**COMSATS University Islamabad,   
Abbottabad Campus**

**Project Proposal   
(SCOPE DOCUMENT)**

**for**

**Liver Tumor Segmentation in CT Scan images Using Light Weight Deep Learning Model**  
Version 1.0

***By***

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**SCOPE DOCUMENT REVSION HISTORY**

**Supervisor Signature**

**Date:**

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**Project Category: (**Select all the major domains of proposed project**)**

* **A-**Desktop Application/Information System **B-**Web Application/Web Application based Information System **C-** Problem Solving and Artificial Intelligence ** D-**Simulation and Modeling ** E-** Smartphone Application ** F-** Smartphone Game ** G-** Networks ** H-** Image Processing****Other (specify category) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This research aims to improve liver cancer diagnosis through automated segmentation of Liver and tumor in 3D CT images using the nnFormer architecture. By integrating convolutional layers with attention mechanisms and processing images as smaller patches, we expect to enhance the accuracy and reduce the computational complexity.

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# Introduction

Liver cancer is the most common cause of death all around the world, past statistics shows that over 800,000 deaths have been caused by liver cancer [1, 2]. This is a serious threat to public health, which increases the demand for liver cancer diagnosis. This process of liver cancer diagnosis involves the accurate prediction of the tumor from the CT (Computed Tomography) images, which provides the facilitation of liver cancer treatment [4, 5].

However, manually diagnosing the liver tumor requires physician’s experience and is also a time-consuming process. It is also a challenge to figure out the sharpness of the edges of the liver with naked eyes. This emerges the demand of automating the liver tumor segmentation process [15].

The automation process of liver tumor segmentation brings along several challenges. 1) The shape of liver is affected by the presence of neighbouring organs, as the liver is a soft tissue. 2) Visualization is quite difficult because of the blurred boundaries with neighbouring organs, especially with organs such as spleen or stomach. 3) Diagnostics of lesion can affect shape and appearance of the liver [10]. To overcome the problems, we propose an automatic Liver Tumor Segmentation in CT image.

Our task is to segment the Liver from the CT scans and then segment the tumor out of the Liver segment. We propose liver tumor segmentation using nnFormer Architecture [12]. nnFormer Architecture uses a hybrid stem where convolution layer and self-attention are interlinked to exploit their ability. A light-weight convolutional embedding layer is put ahead of transformer blocks which extracts features whereas the transformer encodes the global context, with convolutional layer we encode pixel-level spatial information, more precisely compared to patch based positional encoding. This architecture also uses small kernel sizes for the convolutional layer to reduce computational complexity [12].

# Problem Statement

Medical image segmentation plays an important role in accurately diagnosing and treating liver diseases. Traditional methods, like CNNs (Convolutional Neural Networks), mostly struggle in capturing detailed information within 3D medical images because they rely on local features [12]. Other methods like TransUNet (Transformer UNet), which is a hybrid CNN-Transformer architecture to gain both high-resolution spatial information from the extracted features using CNN, and the global context encoded by Transformers [13]. TransUNet relies on CNNs, which means that the benefits of transformers are not fully exploited, the model also uses one or two layers of transformers which are not enough to capture long-range dependencies. Researchers started using transformers as the main stem for medical image segmentation. SwinUNet improves upon TransUNet by using transformers as the main part of its architecture, Swin-UNet is the first transformer based UNet model for 2D medical image segmentation. It splits input images into patches, treating each patch like a “token”. These tokens are passed through an encoder to learn features, and then a decoder up-samples to restore the image resolution and predict the segmentation [14, 12]. However, they did not appropriately combine convolution and self-attention which can improve this task [12].

# Problem Solution for Proposed System

The nnFormer model overcomes these challenges by using a hybrid approach that interlinks convolution and transformer operations. This model effectively captures both local and global information, leading to improved segmentation results. it uses two types of attention mechanisms, Local Volume-based Multi-head Self-attention (LV-MSA) and Global volume-based Multi-head Self-attention (GV-MSA) to create feature layers that help represent liver tissues in much more detail [12].

This research aims to implement nnFormer for liver tumor segmentation in 3D medical images using Lits17 database, with the intention of comparing its performance against existing architectures like CNN based UNet, TransUNet, and SwinUNet. The goal is to demonstrate that nnFormer achieves better segmentation accuracy to contribute to better diagnostic decisions in Liver disease cases [12].

# Scope

This research focuses on developing an automated liver and tumor segmentation using the nnFormer architecture to improve diagnostic accuracy for liver cancer. The system will process 3D CT images converted to 2D slices from Lits17 database, segmenting the liver and any tumors within it. By using nnFormer architecture’s, hybrid approach—combining convolutional layers and transformer-based-self-attention mechanisms—this study aims to overcome current challenges in accurately detecting liver tumors, such as blurred boundaries and complex shapes. The performance of nnFormer will be compared with existing models, including CNN-based UNet, TransUNet, and SwinUNet, to ensure its effectiveness in liver tumor segmentation.

# Modules

Write down the modules of the proposed project. Don’t forget to mention special/new features. Briefly explain your one module in 6 to 8 sentences.

(Note: Usually 5-6 Modules for 2 student’s projects and 8-9 modules for 3 student’s project)

**Explanation of a Module:** Module is a section of a program that performs a task. Programs consist of [modules](http://www.webopedia.com/TERM/M/module.html), each of which contains one or more routines. The term routine is synonymous with procedure, function, and subroutine.

Example:

*Enterprise resource planning (ERP) software - is comprised of several large modules (for example, finance, supply chain and payroll, etc.), which may be implemented with little or no customization.*

(Briefly explain each module with respect to major functionality in user context)

Module 1: **Module Name**

Module 2: **Module Name**

# System Limitations/Constraints

1. **Limited Computational Resources for 3D Processing:** While 3D CT images provide valuable depth and detail for liver tumor segmentation, processing them requires high computational power and memory. Due to limited resources, the system converts 3D CT images into 2D slices, which may lead to a loss of depth information, impacting segmentation accuracy.

# Software Process Methodology

Write down your software methodology/ software process that will be used for project development. .Also mention why you have chosen this methodology. (Usually 3-5 sentences)

1. You can use Object Oriented Methodology, or Procedural methodology.
2. Choice of methodology will affect choice of tools and technologies
3. Choice of methodology will affect nature of design (SDS)
4. Choice should be made depending on your expertise and your needs e.g. most simulation and device level software can only be programmed in procedural languages.

# Tools and Technologies

|  |  |  |  |
| --- | --- | --- | --- |
| **Tools**  **And**  **Technologies** | **Tools** | **Version** | **Rationale** |
| Python | 3.12.4 | IDE |
| PyTorch | 2015 | DBMS |
| Adobe Photoshop | CSC 6 | Design Work |
| MS Word | 2015 | Documentation |
| MS Power Point | 2015 | Presentation |
| Pencil | 2.0.5 | Mockups Creation |
| **Technology** | **Version** | **Rationale** |
| C# | 6.0 | Programming language |
| SQL | 2013 | Query Language |
| Html | 5 | Web Development |
|  |  |  |

**Table 2Tools and Technologies for Proposed Project**

# Project Stakeholders and Roles

Write down the project stakeholders and their roles.

**Table 3Project Stakeholders for Proposed Project**

|  |  |
| --- | --- |
| **Project Sponsor** | All web applications and desktop applications should have real client. Mention your project sponsor.  Default option will be: COMSATS University, Islamabad |
| **Stakeholder** | Mention your stake holders with their roles and responsibilities.  Default option will be:   * Students names * Project Supervisor Name: Mr./Miss … * Final Year Project Committee: Evaluation of project |

# Team Members Individual Tasks/Work Division

**Table 4Team Member Work Division for Proposed Project**

|  |  |  |
| --- | --- | --- |
| **Student Name** | **Student Registration Number** | **Responsibility/ Modules** |
| Student 1 Name | Student 1 Registration Number | Describe the work division of each  student along with modules  E.g.  Mr. Ali (Module1-Module3)  Augmented reality and Databases tasks. |

# Data Gathering Approach

Write down information and requirement gathering approaches for proposed project e.g. Interview, Questionnaire etc. (Usually 3-5 sentences)

# Concepts

Mention the concepts that you will learn while doing the proposed project.

For example: Augmented Reality, Virtual Reality, Algorithms, API’’s Code injection, Closures, VI technique etc.

Not more than 4 sentences for one concept. (Usually 3-5 concepts are briefly mentioned)

Example:

*Concept-1: Concept Name E.g. Augmented Reality (Briefly give the overview of concept with respect to your project)*

# Gantt chart

Create the Grant Chart and provide estimated start and end dates of all proposed modules/tasks for each team member. Also identify the dependencies (which tasks cannot be started/completed, until the dependent task is completed). Gantt chart can be created using MS Project.

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Figure 1Sample Gantt chart

# Mockups

Insert minimum mockups (Usually 4-6 mockups) which show the major modules mentioned in the scope section of the document. Do not include mockups for Login, Signup, Forgot Password, Contact Us, About Us etc. If the project is a Web or a Smartphone Application, then include at-least three mockups from each part of the project. You can design mockup in any design tool for example pencil tool (<https://pencil.evolus.vn/>) or Balsamiq (<https://balsamiq.com/>)





# Conclusion

Conclude this document. (Usually 4-5 sentences)

# References

Mention the books, research papers, web links etc.

# Plagiarism Report

Attach the Plagiarism report of your project scope document from library staff of turnitin tool (http://turnitin.com