaps the most critical factor affection the quality of the software; it has a major impact on the later phase, particularly testing,

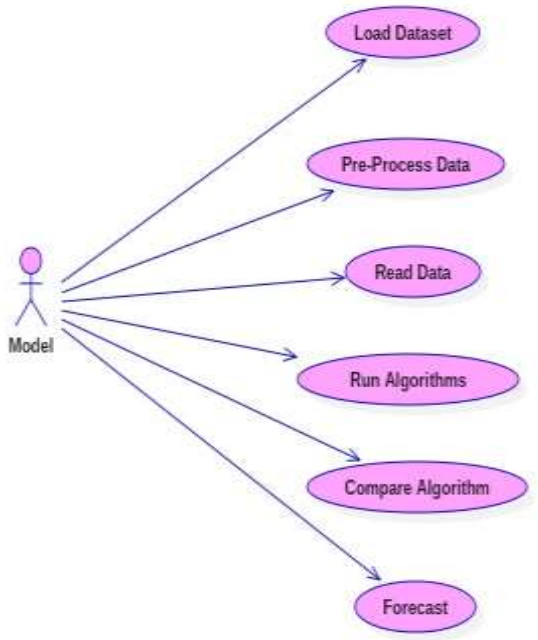
maintenance. The output of this phase is the design document. This document is similar to a blueprint for the solution and is used later during implementation, testing and maintenance. The design activity is often divided into two separate phases System Design and Detailed Design.

5.2 SYSTEM ARCHITECTURE



USE CASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.



CLASS DIAGRAM:

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

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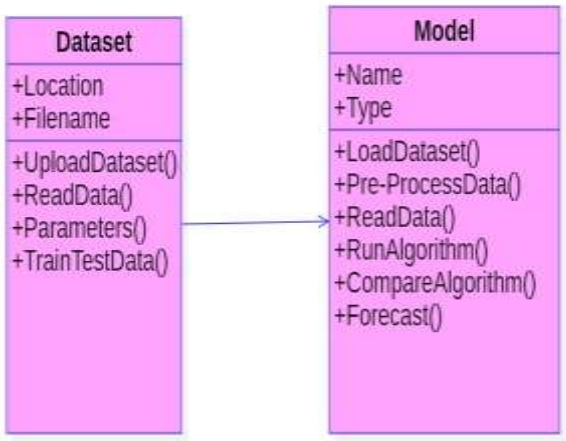

IMPLEMENTATION

6.1 MODULE & DESCRIPTION

MODULES

1. USER
2. SYSTEM
3. User Interaction

MODULES DESCRIPTION

User Functionality:

1. **Image Upload:** The user, has the capability to upload thyroid ultrasound images to the system. These images are crucial for the segmentation and analysis of thyroid nodules.

2. System Functionality:

1. The core functionality of the system is the Semantic Guided U-Net model, which has been developed for thyroid nodule segmentation.

2. The system takes in the uploaded thyroid ultrasound images and processes them through the U-Net model to perform the nodule segmentation task.
3. The system generates segmentation results based on the uploaded images.
4. These results outline the regions occupied by thyroid nodules within the ultrasound images.

3. **User Interaction:**

- The system may offer user-friendly interfaces for image upload, result visualization, and interaction with the segmentation process.
- It may also provide feedback to the user, such as segmentation accuracy metrics or visual overlays of segmented nodules on the original images.

6.4 RESULTS:

CONCLUSION

U-Net represents a significant advancement in the field of thyroid nodule segmentation. Its innovative use of

semantic guidance in combination with the U-Net architecture demonstrates its potential to address the challenges posed by noisy and complex ultrasound images. As deep learning techniques continue to evolve, U-Net offers promising prospects for improving the early diagnosis of thyroid diseases and enhancing patient care.

FUTURE WORK

Future research can explore the integration of multiple imaging modalities, such as ultrasound and computed tomography (CT) scans, to provide complementary information for more accurate nodule segmentation and characterization.

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